CMD 25-H9 CNSC Staff Submission

Reference Package for CMD 25-H9 CNSC Staff Submission on Denison Mines Licence Application to Prepare Site and Construct the Wheeler River Project

Classification	Unclassified
Type of CMD	References
CMD Number	25-H9 (Volume 2)
Original CMD	25-H9
Public hearing date	8 October 2025
PDF e-DOC #	7562400
Summary	This supplemental CMD includes all publicly available documents referenced in CNSC staff CMD 25-H9.
Actions required	There are no actions requested of the Commission. This CMD is in support of the actions and recommendations set out in CNSC staff CMD 25-H9

CMD 25-H9 – Soumission par le personnel de la CCSN

Références liées au CMD 25-H9 Soumission par le personnel de la CCSN la demande de Denison Mines visant à prépare le site du projet de Wheeler River et à entamer les activités de construction

Classification	NON CLASSIFIÉ
Type de CMD	Références
Numéro de CMD	25-H9 (Volume 2)
CMD Original	25-H9
Date de l'audience	8 octobre 2025
Numéro e-Doc du PDF	7562400
Résumé	Ce CMD supplémentaire comprend tous les documents accessibles au public mentionnés dans le CMD 25-H9 du personnel de la CCSN. Les documents
Mesures requises	Aucune mesure n'est requise de la Commission. Le présent CMD appuie les mesures et les recommandations énoncées dans le CMD 25-H9 du personnel de la CCSN.

Denison Mines

Wheeler River Project

Final Environmental Impact Statement

November 2024

Powering
PEOPLE, PARTNERSHIPS
AND PASSION.

Wheeler River Project

Final Environmental Impact Statement

Section 1 – Project Introduction and Overview

November 2024

Denison Mines

Denison Mines Corp.

345 4th Avenue South

Saskatoon, SK, S7K 1N3

Roadmap

This roadmap of the Wheeler River Project Environmental Impact Statement (EIS) has been provided to summarize the main document sections and appendices of the EIS.

Wheeler River Project
Environmental Impact Statement

Executive Summary

Part I: Introduction and Context	Part II: Biophysical Environmental Assessments	Part III: Human Environment Assessments	Part IV: Integrated Topics and Summary
Section 1: Project Introduction and Overview	Section 6: Atmospheric and Acoustic Environment	Section 10: Human Health	Section 14: Accidents and Malfunctions
Section 2: Project Description	Section 7: Geology and Groundwater	Section 11: Land and Resource Use	Section 15: Effects of the Environment on the Project
Section 3: Indigenous and Local Knowledge	Section 8: Aquatic Environment	Section 12: Quality of Life	Section 16: Assessment Summary and Conclusions
Section 4: Engagement	Section 9: Terrestrial Environment	Section 13: Economics	
Section 5: Approach and Methodology of the Assessment			

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Abbreviations, Acronyms, and Units

Abbreviation / Acronym	Definition
CA	Chartered accountant
CCME	Canadian Environmental Assessment Agency
CEO	Chief Executive Officer
CNSC	Canadian Nuclear Safety Commission
CO_2	carbon dioxide
CPA	Chartered Professional Accountant
CSA	Canadian Standards Association
CSR	Corporate Social Responsibility
Denison	Denison Mines Corp.
EA	Environmental assessment
EIS	Environmental Impact Statement
GHG	greenhouse gas
IAEA	International Atomic Energy Agency
IFRS	International Financial Reporting Standards
ISR	In situ recovery
MIT	Massachusetts Institute of Technology
Project	Wheeler River Project
PwC LLP	Pricewaterhouse Coopers Limited Liability Partnership
U_3O_8	Triuranium octoxide
UTM	Universal Transverse Mercator

Units	Definition
°C	degrees Celsius
%	percent
cm	centimetre
CO_2e/KWh	Carbon dioxide equivalent per kilowatt-hour
GWe	gigawatt electrical
ha	hectare
km	kilometre
km^2	square kilometre
lbs	pounds
m	metre
mm	millimetre
MWe	megawatt electric

Glossary

Term	Definition
Concordance table	A table that summarizes where requirements are met within the Environmental Impact Statement.
Environmental Assessment	An assessment of potential environmental consequences of a project. The environmental assessment considers the existing environment where the Project is to be located (including, but not limited to, Indigenous and Local Knowledge), predicts potential effects to valued components of the environment, identifies mitigation measures used to limit the effects of the project on the local environment, classifies potential effects remaining after mitigation, and describes monitoring and follow-up programs.
Environmental Impact Statement	A document that contains the environmental assessment for a project, and can also include details on the project description, engagement, mitigation measures, residual and cumulative effects, accidents and malfunctions, and effects of the environment on the project.
Greenhouse gas	A gas in the Earth's atmosphere that absorbs and emits infrared radiation. The most common examples include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).
In situ recovery	A mining method that uses a water-based solution, fortified with mining reagents, to dissolve naturally occurring uranium from within a host rock, while the host rock remains in place (in-situ) below surface.

1 Project Introduction and Overview

The Wheeler River Project (the Project) is a proposed in situ recovery (ISR) uranium mine and processing plant in northern Saskatchewan, Canada (Figure 1-1). It is located in Saskatchewan's Athabasca Basin approximately 4 km west of Highway 914 (Figure 1-2). The approximate UTM coordinates of the property are 477,000E and 6,374,000N (NAD83, Zone 13). The Project is a joint venture between Denison Mines Corp. (Denison; 90%) and JCU (Canada) Exploration Company Ltd. (JCU; 10%). Denison is also a 50% owner of JCU, which means that Denison has an effective 95% ownership interest in the Project.

The Project falls within the boundaries of Treaty 10, the Nuhtsiye-kwi Benéne (Ancestral Lands) of English River First Nation, the traditional territory of the Kineepik Métis Local #9, the homeland of the Métis, and the Nuhenéné, the traditional territory of the Athabasca Denesųłiné. The Project is also located within the Northern Saskatchewan Administration District (Figure 1-3; Figure 1-4). The Northern Saskatchewan Administration District includes approximately 250,000 km^2 (44% of Saskatchewan's land area) and is home to approximately 36,000 people (3.2% of Saskatchewan's population; Statistics Canada 2022).

Figure 1-1: Wheeler River Project Location in Canada

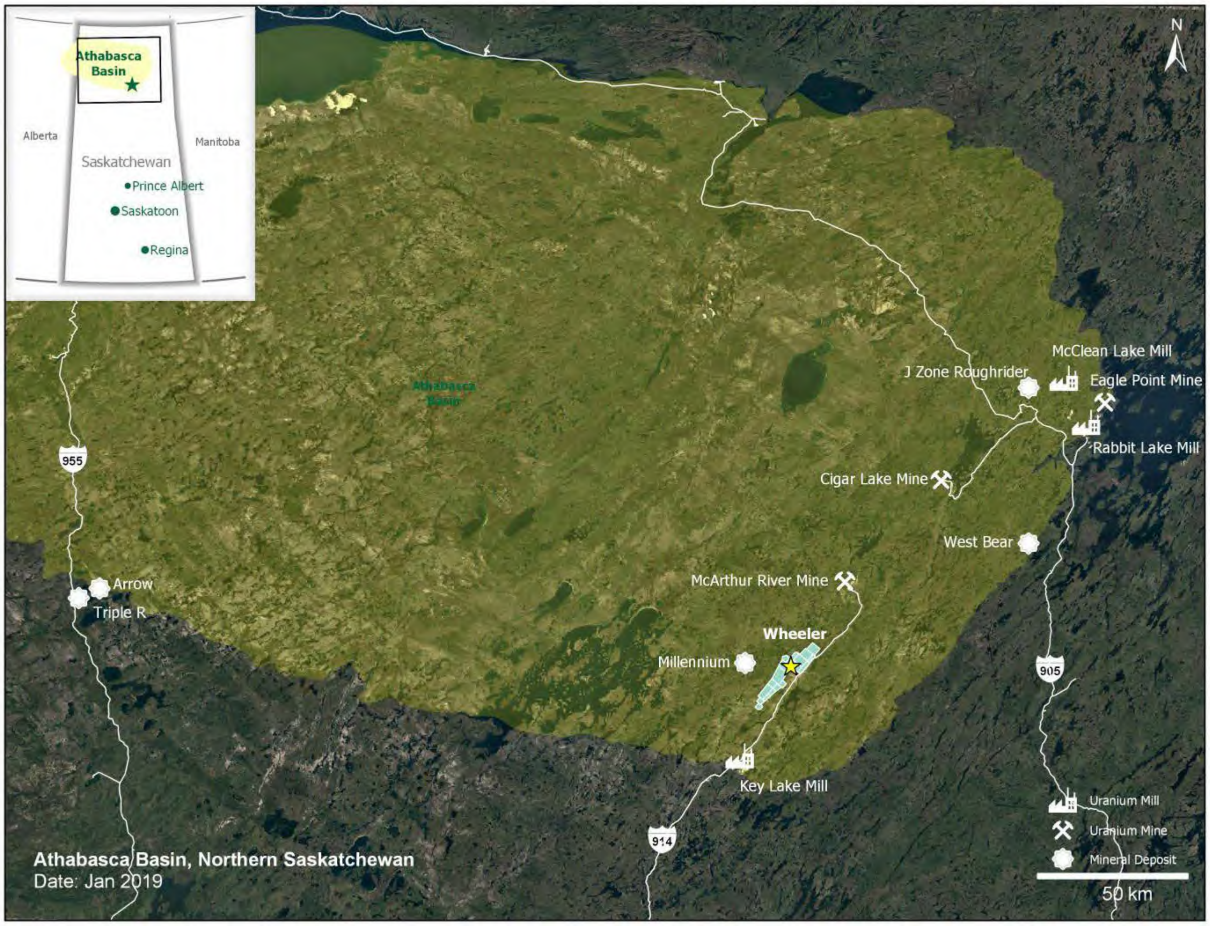


Figure 1-2: Wheeler River Project Location in the Athabasca Basin

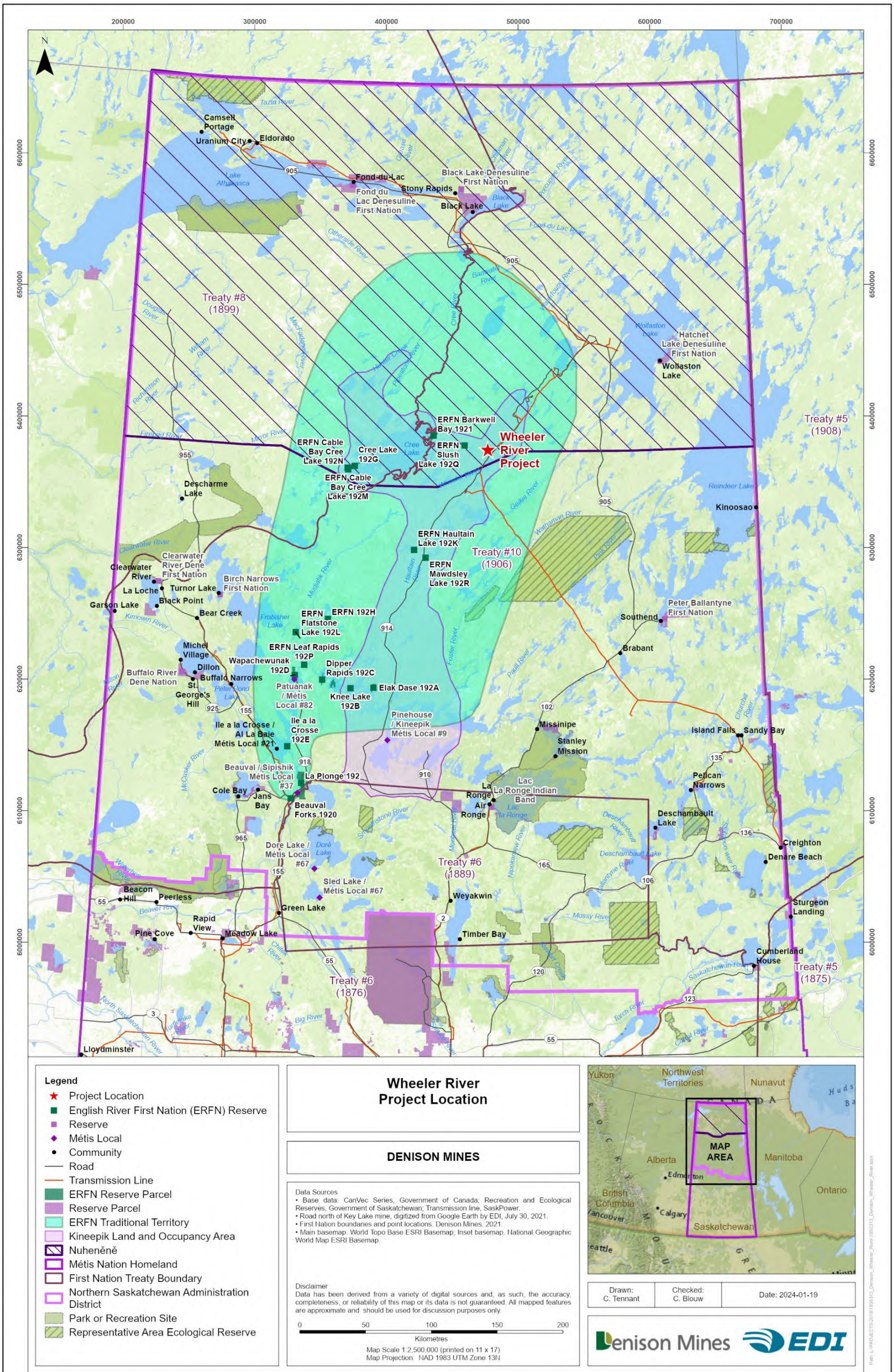


Figure 1-3: Wheeler River Project in Relation to Traditional Territories

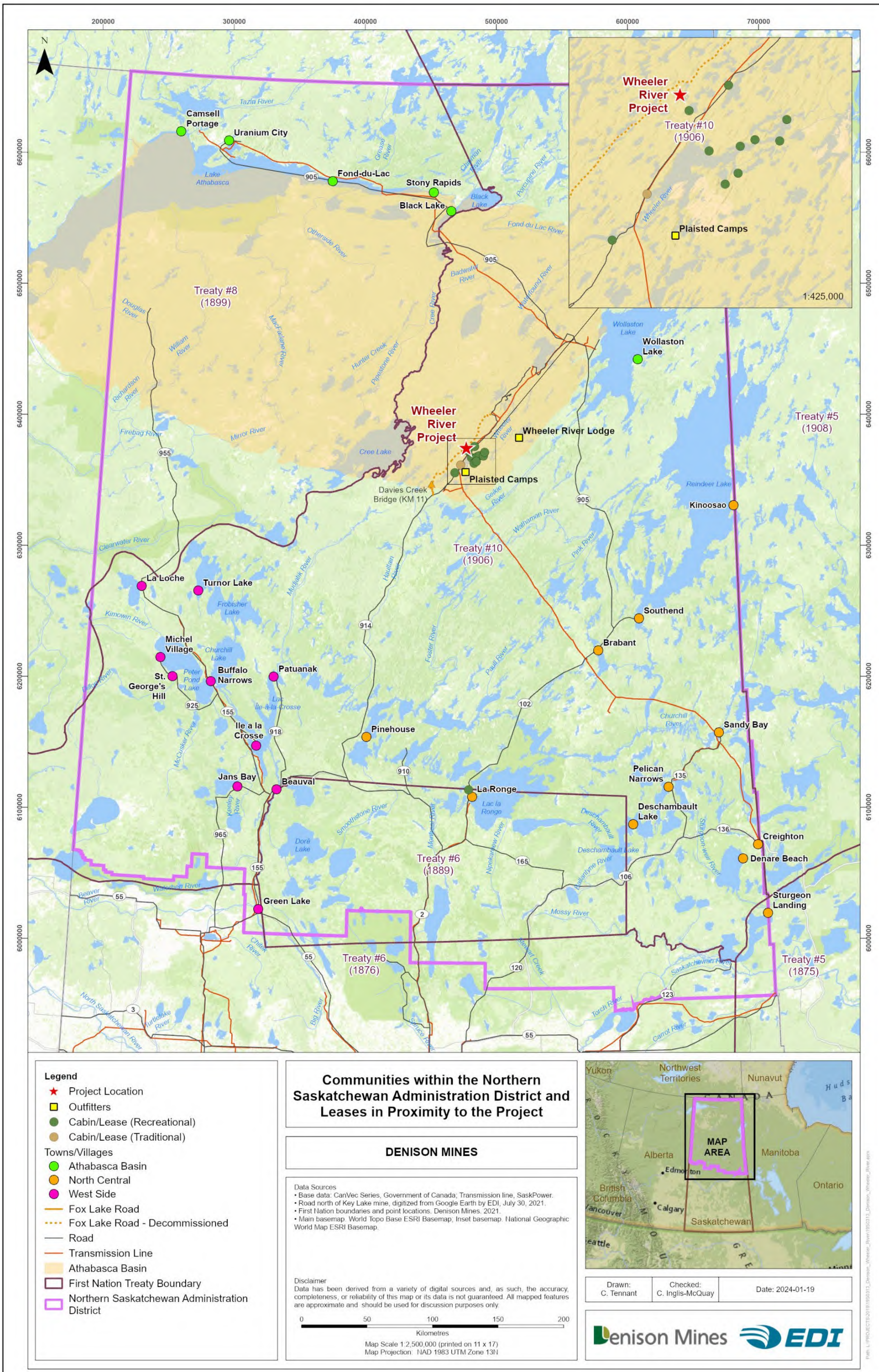


Figure 1-4: Communities within the Northern Saskatchewan Administration District and Leases in Proximity to the Project

No communities are located within the immediate proximity of the Wheeler River property (Figure 1-3 and Figure 1-4). Travelling by existing roads, the closest community to the Project is approximately 260 km away. Calculated using a straight line, the closest communities are approximately 150 km from the site and Saskatoon is 600 km south. The federal lands within a 100 km radius of the Wheeler River property are First Nation reserve land without permanent residences (Figure 1-3 and Table 1-1).

Table 1-1: Federal Lands in Proximity to the Project

Federal Land Type	Name	Distance from Project (km)
First Nation	English River First Nation Slush Lake Reserve No. 192Q	16
First Nation	English River Barkwell Bay Indian Reserve 192I	39
First Nation	English River First Nation Mawdsley Lake Reserve No. 192R	91
First Nation	English River Haultain Lake Indian Reserve 192K	94
First Nation	Cree Lake Indian Reserve 192G	98

The Project is located mid way between Cameco Corporation's Key Lake Operation (a uranium mill) and McArthur River Operation (a uranium mine; Figure 1-2). Ground access to the Project is along Highway 914. Access to the highway north of the Key Lake Operation is controlled at the Cameco Key Lake Operation gatehouse. Existing infrastructure in the area includes Highway 914, the provincial power line adjacent to the highway, and infrastructure for the Key Lake Operation and McArthur River Operation (Figure 1-2). Existing disturbances in the area are mainly from exploration activities, such as line cutting, drilling, and access routes (Section 1.1.2).

The main land use activities in the area by Indigenous and other land users are hunting, trapping, and fishing. There are recreational and traditional resource user leases nearby (Figure 1-4). The closest recreational lease is located approximately 2.5 km away. The closest traditional resource user lease is located approximately 12 km away.

The climate of the Project area is typical of the continental sub-arctic region of Canada and is characterized by extremely cold, dry winters and short summers. The Project's position near the centre of the continent, a relatively high latitude, and great distance from the moist and moderating influence of oceans results in temperatures that varying greatly between seasons. Daily mean temperatures are typically below freezing from January to April and again from October to December; temperature extremes in a year can range from -50°C to +35°C. The area is relatively dry with most of the annual precipitation falling in June, July, and August. During winter the snowpack is typically less than 1 m.

The Project is located in the Boreal Shield Ecozone and, more specifically, in the Wheeler River Upland Landscape Area of the Athabasca Plain Ecoregion (McLaughlan et al. 2010; Figure 1-5).

Topography is more subdued (low relief) in this ecoregion than elsewhere in the Canadian Shield due to flat-lying sandstone and almost continuous cover of sandy glacial deposits.

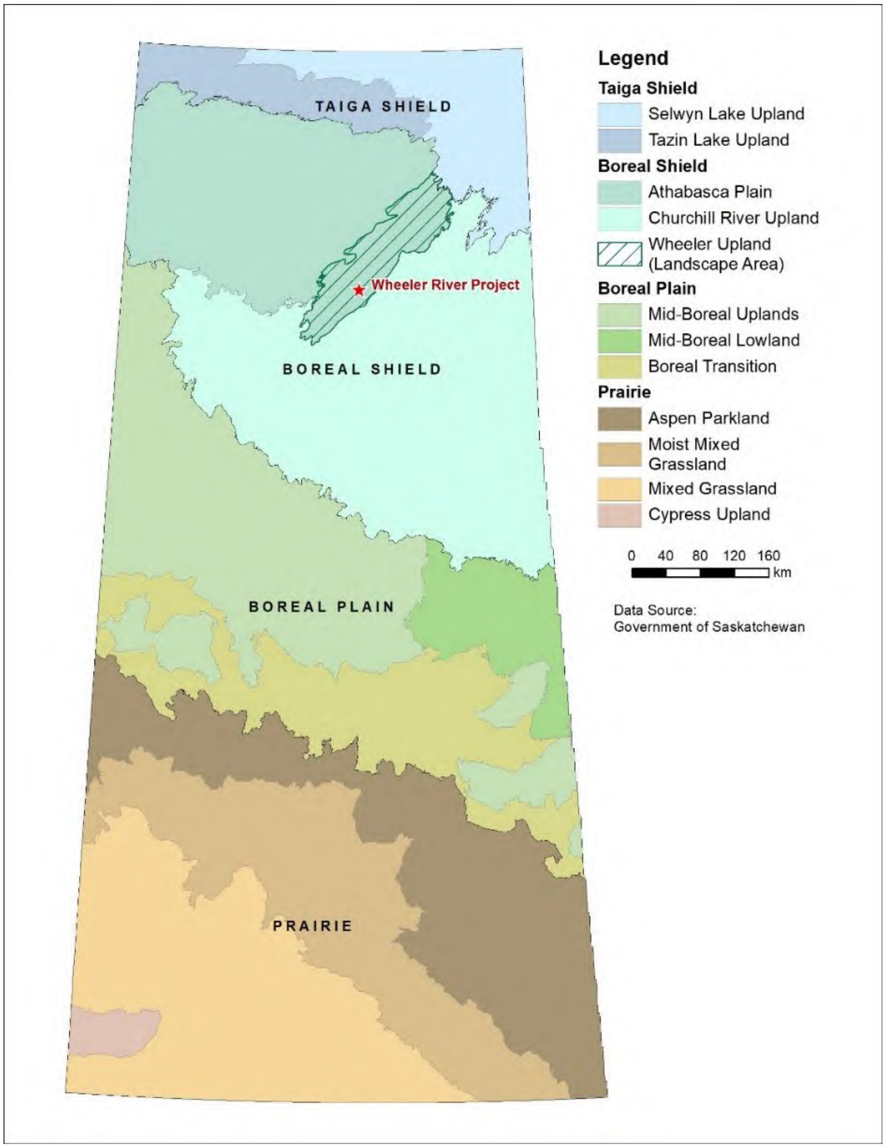
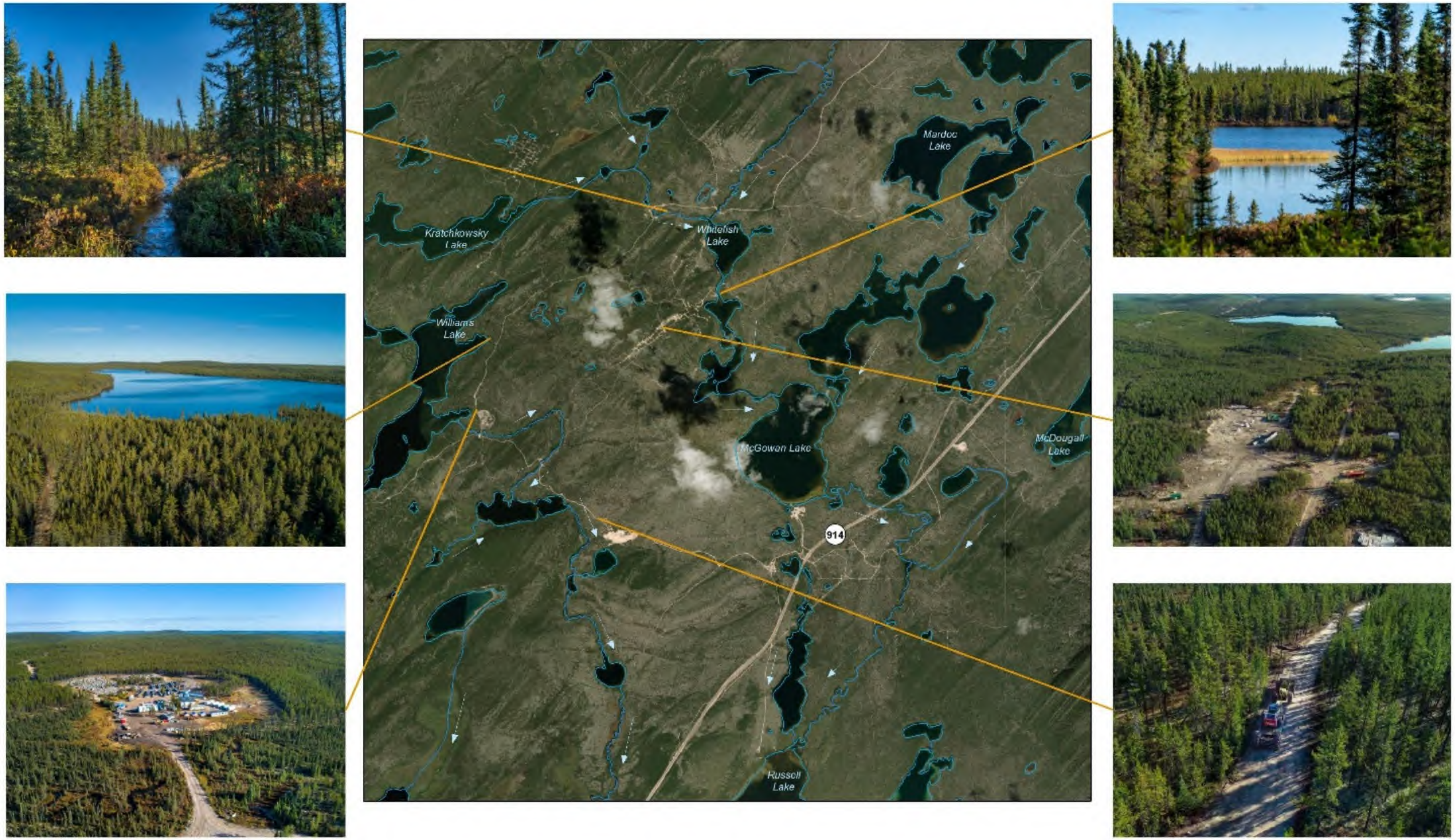


Figure 1-5: Project Location in the Boreal Shield Ecozone

Open stands of jack pine and jack pine-black spruce forests dominate the drier upland areas with a thin ground cover of lichen and blueberry. Black spruce, and less commonly tamarack, are the dominant forest types in wetter lowland areas, including bogs and fens, where Labrador tea is a common ground cover. White spruce, aspen, balsam poplar, birch, and willow are less common. The Boreal Shield Ecozone experiences a largely natural fire regime that results in the most area burned per unit area and the highest proportion of very large fires (more than 50,000 ha) in the province (Parisien et al. 2004). Much of the vegetation in the area is in various stages of post-fire regeneration. Examples of terrestrial animals in the area include moose, woodland caribou, grey wolf, mink, marten, snowshoe hare, black bear, fox, and a variety of migratory and year-round resident birds such as ducks, grouse, songbirds, and raptors. Numerous lakes and streams are present in the Boreal Shield Ecozone. Water in the Project Area drains towards Russell Lake, the Wheeler River, and ultimately into Wollaston Lake (via the Geikie River). Examples of fish in the area include spottail shiner, slimy sculpin, white sucker, northern pike, lake whitefish, and walleye.

Figure 1-6 provides an overview of the current site conditions and the typical landscape near the Project.



Note: Clockwise from top right the photos taken in 2021 show: Whitefish Lake, the Phoenix deposit (with Whitefish Lake visible in the background), a section of the existing exploration access road, exploration camp facility, Williams Lake, and Kratchkowsky Creek flowing from Kratchkowsky Lake to Whitefish Lake.

Figure 1-6: Landscape Features and Current Site Conditions near the Project

1.1 Site History

The Wheeler River property was staked on July 6, 1977. Excluding the years 1990 to 1994, exploration activities, such as airborne and ground geophysical surveys, geochemical surveys, prospecting, and diamond drilling, have been carried out on the property from 1978 to present. Denison became the operator of the property in November 2004 and carried out property-wide airborne geophysical surveys in 2005. The Phoenix deposit was discovered by diamond drilling in 2008 with subsequent delineation completed over the next six years from 2008 to 2014.

1.1.1 Deposit and Geology

The Wheeler River property is located within the eastern margin of the Athabasca Basin of northern Saskatchewan and is host to the Phoenix and Gryphon uranium deposits. The Phoenix deposit is amenable to ISR mining and is the primary source of uranium expected to be mined by the ISR mining method, as evaluated in this Environmental Impact Statement (EIS). The Gryphon deposit is not amenable to ISR mining and, accordingly, is not included in the EIS evaluation. Like many other uranium deposits on the eastern portion of the Athabasca Basin (described in Jefferson et al. 2007), the Phoenix deposit is located at the base of the sandstones, just above the major unconformity that separates the sandstones and the underlying basement rock. This unconformity represents the period when the basement rock was exposed and subject to extensive weathering and erosion.

The Phoenix deposit is overlain and underlain by a natural barrier that has limited the release or movement of uranium and other chemicals associated with the mineralization in the deposit, outside of the ore body itself.

The Phoenix deposit is geologically situated at or above the unconformity between the Athabasca Basin sandstone and older basement rocks, approximately 400 m below the surface (Figure 1.1-1). To date, the Phoenix deposit has been estimated to contain a total of 70.2 million pounds of triuranium octoxide (U_3O_8) in indicated mineral resources, based on 166,400 tonnes of ore at an average grade of 19.14% U_3O_8. Globally, the Phoenix deposit ranks as the highest-grade undeveloped uranium deposit that has estimated resources over 50 million pounds U_3O_8.

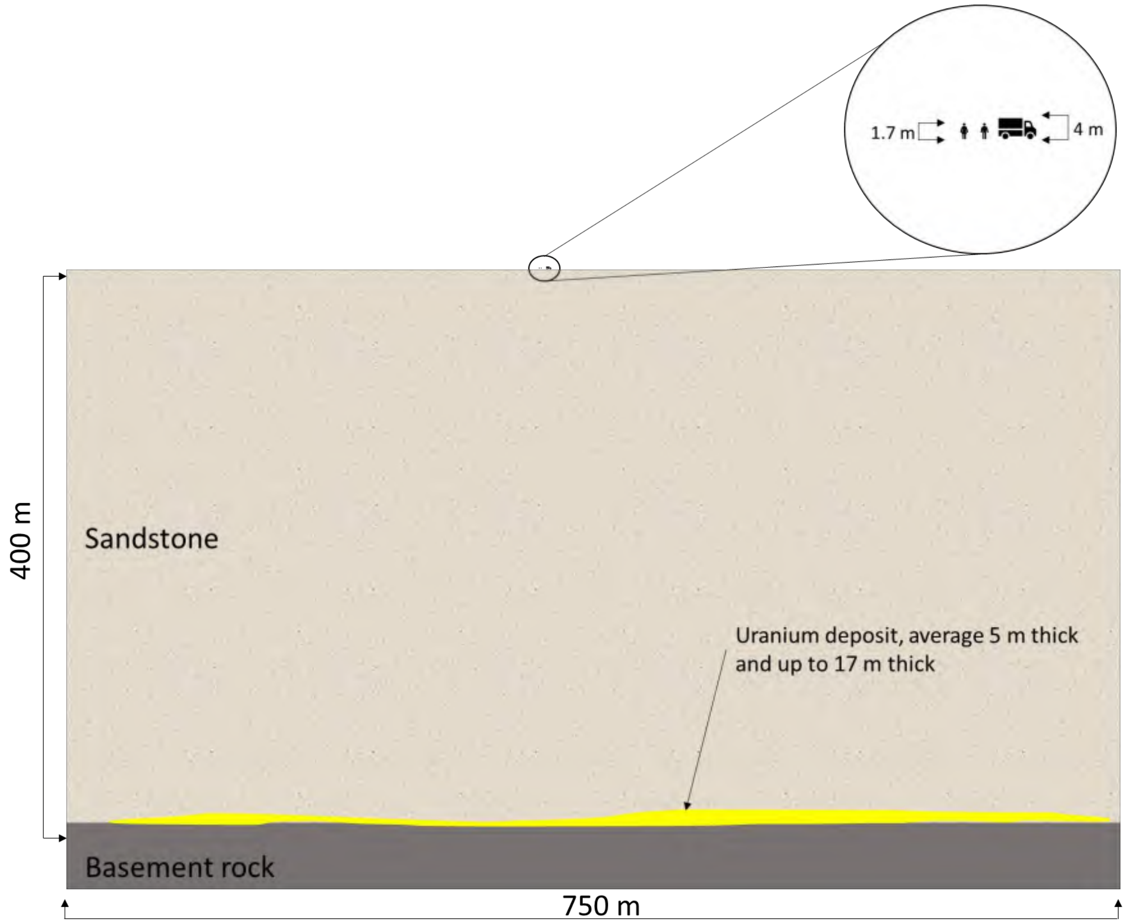


Figure 1.1-1: Uranium Deposit in Relation to People and Vehicles on the Surface

1.1.2 Current Site Conditions

Exploration field operations are currently conducted from Denison's on-site camp facilities, which are located approximately 3 km southwest of the Phoenix deposit. The camp provides accommodations for field staff using ATCO trailer units and tent facilities (Figure 1-6). Fuel and miscellaneous supplies are stored in existing warehouse and tank facilities at the camp. Drill core from exploration activities is also stored on site. The exploration site currently generates its own power by diesel generator. The camp and its activities are permitted through the Saskatchewan Ministry of Environment.

Denison maintains portions of the site roads (Figure 1-6) necessary to gain access to the camp facilities and to complete field activities. Maintenance includes installation of temporary water crossings (bridges) and general road maintenance to facilitate safe travel by either four-wheel-drive vehicle or all-terrain vehicle. In addition, several gravel and sand roads and drill trails provide access by either four-wheel-drive vehicle or all-terrain vehicle to the rest of the property. These roads are maintained only as necessary.

Outside of the Phoenix deposit (Figure 1-6) and exploration camp facility, various surface disturbances have occurred since commencement of exploration activities in 1978. Several ground geophysical survey grid lines transect the property uniformly, and approximately 750 exploration pads were cleared to accommodate diamond drill hole exploration programs. As a result of exploration activities, some areas of the property have been previously disturbed via vegetation removal to allow for access trails and drilling areas. Refer to Figure 1-6 for an overview of location the exploration camp and Phoenix deposit, along with other photos of the surrounding area.

1.2 Project Proponent

Denison is the operator of the Project and, as such, the proponent in all regulatory matters.

Denison is a publicly traded uranium exploration and development company with interests focused in the Athabasca Basin region of northern Saskatchewan. The company trades on the Toronto Stock Exchange and NYSE American exchange and is headquartered in Toronto, Ontario, with offices in Saskatoon, Saskatchewan, and Elliot Lake, Ontario.

1.2.1 History of Uranium Mining

Denison has a long legacy of uranium mining, with over 50 years of uranium mining experience (including predecessor companies) in Ontario, Saskatchewan, and the United States. In addition to an effective 95% ownership in the Project, Denison is part owner (22.5%) of the McClean Lake Joint Venture, which includes the operating McClean Lake uranium mill in northern Saskatchewan, and provides expert mine decommissioning and environmental services through its Closed Mines group.

Denison's history of uranium mining and unique expertise in the specialized sectors of uranium mine decommissioning and exploration, as well as its active involvement in the uranium sales and marketing business through its previous management of Uranium Participation Corporation (now the Sprott Physical Uranium Trust), have uniquely prepared the company to be a qualified proponent to develop and operate the Project.

Denison currently holds licences with the Canadian Nuclear Safety Commission (CNSC) for its decommissioned uranium mine sites in the Elliot Lake region, and for the areas within the Wheeler River Property as part of feasibility field testing (Federal Nuclear Substance and Radiation Device Licence). Additionally, Denison holds a permit to Operate a Pollutant Control Facility with the Province of Saskatchewan in connection with the feasibility field testing at Wheeler River. Denison's performance under its licences and permits exemplifies the company's commitment to the operation of its facilities in a manner that prioritizes safety, environmental protection, and sustainable development.

1.2.2 Governance Structure

As a TSX and NYSE American publicly listed company, Denison has developed a culture of rigorous governance and controls, which ensure that the Company's actions are properly deliberated, planned, implemented, and evaluated. Ultimate responsibility for the company's actions rests with Denison's Board of Directors, which is comprised of eight highly qualified professionals with varied experience and expertise in the fields of mine engineering, health and safety, sustainability, corporate securities law, finance, human resources, corporate commercial law, nuclear energy, and uranium marketing.

Board composition is regularly monitored by Denison's corporate governance and nominating committee to ensure that the Board is properly able to provide oversight of the company's management. A Technical Committee of the Board of Directors provides technical oversight for the advancement of Denison's projects and is comprised of Mr. Ron Hochstein (Chief Executive Officer [CEO] of Lundin Gold Inc. and previous Chief Operating Officer and CEO of Denison while the company operated the White Mesa Mill in Utah) and Mr. David Neuburger (previous Vice President, Mining Division for Cameco Corporation and past President of the Saskatchewan Mining Association). Mr. Hochstein and Mr. Neuburger are both Professional Engineers. Similarly, Denison's Audit Committee provides financial oversight and is chaired by Patricia Volker, an experienced Chartered Professional Accountant (CPA) and chartered accountant (CA), that has previously served as the Director of Standards Enforcement and the Director of Public Accounting for CPA Ontario, the self-regulating body for Ontario's CPAs.

The Board places a high value on the environment, corporate social responsibility, sustainability, and governance, recognizing the importance of understanding the impact of Denison's strategies and how such understanding can contribute to the long-term sustainability of the corporation's business, help identify and manage risk, and lead to transformative opportunities. Denison has completed a comprehensive Environment, Social and Governance report for 2021 (Denison 2022), which exemplifies the company's commitment to these business critical considerations. Additionally, Denison has adopted an industry-leading Indigenous Peoples Policy (Denison 2021), which recognizes the critical necessity of advancing reconciliation with Indigenous peoples in Canada and the important role of Canadian business in the reconciliation process.

Denison's President and CEO, Mr. David Cates, is responsible for oversight of the company's day-to-day operations consistent with the company's guiding policies and for facilitating reporting and engagement between management and the Board of Directors. Mr. Cates is a CPA and CA and holds a Master of Accounting degree from the University of Waterloo. Mr. Cates has extensive expertise in the Canadian and international uranium mining industry from nearly two decades of senior management and financial experience, and serves as a director on the board and executive committee (Finance Chair) of the Canadian Nuclear Association.

1.2.3 Management Structure

Denison’s current management structure is comprised of an executive leadership team and a management team, illustrated in the following organizational chart (Figure 1.2-1). The executive team provides overall direction on projects and expenditures to meet operational objectives. The management team executes operational directives set by the executive team. Ultimately, the collective team is governed by Denison’s Board of Directors.

David Cates – President and Chief Executive Officer

Mr. Cates is a CPA and CA and holds a Master of Accounting and Honours Bachelor of Arts degrees from the University of Waterloo. Mr. Cates has extensive expertise in the Canadian and international uranium mining industry from over a decade of senior management and financial experience in various roles with Denison. Mr. Cates was appointed President and CEO of Denison in 2015, having previously served as the company's Vice President, Finance and Tax and Chief Financial Officer. Prior to joining Denison in 2008, Mr. Cates held positions at Kinross Gold Corp. and Pricewaterhouse Coopers Limited Liability Partnership (PwC LLP). Mr. Cates also serves as a Director of Denison and is a Director of the Canadian Nuclear Association, SkyHarbour Resources Ltd. (TSX-V: SYH), and GoviEx Uranium Inc. (TSX-V: GXU). Both Skyharbour and GoviEx are engaged in uranium exploration and/or development.

Elizabeth Sidle – Vice President Finance and Chief Financial Officer

Ms. Sidle joined Denison in 2016 as Vice President Finance in September 2021 and was appointed to Chief Financial Officer in December 2023. Prior to joining Denison, she held various roles at Ernst & Young LLP, including serving in the firm's National Accounting and Assurance Group. Ms. Sidle has extensive experience in financial reporting under IFRS and has acquired substantial experience within the resource sector during her time with Denison and her exposure to multiple large Canadian mining companies while practicing in public accounting. Ms. Sidle is a CPA and CA and holds a Bachelor of Science degree from Queen's University and a Diploma in Accounting from Wilfred Laurier University.

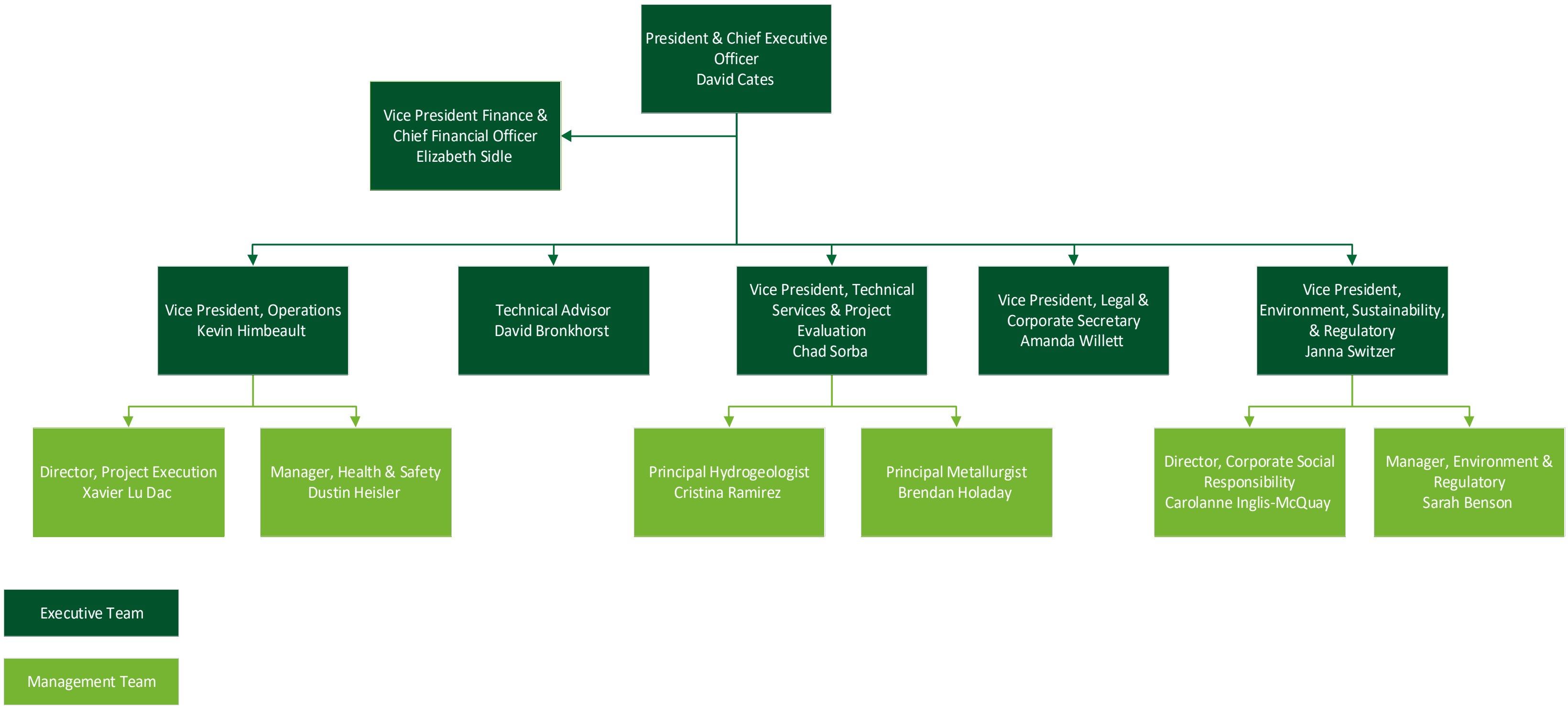


Figure 1.2-1: Denison Organizational Chart

David Bronkhorst – Technical Advisor

Mr. Bronkhorst is a seasoned mining executive with over 35 years of experience in base metals, gold, and uranium mining. Most recently, he held the position of Vice President, Mining, Projects and Technology at Cameco Corporation, which involved responsibilities for conventional mining operations in the Athabasca Basin region in northern Saskatchewan and ISR mining operations in the United States. During his 16-year career with Cameco Corporation, David also served as the General Manager at the Rabbit Lake Operation and the McArthur River Operation. Through his experience with Cameco Corporation's various mining operations, David has acquired unique senior-level expertise with both conventional and highly specialized uranium extraction techniques. David is a graduate of the Mining Engineering program at Queen's University and is a member of the Association of Professional Engineers in Saskatchewan. He has served as a director for the Saskatchewan Mining Association and continues to support the International Atomic Energy Agency as an expert in uranium extraction methods.

Kevin Himbeault – Vice President Operations

Mr. Himbeault has significant operational and regulatory experience, with over 25 years of diverse involvement in the mining industry through consulting and operations management. In previous roles, Mr. Himbeault has been responsible for substantial improvements in mining and processing facilities to ensure sustainability of operations, and has successfully facilitated environmental assessments (EAs) in both the uranium and diamond mining sectors. During his 18-year career with Cameco Corporation, Mr. Himbeault led the Key Lake Operation through multiple relicensing processes and spearheaded the development and approval of the EA for the Key Lake Extension Project. With over 14 years of direct experience at the Key Lake Operation, his responsibilities have included senior management leadership for plant operations (including uranium processing, site infrastructure services, maintenance, and recent automation initiatives) as well as oversight of the development of safety, health, quality, and radiation protection programs. Mr. Himbeault holds a Master of Science degree in Toxicology from the University of Saskatchewan.

Amanda Willet – Vice President Legal and Corporate Secretary

Ms. Willett joined Denison as Corporate Counsel and Corporate Secretary in 2016. Prior to joining Denison, Ms. Willett was a securities law associate at Blake, Cassels & Graydon LLP in Vancouver since 2011 and a corporate and securities law associate with Stikeman Elliott LLP in Toronto since 2008. Her practice focused on advising public and private companies on matters, including mergers and acquisitions, joint ventures, securities offerings, securities law and stock exchange compliance matters, and general corporate matters. She has been involved in a broad range of transactional and corporate governance work for companies listed on the TSX and the TSX Venture Exchange, with an emphasis on advising companies in the mining industry. Ms. Willett graduated from York University in 2007 with an LL.B. from Osgoode Hall Law School and a Master of Business

Administration degree from the Schulich School of Business. She is a member of both the Ontario and British Columbia Bars.

Janna Switzer – Vice President Environment, Sustainability and Regulatory

Ms. Switzer joined Denison in early 2020 to oversee the environment department and became the Vice President of Environment, Sustainability and Regulatory in January 2024. With over 20 years of experience in the resource industry, including 16 years in uranium mining and exploration, Ms. Switzer has developed substantial experience in EA, regulatory compliance, and community and regulatory relations. She led the EA for the Millennium Mine Project and the Rabbit Lake Tailings Extension with Cameco Corporation and, more recently, held the position of Senior Advisor of Communities and Social Performance with Rio Tinto Exploration before her role with Denison. Ms. Switzer holds a Bachelor of Science Degree from the University of Alberta, maintains her designation as a Project Management Professional and is a member of Métis Nation-Saskatchewan.

Chad Sorba – Vice President Technical Services and Evaluation

Mr. Sorba joined Denison in 2008 and became Vice President of Technical Services and Evaluation in January 2024. Mr. Sorba has over 16 years of experience in the mineral industry, including exploration geology, resource estimation, project development, and project evaluations. For the past 16 years, Mr. Sorba has held positions of increasing responsibility at Denison within its global portfolio of uranium exploration and development projects in North America, Africa, and Mongolia. Mr. Sorba has extensive experience in Saskatchewan's uranium industry through both majority-owned company projects as well as joint ventures. At Denison, Mr. Sorba was a significant contributor to the team that discovered, delineated, and developed the novel ISR mining methodology of over 130M lbs of mineral resources at the Project, including the Phoenix and Gryphon deposits. He has also co-authored NI 43-101 economic studies related to Denison's Midwest, Midwest A, and THT deposits.

Carolanne Inglis-McQuay – Director Corporate Social Responsibility

Ms. Inglis-McQuay joined Denison in 2019 as the Corporate Social Responsibility Manager and became the Director of Corporate Social Responsibility in January 2023. Prior to joining Denison, she held various roles at Orano Canada, including most recently as a Senior Advisor for Corporate Social Responsibility, where she was tasked with implementing company-wide systems for ensuring transparency in relation to key social metrics regarding the existing uranium mining operation. Ms. Inglis-McQuay has extensive experience in facilitating and leading negotiations with Indigenous communities in relation to a wide array of agreements. She also has more than 20 years of experience leading engagement activities with the public for complex mining projects, a career which began in Cambridge Bay, Nunavut. Ms. Inglis-McQuay holds a Bachelor of Arts from the University of Calgary.

Xavier Lu Dac – Director Project Execution

Mr. Lu Dac joined Denison in 2020 as a senior Project Engineer and became the Director of Project Execution in January 2023. Prior to joining Denison, he held various roles at the Mosaic Company where he worked in Surface Operations and Capital projects departments. Mr. Lu Dac has extensive experience in Engineering and Project Management from his prior roles held in mining, consulting, engineering, and equipment manufacturing. Mr. Lu Dac is a Professional Engineer in the Province of Saskatchewan and holds a Mechanical Engineering Degree from the University of Technology of Belfort Montbeliard, France, which he obtained in 2004.

Dustin Heisler – Safety Manager

Mr. Heisler joined Denison in 2021, bringing with him a wealth of knowledge from working in various manufacturing and mining industries. Prior to joining Denison, he most recently worked at the Suncor base plant in Fort McMurray for Worley Industrial Services, providing health and safety oversite in various divisions. His eight years in this role included advising Suncor and Worley on necessary improvements to their health and safety programs, ensuring compliance with regulatory requirements, incident investigation, and case management, and was the direct health and safety contact with the Suncor senior leadership team. Mr. Heisler's health and safety career began in the potash industry and continued with Occupational Health and Safety education at the University New Brunswick. In 2019, Mr. Heisler achieved the highest health and safety designation in Canada after successfully becoming a Canadian Registered Safety Professional.

Sarah Benson – Environment and Regulatory Manager

Ms. Benson joined Denison in early 2021 as Environmental and Regulatory Manager in Denison's Closed Mines division. This role has since expanded to include Denison's Saskatchewan projects. Prior to joining Denison, she was an Environmental Scientist at Orano Canada, for 14 years, providing technical support to both operating and decommissioned uranium mine sites and proposed projects in the areas of environmental monitoring, reporting, regulatory compliance, and licensing. Ms. Benson has developed substantial experience in environmental assessment, regulatory compliance and approvals and is knowledgeable in the application of provincial and federal environmental legislation, regulations, standards, and guidelines. She was part of the team that completed the final Cuff Lake Project assessment, advancing it to acceptance into the Saskatchewan Institutional Control Program before her role with Denison. Ms. Benson holds a Bachelor of Science Degree in Biology and a Master of Science degree in Toxicology, both from the University of Saskatchewan.

Cristina Ramirez – Principal Hydrogeologist

Ms. Ramirez joined Denison in 2023 as Principal Hydrogeologist. Prior to joining Denison, she has various roles in gold and copper open pit mining, including drilling programs, implementing the dewatering and groundwater control system of the mine site. She has 19 years expertise in groundwater mining management with hydrogeology model, well design, surface infrastructure and optimization during construction and operation with Barrick Gold, in Pueblo Viejo Mine and Inmet Mining in Cobre Las Cruces, include. Ms. Ramirez holds a Bachelor of Geology from Universidad de Huelva, a postgraduate in Groundwater from Universitat Politecnica de Catalunya, a Master of Business Administration degree from UQAM and also a Master of Occupational Hazard from Universidad Camilo Jose Cela.

Brendan Holaday - Principal Metallurgist

Mr. Holaday joined Denison in early 2022 as Senior Metallurgist and was appointed to Principal Metallurgist in January 2024. He has 15 years of experience in the uranium industry, and brings with him technical, operational, and industry specific knowledge to support the Denison team. Prior to joining Denison, he worked at Orano's McClean Lake Operation, and Cameco's Rabbit Lake Operation as a senior member of their on-site metallurgy teams. Mr. Holaday is a Professional Engineer registered with the Association of Professional Engineers and Geoscientists of Saskatchewan, and holds a Bachelor of Science degree in Chemical Engineering from the University of Saskatchewan which he obtained in 2009.

1.2.4 Key Contact Information

The primary contact for the purposes of the EIS for the Project is:

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Fax: (306) 652-8202
Email: jswitzer@denisonmines.com

1.2.5 Environmental Impact Statement Preparation Team

Completing an EIS is a complex undertaking. This document was prepared by a team of Denison staff along with various consultants. Table 1.2-1 provides a list of key consultants and contributors who supported Denison with drafting EIS sections.

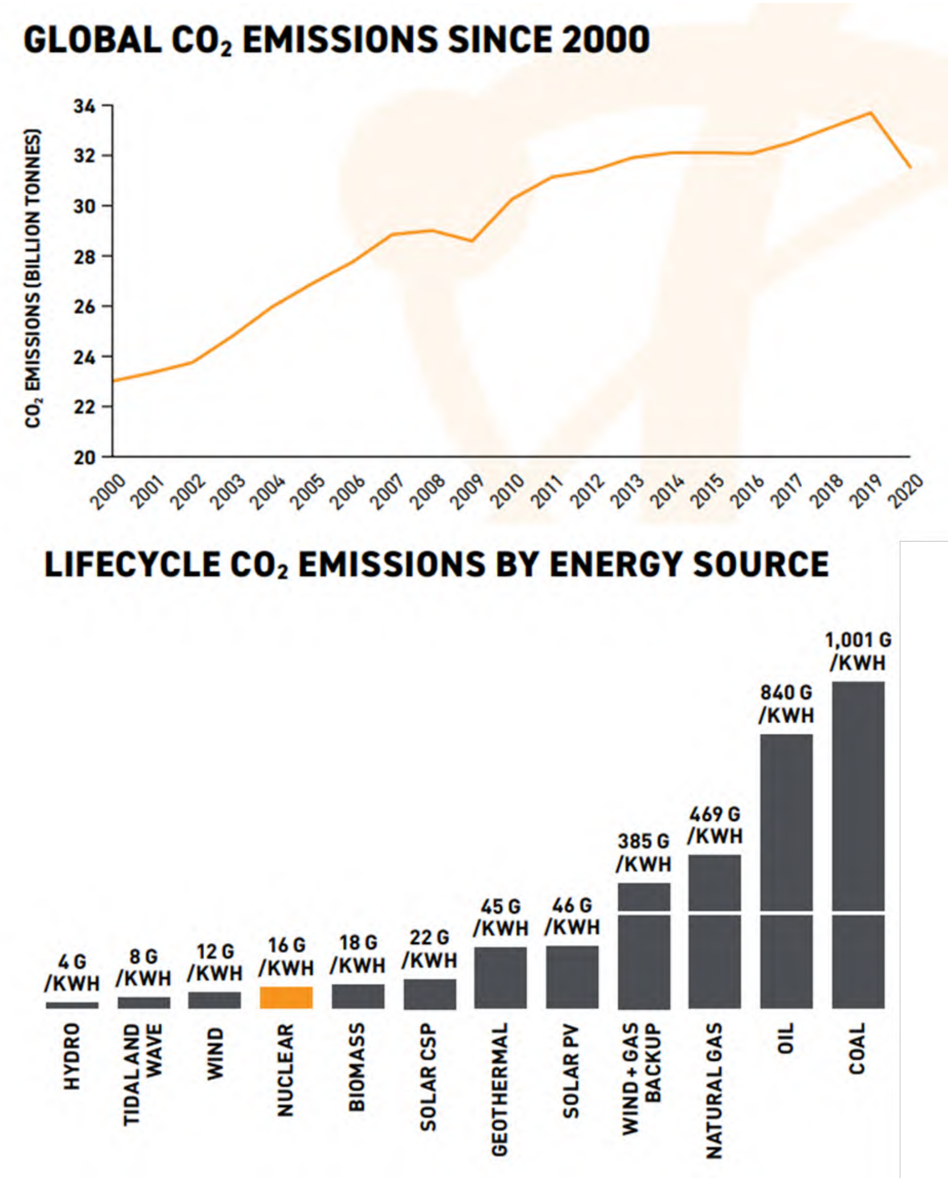
Table 1.2-1: Wheeler River Project Environmental Impact Statement – Consultants and Contributors

Wheeler River Project EIS Section		Consultant or Contributor
1	Project Introduction and Overview	Bennett Hain Consulting Ltd.
2	Project Description	Bennett Hain Consulting Ltd.
3	Indigenous and Local Knowledge	English River First Nation, InterGroup Consultants Ltd.
4	Engagement	InterGroup Consultants Ltd.
5	Approach and Methodology of the Assessment	EDI Environmental Dynamics Inc.
6	Atmospheric and Acoustic Environment	Independent Environmental Consultants
7	Geology and Groundwater	EcoMetrix Inc., GeoCentric Environmental Ltd., Aqua Insight Inc.
8	Aquatic Environment	EcoMetrix Inc., NewFields
9	Terrestrial Environment	EDI Environmental Dynamics Inc.
10	Human Health	EcoMetrix Inc.
11	Land and Resource Use	InterGroup, Canada North Environmental Services
12	Quality of Life	InterGroup Consultants Ltd.
13	Economics	InterGroup Consultants Ltd.
14	Accidents and Malfunctions	EcoMetrix Inc.
15	Effects of the Environment on the Project	EDI Environmental Dynamics Inc.
16	Assessment Summary and Conclusions	All consultants contributed

1.3 Need for and Purpose of the Project

The United Nations estimates that the world's population will grow from approximately 7.6 billion in 2017 to over 9.7 billion in 2050 (United Nations 2017), which is expected to substantially increase global electricity demand. Economic development in non-Organization for Economic Co-Operation and Development countries is rapidly shifting global electricity demands and generating more interest in new nuclear plant investments (MIT 2018). According to the International Atomic Energy Agency, high-case projections for nuclear generating capacity suggest that current global capacity could increase from 392 GWe in 2019 to 715 GWe in 2050 (IAEA 2020). At present, there are approximately 442 operable nuclear reactors worldwide, with an additional 51 reactors under construction, over 100 reactors on order or planned, and over 300 proposed reactors (Canadian Nuclear Association 2021).

Hand-in-hand with the rising demand for reliable and low-cost energy is the discussion surrounding greenhouse gas (GHG) emissions and climate change. Despite numerous environmental initiatives and on-going research, global climate change continues at an alarming rate. In 2019, global energy-related carbon dioxide (CO_2) emissions rose to 33.5 billion tonnes, the highest on record, which was approximately 45% above the total in 2000 (World Nuclear Association 2021; Canadian Nuclear Association 2021; Figure 1.3-1). One of the most influential energy sources available to combat the rise of CO_2 emissions is nuclear power. If all the world's coal and natural gas plants were replaced with low carbon nuclear, CO_2 emissions would be reduced by nearly 13 billion tonnes annually (Canadian Nuclear Association 2021).



Source: The Canadian Nuclear Association 2021

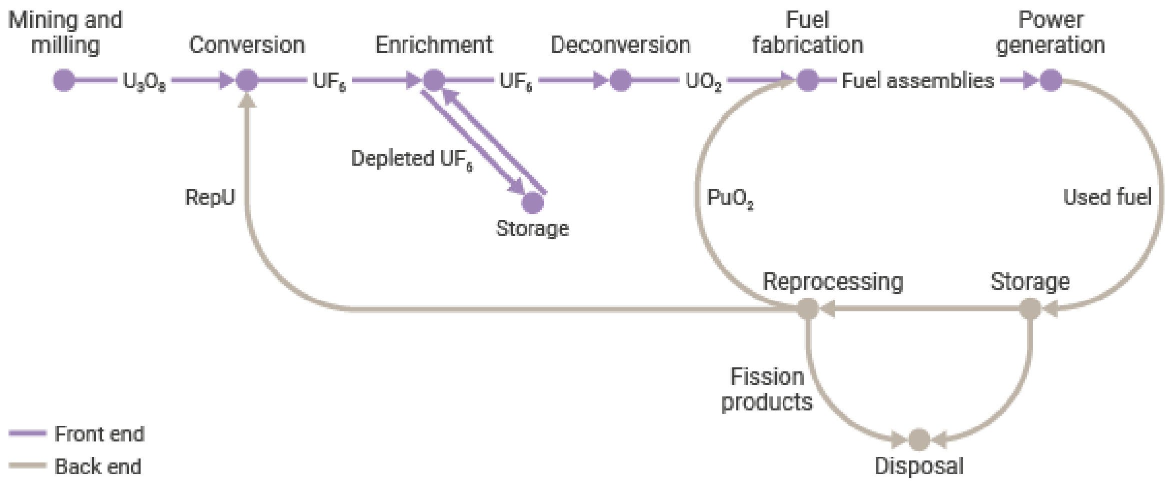
Figure 1.3-1: Global CO_2 Emissions Since 2000 and Lifecycle CO_2 Emissions by Energy Source

A recent report by the United Nations Intergovernmental Panel on Climate Change examined 89 climate change mitigation scenarios and concluded that achieving the 1.5°C target from the Paris Agreement will require an immediate reduction in global GHG emissions and an increase in nuclear power generation of approximately 2.5 times by 2050 (World Nuclear Association 2021). Without a significant contribution from nuclear energy, as the global power mix shifts to respond to climate change initiatives, the cost of achieving meaningful decarbonisation targets will steadily rise, or targets will simply go unmet. Nuclear energy is critical to global climate change objectives because of its unique combination of low carbon emissions, large scale, and high level of reliability.

Nuclear power is safe and reliable. The Canadian nuclear industry is one of the most closely monitored industries in the world. Major nuclear facilities are the most protected critical infrastructure in Canada. Not once has a nuclear incident caused a death in Canada and very few other industries have such a strong health and safety record. Canada's nuclear safety record is unmatched by any other industry in the world (Canadian Nuclear Association, 2022). It is one of the few reliable energy sources that can reduce greenhouse gas emissions. The world's current use of nuclear power already reduces emissions by about 2.5 billion tonnes of carbon dioxide each year by avoiding fossil fuels (World Nuclear Association 2022a).

According to Natural Resources Canada, 15% of Canada's electricity was provided by nuclear power in 2018 (Natural Resources Canada 2022). The nuclear industry in Canada directly and indirectly supports a total of 76,000 jobs, with a total impact on the Canadian gross domestic product of $17 billion per year (Canadian Nuclear Association 2021). Given the integral role it plays in the Canadian economy, the nuclear power industry has been, and will continue to be, a growth vehicle for economic and employment opportunities, an aid to rapidly increasing electricity demand, and a key contributor in the battle against the environmental effects associated with GHG emissions.

Mining of uranium is the first step in the nuclear fuel cycle (Figure 1.3-2), which ultimately concludes with the furnishing of nuclear fuel assemblies to nuclear power plants around the world for the generation of low-carbon and low-cost electricity. Accordingly, uranium mining is an essential component in the global battle against climate change and the shift towards the generation of low-carbon electricity. Lifecycle GHG emissions associated with nuclear power at 16 g CO_2e/KWh (Figure 1.3-1) include uranium mining and milling, which have been estimated to contribute 1.1g CO_2e/KWh (Parker et al. 2016) to the total lifecycle.



Source: World Nuclear Association 2022

Figure 1.3-2: The Nuclear Fuel Cycle

Presently, the annual global uranium supply is less than the annual global demand, and limited inventories have been accessed to make up the supply shortfall. In the upcoming decade, many new uranium mining projects will be required to meet the needs of existing global nuclear power plants, without considering additional demands from new plants (both conventional and emerging small modular reactor designs) and life extension of existing plants (World Nuclear Association 2022). In Canada, new build, small modular reactor projects are currently under consideration in New Brunswick, Ontario, and Saskatchewan.

The purpose of the Project is to construct and operate an ISR uranium mine and processing plant to provide a uranium supply necessary to meet existing and increasing global demand for nuclear power generation. Facilitating global growth in nuclear through environmentally sustainable uranium exports positions Canada and the Province of Saskatchewan to not only help Canada meet its climate change objectives, but to support numerous nations around the world to do the same.

The ISR mining method proposed for the Project has the potential to improve overall economics for smaller-scale uranium deposits while minimizing disturbance to the land and resources in the area. In situ recovery mining uses a water-based solution, fortified with mining reagents, to dissolve naturally occurring uranium from within a host rock, while the host rock remains in place (in situ) below the surface. This mining method can extract the uranium mineralization without physically removing the host rock for processing on the surface. Accordingly, the Project involves no underground or open pit mine workings, no heavy equipment is needed to excavate rocks, and people do not work underground. Taken together, ISR mining is an environmentally sustainable way to mine uranium. As minimal surface disturbance occurs, minimal waste rock is generated and no long-term placement of conventional tailings are produced.

While the ISR method has been used to mine uranium globally for many years, the Project aims to be the first application of this method of uranium mining in Canada. If successful, the Project will pioneer the use of the ISR method amongst the high-grade uranium deposits of the Athabasca Basin region in northern Saskatchewan, which could potentially unlock additional uranium deposits that are currently unsuitable for other mining methods or are uneconomic.

Canada is uniquely positioned to support global climate change initiatives. Canada is the second largest producer and fourth largest exporter of uranium in the world (Natural Resources Canada 2022). In 2019, approximately 75% of the uranium produced in Canada was exported for use in nuclear power throughout the world (Natural Resources Canada 2022). Canada has a rich history of involvement with nuclear power, uranium mining, and the technological advances that have been made within the industry since the early 1940s. Canada also has a mature regulatory regime for the nuclear industry, including uranium mining, which is globally recognized and respected.

The amount of uranium produced during the life of mine from the Wheeler project could supply power to 1,000,000 Canadian homes for 100 years (WNA, 2022, Stats Can, 2019). In addition, to supporting the reduction of GHG, the Project is expected to (1) contribute economically to Canada's nuclear energy industry and (2) provide positive benefits through employment and business opportunities to Indigenous and northern communities in Saskatchewan.

Denison recognizes the thriving culture and deep-rooted traditions of northern Saskatchewan communities and their aspirations of achieving economic growth and prosperity. Denison strives to achieve the development of the Project through positive partnerships with Communities of Interest, integrating information from Indigenous and non-Indigenous Interested Parties, and maintaining high standards for environmental protection and worker safety.

Overall, the world and Canada need uranium to meet the projected future needs of nuclear power generation, and the Project can provide a critical component in the nuclear fuel cycle while making a meaningful contribution to the Canadian economy and Saskatchewan's northern and Indigenous communities.

1.4 Structure of the Environmental Impact Statement

The EIS has been organized to facilitate navigation and readability. The main part of the document has been presented in four parts: Part I Introduction and Context, Part II Biophysical Environment Assessments, Part III Human Environment Assessments, and Part IV Integrated Topics and Summaries.

Within these four main parts, there are a total of 16 sections.

- Part I: Introduction and Context
  - Section 1 Project Introduction and Overview
  - Section 2 Project Description

  - Section 3 Indigenous and Local Knowledge
  - Section 4 Engagement
  - Section 5 Approach and Methodology of the Assessment
- Part II: Biophysical Environment Assessments
  - Section 6 Atmospheric and Acoustic Environment
  - Section 7 Geology and Groundwater
  - Section 8 Aquatic Environment
  - Section 9 Terrestrial Environment
- Part III: Human Environment Assessments
  - Section 10 Human Health
  - Section 11 Land and Resource Use
  - Section 12 Quality of Life
  - Section 13 Economics
- Part IV: Integrated Topics and Summaries
  - Section 14 Accidents and Malfunctions
  - Section 15 Effects of the Environment on the Project
  - Section 16 Assessment Summary and Conclusions

Supporting documents have been presented as appendices to the main document. Appendices include databases, baseline reports, technical reports, and concordance tables.

The structure of the EIS is presented graphically in Figure 1.4-1, with the list of appendices identified in Figure 1.4-2. The central biophysical and human environment assessments are shown in Figure 1.4-3.

Figure 1.4-1: Wheeler River Project Environmental Impact Statement Roadmap – Main Document

Part I: Introduction and Context

- Appendix 1-A Concordance Tables
- Appendix 2-A Engagement Database Summary – Project Description
- Appendix 2-B Project-related Traffic
- Appendix 2-C Alternative Means Assessment
- Appendix 3-A Ya'thi Néné Report
- Appendix 4-A Supporting Materials
- Appendix 4-B Interests, Issues and Concerns Tables: Indigenous
- Appendix 4-C Interests, Issues and Concerns Tables: General Public

Part II: Biophysical Environmental Assessments

- Appendix 6-A Air Quality Technical Supporting Document
- Appendix 6-B Engagement Database Summary – Atmospheric and Acoustic Environment
- Appendix 6-C Climate Baseline and Greenhouse Gas Emissions Report
- Appendix 6-D Baseline Air Quality Monitoring Report
- Appendix 6-E Acoustic Assessment Technical Supporting Document
- Appendix 7-A Baseline Geology and Hydrogeology Report
- Appendix 7-B Engagement Database Summary – Geology and Groundwater
- Appendix 7-C Post-Decommissioning Groundwater Conditions
- Appendix 8-A Engagement Database Summary – Aquatic Environment
- Appendix 8-B Hydrology Baseline Report

Part II: Biophysical Environmental Assessments

- Appendix 8-C Hydrological Effects Assessment Report
- Appendix 8-D Aquatic Environment Baseline Study
- Appendix 8-E Constituent Concentrations and Mixing Zone Assessment Report
- Appendix 8-E Wetlands Effects Assessment Report
- Appendix 9-A Engagement Database Summary – Terrestrial Environment
- Appendix 9-B Terrestrial Environment, Wildlife and Vegetation Baseline Inventory
- Appendix 9-C Soil, Vegetation and Wildlife: Annex Baseline Report
- Appendix 9-D Wildlife Species at Risk
- Appendix 9-E Caribou Management Framework
- Appendix 9-F Supplemental Information Generated During the Draft EIS Review

Figure 1.4-2: Wheeler River Project Environmental Impact Statement Roadmap – Appendices

PART III: HUMAN ENVIRONMENT ASSESSMENTS

- Appendix 10-A Environmental Risk Assessment
- Appendix 10-B Engagement Database Summary – Human Health
- Appendix 10-C Worker Dose Assessment
- Appendix 11-A Engagement Database Summary – Land and Resource Use
- Appendix 11-B Heritage Resource Management Plan
- Appendix 11-C Heritage Resources Baseline Report (2017)
- Appendix 11-D Heritage Resources Baseline Report (2019)

PART III: HUMAN ENVIRONMENT ASSESSMENTS

- Appendix 12-A Engagement Database Summary – Quality of Life
- Appendix 12-B Community Profiles
- Appendix 12-C Demographic and Population Indicators
- Appendix 12-D Crime Statistics
- Appendix 12-E Traffic Collision Data
- Appendix 13-A Engagement Database Summary – Economics
- Appendix 13-B Economic Indicators

PART IV: INTEGRATED TOPICS AND SUMMARY

- Appendix 14-A Accident and Malfunction Technical Supporting Document
- Appendix 14-B Engagement Database Summary – Accidents and Malfunctions
- Appendix 15-A Engagement Database Summary – Effects of the Environment on the Project
- Appendix 16-A Summary of Residual Effects
- Appendix 16-B Summary of Cumulative Effects
- Appendix 16-C Summary of Monitoring and Follow-up Programs

Figure 1.4-2: Wheeler River Project Environmental Impact Statement Roadmap – Appendices continued

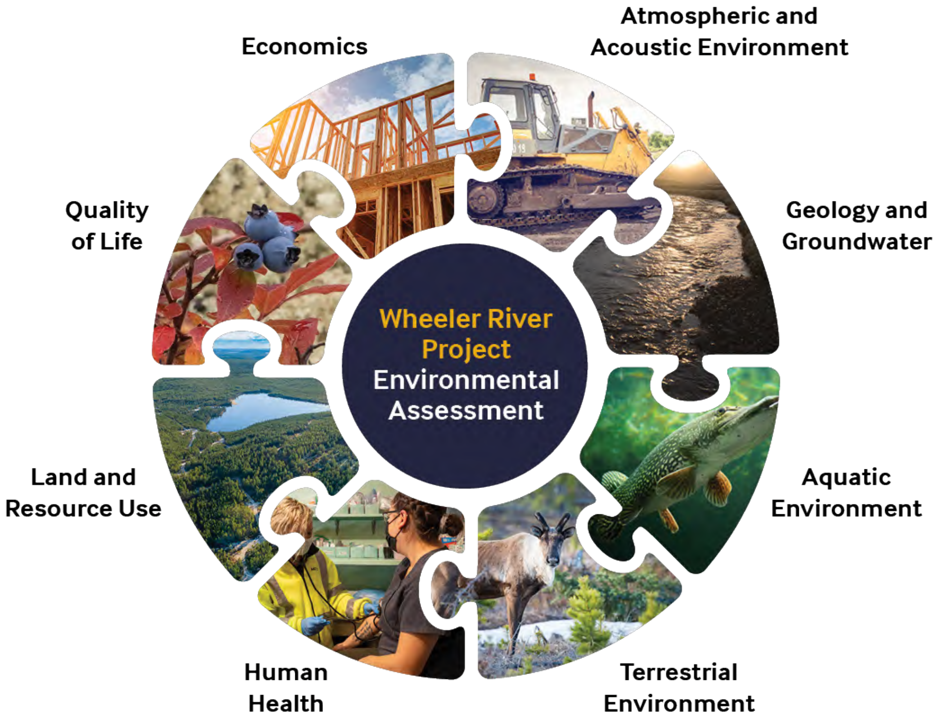


Figure 1.4-3: Biophysical and Human Environment Assessments for the Wheeler River Project Environmental Assessment

1.5 Project Summary

The proposed site layout for the Project is provided in Figure 1.5-1.

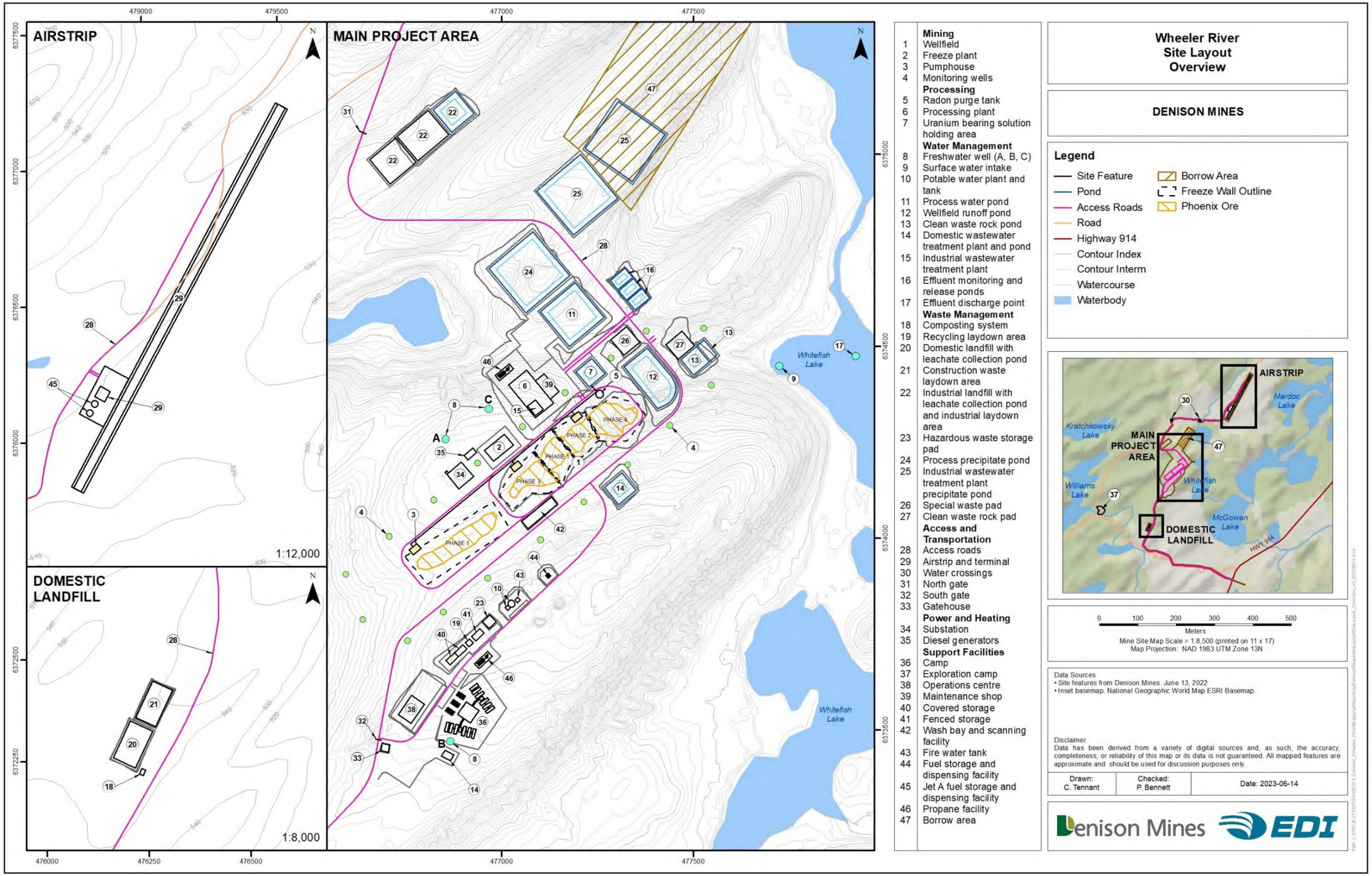


Figure 1.5-1: Wheeler River Project Proposed Site Layout

Briefly, Denison proposes to use the ISR method to mine uranium from the Phoenix uranium deposit. The deposit is a high-grade (average grade 19% uranium ore concentrate [i.e., U_3O_8]) with approximately 70.2 million pounds of U_3O_8. The ISR method involves drilling several wells and then circulating an acidic mining solution underground. The mining solution dissolves uranium, which is brought to the surface and run through a simple processing plant. The processing plant will remove precipitates from the solution and then process the solution to produce yellowcake. The yellowcake is a final, saleable product that is transported off site to customers.

Denison has bound the EA above the Phoenix deposit's indicated resources of 70.2 million pounds. It has been assumed that the Project will generate an annual average production of 9 million pounds of U_3O_8, with a potential annual peak production of 12 million pounds of U_3O_8, and Operation will last up to 15 years. The conservative EA case allows for overall total life of mine production of 135 million pounds of U_3O_8, which is expected to allow for the EA case to accommodate operational flexibility from one year to the next.

Various components and activities are required to support the ISR mining and processing activities. This includes infrastructure and systems for water management, waste management, site access and transportation, power, heating, and other support features, such as a camp.

1.6 Project Schedule

The total duration of the proposed Project is estimated to be approximately 38 years, which includes about 2 years for Construction, 15 years for Operation, five years for Decommissioning, and 15 years for Post-Decommissioning. A summary of the anticipated key activities for Construction, Operation, Decommissioning, and Post-Decommissioning are provided in Table 1.6-1.

Table 1.6-1: Key Activities for the Wheeler River Project

Phase and Year	Description of Activities
Construction Year 1 to 3	• Development of access roads and air strip • Site preparation and earthworks; clearing, levelling, and grading of the Project Area • Power generation – generators • Installation of main substation and distribution of power around site • Wellfield and freeze hole drilling; ground freezing • Batch plant operation (concrete); crusher at borrow area • Development of surface infrastructure (camp, operations centre, plants, ponds, pads, and support facilities) • Waste management (composting, domestic and industrial landfill operation, recycling) • Water management (including treatment and site runoff) • Groundwater supply • Surface water withdrawal • Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel) • On-site and off-site operation of vehicles and transport of materials • Air transportation for workers • Regulatory site inspections • Engagement – site visit from Interested Parties • Employment and expenditures

Phase and Year	Description of Activities
Operation Year 3 to 18	• Operation of the ISR wellfield • Wellfield and freeze wall drilling • Operation and expansion of freeze wall • Batch plant operation (grout and cement); crusher at borrow area • Expansion of pond and pads • Operation of the processing plant and production of uranium concentrate • Water withdrawal from groundwater or surface water body • Management of surface water (including seepage and site runoff) • Water treatment, both domestic and industrial • Water release to surface water body • Waste management (composting, domestic and industrial landfill operation, recycling) • Hazardous waste management (temporary storage, handling, and off-site transportation) • Storage and disposal of drill waste rock, process precipitates, and industrial wastewater treatment plant precipitates • On-site and off-site operation of vehicles and transport of materials • Power supply – primarily power from the grid, also generators and back-up generators • Package and transport of nuclear substances • Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel) • Air transportation for workers • Progressive decommissioning and reclamation • Regulatory site inspections • Engagement – site visit from Interested Parties • Employment and expenditures
Decommissioning Year 18 to 23	• Site water management, treatment, and release • Mining area remediation and thawing of freeze wall • Process water treatment and release • Closure of ISR and freeze wells and related infrastructure • Decontamination of surface facilities and injection, recovery, and monitoring wells • Asset removal (including site power transmission lines and electrical infrastructure) • Demolition and disposal of non-salvageable surface infrastructure and materials • Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area) • Power generation – generators • Waste management (composting and landfill operation) • Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal) • On-site and off-site operation of vehicles and transport of materials • Reclamation of disturbed areas • Regulatory site inspections • Engagement – site visit from Interested Parties • Employment and expenditures
Post-Decommissioning Year 23 to 38	• Environmental monitoring • Regulatory site inspections • Engagement – site visit from Interested Parties • Employment and expenditures

1.7 Regulatory Framework

The proposed Project is subject to both a federal and provincial EA process. This section provides an overview of the regulatory framework for the EIS. A detailed consideration of applicable legislation, guidelines, policies, standards, and codes is incorporated into each assessment.

The provincial and federal EA processes for the Project will be conducted in parallel. The Saskatchewan Ministry of Environment's Environmental Assessment and Stewardship Branch and the CNSC will cooperate in conducting a coordinated provincial-federal EA that will follow the spirit of the Canada-Saskatchewan Agreement on Environmental Assessment Cooperation (2005; Government of Canada 2016) to the extent possible. The agreement allows for cooperation in the assessment of projects that require regulation by both levels of government. The cooperation agreement allows for the production of a single EIS that meets the requirements of both levels of government, such that each level of government can make an independent decision on the approval of the EIS.

1.7.1 Provincial Legislation

Denison has conducted, prepared, and submitted this EIS for the Project to the Saskatchewan Ministry of Environment's Environmental Assessment and Stewardship Branch. This EIS meets the requirements outlined in the *Environmental Assessment Act* (Government of Saskatchewan 2018d). Ultimately, the Project will require issuance of a ministerial approval under Section 15 of the *Environmental Assessment Act* (Government of Saskatchewan 2018d) before proceeding to licensing and permitting.

Provincial acts and associated regulations applicable to the Project are summarized in the following list. This list is not exhaustive.

- *The Environmental Assessment Act* (Government of Saskatchewan 2018d)
- The *Environmental Management and Protection Act*, 2010 (Government of Saskatchewan 2018e)
  - The Mineral Industry Environmental Protection Regulations, 1996 (Government of Saskatchewan 1996)
  - The Hazardous Substances and Waste Dangerous Goods Regulations (Government of Saskatchewan 2000)
  - The Waterworks and Sewage Works Regulations (Government of Saskatchewan 2020f)
  - The Environmental Management and Protection (Saskatchewan Environmental Code Adoption) Regulations (Government of Saskatchewan 2021a)
- *The Wildlife Act, 1998* (Government of Saskatchewan 2020g)
  - The Wildlife Regulations, 1981 (Government of Saskatchewan 2022d)

- *The Wildlife Habitat Protection Act* (Government of Saskatchewan 2018h)
  - The Wildlife Habitat Lands Disposition and Alteration Regulations (Government of Saskatchewan 2001)
- *The Fisheries (Saskatchewan) Act*, 2020 (Government of Saskatchewan 2020b)
  - The Fisheries Regulations (Government of Saskatchewan 2022b)
- *The Forest Resources Management Act* (Government of Saskatchewan 2021b)
  - The Forest Resources Management (Saskatchewan Environmental Code Adoption) Regulations (Government of Saskatchewan 2021c)
  - The Forest Resources Management Regulations (Government of Saskatchewan 2020c)
- *The Natural Resources Act* (Government of Saskatchewan 2019e)
- *Wildfire Act* (Government of Saskatchewan 2019)
- *The Heritage Property Act* (Government of Saskatchewan 2019c)
- *The Provincial Lands Act, 2016* (Government of Saskatchewan 2019f)
- *The Saskatchewan Employment Act* (Government of Saskatchewan 2021h)
  - The Mines Regulations, 2018 (Government of Saskatchewan 2019d)
  - The Occupational Health and Safety Regulations, 2020 (Government of Saskatchewan 2021e)
  - The Radiation Health and Safety Regulations, 2005 (Government of Saskatchewan 2005)
- *The Reclaimed Industrial Sites Act* (Government of Saskatchewan 2018g)
  - The Reclaimed Industrial Sites Regulations (Government of Saskatchewan 2021g)
- *The Water Security Agency Act* (Government of Saskatchewan 2019g)
- *The Dangerous Goods Transportation Act* (Government of Saskatchewan 2018c)
  - The Dangerous Goods Transportation Regulations (Government of Saskatchewan 2002)

1.7.2 Federal Legislation

This EIS has been prepared to comply with the requirements of the *Canadian Environmental Assessment Act, 2012* (Government of Canada 2019a).

The proposed Project will include the construction, operation, and decommissioning of a uranium mine, processing plant, and supporting facilities on a site that is not within the boundaries of an existing licensed uranium mine or mill. As such, the Project is a designated project as set out in Section 31 of the Regulations Designating Physical Activities (Government of Canada 2014) and is therefore subject to a federal EA.

The CNSC is the federal authority responsible for the Project's EA. Federal acts and associated regulations applicable to the Project are summarized in the following list. This list is not exhaustive.

- *Fisheries Act* (Government of Canada 2019c)
  - Metal and Diamond Mining Effluent Regulations (Government of Canada 2022a)
- *Canadian Environmental Assessment Act* (Government of Canada 2019a)
  - Regulations Designating Physical Activities (Government of Canada 2014)
  - Prescribed Information for the Description of a Designated Project Regulations (Government of Canada 2019e)
- *Species at Risk Act* (Government of Canada 2022b)
- *Nuclear Safety and Control Act* (Government of Canada 2017c)
  - General Nuclear Safety and Control Regulations (Government of Canada 2015a)
  - Uranium Mines and Mills Regulations (Government of Canada 2017d)
  - Packaging and Transport of Nuclear Substances Regulations, 2015 (Government of Canada 2015b)
  - Radiation Protection Regulations (Government of Canada 2021b)
- *Migratory Birds Convention Act*, 1994 (Government of Canada 2017b)
- *Transportation of Dangerous Goods Act*, 1992 (Government of Canada 2019f)
  - Transportation of Dangerous Goods Regulations (Government of Canada 2021c)
- *Canadian Environmental Protection Act*, 1999 (Government of Canada 2021a)
  - Environmental Emergency Regulations, 2019 (Government of Canada 2019b)
- *Canada Wildlife Act* (Government of Canada 2017a)
- *Canadian Navigable Waters Act* (Government of Canada 2019d)

1.7.3 Guidelines, Policies, Standards, and Codes

In addition to regulatory requirements from federal and provincial acts and regulations, Denison has applied several guidelines, policies, standards, and codes to the Project while completing this EIS. The following list provides examples of guidelines, policies, standards, and codes that are applicable to the Project. This list is not exhaustive.

- Canadian Environmental Assessment Agency
  - Technical Guidance for Assessing Physical and Cultural Heritage or any Structure, Site or Thing that is of Historical, Archaeological, Paleontological or Architectural Significance under the *Canadian Environmental Assessment Act, 2012* (CEAA 2015c)
  - Addressing “Purpose of” and “Alternative Means” under the *Canadian Environmental Assessment Act, 2012* (CEAA 2015a)

  - Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects under the *Canadian Environmental Assessment Act, 2012* (CEAA 2018)
  - Reference Guide Considering Aboriginal Traditional Knowledge in Environmental Assessments Conducted under the *Canadian Environmental Assessment Act, 2012* (CEAA 2015b)
- The Federal Policy on Wetland Conservation (Government of Canada 1991)
- Various CNSC regulatory documents, including:
  - REGDOC-2.9.1 Environmental Protection – Environmental Principles, Assessments and Protection Measures (CNSC 2020);
  - REGDOC-2.11-2 Waste Management – Decommissioning (CNSC 2021c);
  - REGDOC-3.1.2 Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills (CNSC 2018); and
  - REGDOC-3.2.2 Indigenous Engagement (CNSC 2019b).
- Generic Guidelines for the Preparation of an Environmental Impact Statement pursuant to the *Canadian Environmental Assessment Act, 2012* (CNSC 2021a)
- Various Canadian Standards Association standards, including:
  - N288.4-10 Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills (CSA 2010);
  - N288.7-15 Groundwater protection programs at Class I nuclear facilities and uranium mines and mills (CSA 2015);
  - N286-12 Management system requirements for nuclear facilities (CSA 2012b);
  - N288.5-11 Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills (CSA 2011);
  - N288.6-12 Environmental risk assessments at Class I nuclear facilities and uranium mines and mills (CSA 2012a); and
  - N294-19 Decommissioning of facilities containing nuclear substances (CSA 2019).
- Guidelines for Compost Quality (CCME 2005)
- Northern Mine Decommissioning and Reclamation Guidelines (Government of Saskatchewan 2008)
- Saskatchewan Environmental Code and attendant standards (Government of Saskatchewan 2022a)

1.7.4 Concordance Tables

Concordance tables linking the content of the EIS to specific requirements are provided in Appendix 1-A. Concordance tables have been generated between the EIS and the following documents:

- Generic Guidelines for the Preparation of an Environmental Impact Statement pursuant to the Canadian *Environmental Assessment Act*, 2012 (version: March 23, 2021; CNSC 2021a);
- Denison Mines Wheeler River Project Terms of Reference (Denison 2019).

1.7.5 Licensing and Permitting

The following list of permits, approvals, and licences are anticipated at different stages of the Project.

- Provincial EA approval
- Federal EA approval
- CNSC licences to:
  - prepare and construct the site
  - operate the site
  - decommission the site
  - abandon the site (release from licensing)
- Surface lease agreement
- Saskatchewan Heritage Conservation Branch approval
- Provincial forest product permit
- Saskatchewan Water Security Agency aquatic habitat protection permit
- Saskatchewan Water Security Agency permit to operate a waterworks
- Saskatchewan Water Security Agency permit to operate a sewage works
- Provincial approval to construct an approach to a highway
- Provincial approval to construct and operate a pollutant control facility
- Provincial approval to construct a hazardous substances and waste dangerous goods facility and store hazardous substances and waste dangerous goods
- Provincial approval to decommission a pollutant control facility
- Release from decommissioning and reclamation requirements
- Provincial acceptance of the decommissioned and reclaimed site into the Institutional Control Program

It is important to note that Denison is completing a sequential EA and licensing process for the Project.

While a preview of the permits, approvals, and licences required after the EA process is complete is important to consider and provides valuable context, detailed information needed to support licensing and permitting has not be included in the EIS. A summary of the main phases for the CNSC's licensing process and the Government of Saskatchewan's approval process is provided in Figure 1.7-1.

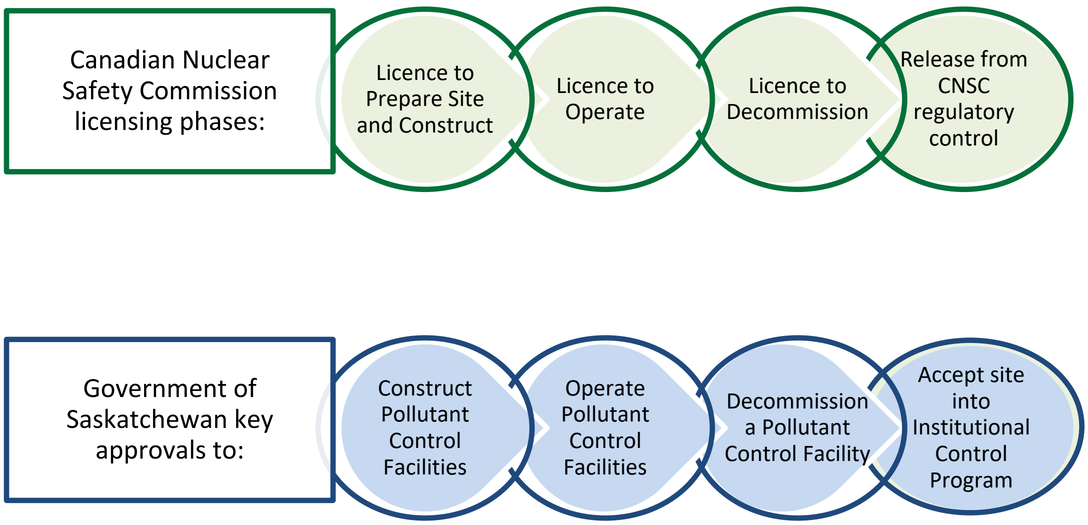


Figure 1.7-1: Key Post-Environmental Impact Statement Project Licences and Approvals

1.8 References

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Appendix 1-A Concordance Tables

See file “S1_App 1-A Concordance Tables_Wheeler River.pdf”

Denison Mines

Wheeler River Project

Final Environmental Impact Statement

November 2024

Powering
PEOPLE, PARTNERSHIPS AND PASSION.

Wheeler River Project

Final Environmental Impact Statement

Section 2 – Project Description

November 2024

Denison Mines

Denison Mines Corp.

345 4th Avenue South

Saskatoon, SK, S7K 1N3

Roadmap

This roadmap of the Wheeler River Project Environmental Impact Statement (EIS) has been provided to summarize the main document sections and appendices of the EIS.

Wheeler River Project
Environmental Impact Statement

Executive Summary

Part I: Introduction and Context	Part II: Biophysical Environmental Assessments	Part III: Human Environment Assessments	Part IV: Integrated Topics and Summary
Section 1: Project Introduction and Overview	Section 6: Atmospheric and Acoustic Environment	Section 10: Human Health	Section 14: Accidents and Malfunctions
Section 2: Project Description	Section 7: Geology and Groundwater	Section 11: Land and Resource Use	Section 15: Effects of the Environment on the Project
Section 3: Indigenous and Local Knowledge	Section 8: Aquatic Environment	Section 12: Quality of Life	Section 16: Assessment Summary and Conclusions
Section 4: Engagement	Section 9: Terrestrial Environment	Section 13: Economics	
Section 5: Approach and Methodology of the Assessment			

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Abbreviations, Acronyms and Units

Abbreviation / Acronym	Definition
AADT	Annual Average Daily Traffic
ALARA	As Low As Reasonably Achievable
ATV	All-terrain vehicle
BATEA	best available technology economically achievable
CDP	conceptual decommissioning plan
COPC	constituent of potential concern
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
DDP	Detailed decommissioning plan
Denison	Denison Mines Corp.
DWWTP	Domestic wastewater treatment plant
EA	Environment Assessment
ECCC	Environment and Climate Change Canada
EI	Emission Intensity
EIS	Environmental Impact Statement
EMS	Environmental Management System
ERFN	English River First Nation
GCL	Geosynthetic Clay Liner
GHG	Greenhouse gas
GM	Geomembrane
GWMP	Groundwater protection and groundwater monitoring plan
GWP	Global Warming Potential
HDPE	High-density polyethylene
HVAC	Heating, ventilation, air conditioning
IWWTP	Industrial Wastewater Treatment Plant
IPCC	Intergovernmental Panel on Climate Change
ISR	In situ recovery
IWWTP	Industrial Wastewater Treatment Plant
LSA	Local Study Area
MDMER	Metal and Diamond Mining Effluent Regulations
NIR	National Inventory Report
PAG	Potentially Acid Generating
PDP	Preliminary decommissioning plan
PEA	Preliminary economic assessment
PFS	Prefeasibility study

Abbreviation / Acronym	Definition
PMP	probable maximum precipitation
Project	Wheeler River Project
SACC	Strategic Assessment of Climate Change
SK MOE	Saskatchewan Ministry of the Environment
SRC	Saskatchewan Research Council
TAADT	Truck Annual Average Daily Traffic
UBS	Uranium bearing solution
VWP	Vibrating wire piezometers
WTP	Water treatment plant

Units	Definition
cm	centimeter
°C	degrees Celsius
g/L	gram per litre
ha	hectare
in	inch
km	kilometre
L	litre
L/day	litres per day
L/min	litre per minute
L/s	litres per second
m	metre
m^2	square metre
m^3	cubic metre
mg/L	milligram per litre
Mlbs	million pounds
Mlbs/year	million pounds per year
psi	pound per square inch
tonne	a metric unit of mass equal to a thousand kilogram

Glossary

Term	Definition
Active mining area	The active area within the broader mining area where focused in situ recovery mining will occur. The active mining area is effectively the ore zone, where the injection and recovery wells will be screened. The ore zone has an average thickness is 5 m, with a range of 2 to 17 m.
Basement rock	The foundation of thick, ancient rocks (e.g., metamorphic and igneous), which form the crust of continents. For the Wheeler River Project, it involves rock of low permeability located under the uranium ore deposit.
Bounding	Bounding in the context of environmental assessment refers to establishing the limits or boundaries within which the assessment will be conducted.
Brine solution	A solution of calcium chloride that will be circulated through the freeze holes to remove heat from the ground to create the freeze wall.
Clean waste rock	Waste rock generated as sandstone cuttings and core from drilling activities associated with well and freeze hole development that does not have uranium containing materials.
Climate Change	Refers to long-term shifts in temperatures and weather patterns and events.
Combustion	The act or instance of burning a fuel like natural gas to produce energy. For example, combustion is typically the process that powers automobile engines and power plant generators.
Diamond drilling	A form of core drilling which uses a rotary drill with a diamond drill bit attached in order to create precisely measured holes and obtain cores of rock samples.
Domestic Wastewater Treatment Plant	The wastewater facility for the treatment of domestic wastewater, i.e., greywater (e.g., water drained from sinks, showers, washing machines) and blackwater (i.e., sewage).
Dry (dries, or mine dry)	A mine dry is a change room which provide workers with a safe space to change and clean up before returning to their living quarters.
Environmental Assessment	An assessment of potential environmental consequences of a project. The environmental assessment considers the existing environment where the Project is to be located (including, but not limited to, Indigenous and Local Knowledge), predicts potential effects to valued components of the environment, identifies mitigation measures used to limit the effects of the project on the local environment, classifies potential effects remaining after mitigation, and describes monitoring and follow-up programs.
Environmental Impact Statement	A document that contains the environmental assessment for a project, and can also include details on the project description, engagement, mitigation measures, residual and cumulative effects, accidents and malfunctions, and effects of the environment on the project.
Freeze pipe	As it relates to the freeze wall, a pipe that is used to deliver the cold brine solution to the ground in a controlled manner to remove heat from the ground and create a freeze wall. The brine, warmed by the ground, is returned to the top of the freeze pipe in the gap between the injection tube and casing of the freeze pipe.
Freeze wall	A wall of frozen ground extending from surface down to basement rock. The freeze wall is used to limit groundwater movement into the vertical area in and above the mining area and, in conjunction with well design and hydraulic containment from pumping, contain solutions (mining solution and uranium bearing solution) within the mining area.
Geomembrane liner	A synthetic material with low permeability used to control or prevent the migration of a liquid or gas.
Geosynthetic clay liner	A liner made of geotextiles and bentonite to prevent the migration of a liquid or gas.

Term	Definition
Greenhouse gas	A gas in the Earth's atmosphere that absorbs and emits infrared radiation. The most common examples include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).
Industrial Wastewater Treatment Plant	The wastewater facility for the treatment of industrial wastewater, including wastewaters produced in the processing plant during uranium extraction and from other various sources (e.g., wash bay sump water, leachate from the industrial landfill, wellfield runoff pond).
Industrial Wastewater Treatment Plant Precipitates	Precipitates generated in stage 2 of the Industrial Wastewater Treatment Plant which are non-radioactive and planned to be decommissioned on site.
Injection tube	As it relates to the freeze wall, a tube in a freeze pipe that delivers cold brine solution to freeze the ground around the pipe.
Injection well	The well that delivers mining solution to the uranium ore deposit.
In situ recovery	A mining method that uses a water-based solution, fortified with mining reagents, to dissolve naturally occurring uranium from within a host rock, while the host rock remains in place (in situ) below surface.
Laydown	A laydown is an area on a construction site where tools, materials, equipment, and vehicles are stored temporarily when they are not in use.
Lixiviant	A chemical used to extract a particular element from ore. The lixiviant for the Project is referred to as mining solution.
Mining solution	An acidic solution prepared on site by adding reagents, such as sulphuric acid, hydrogen peroxide, and ferric sulphate, to water.
Mining area	Underground area where in situ recovery mining occurs and within which mining solutions are contained. The maximum extent of the mining area is roughly 90 m wide x 750 m long x 50 m high. This is the approximate wellfield width and length, with consideration for the maximum vertical migration of mining fluids above the ore zone.
Mud rotary drilling	A drilling technique that uses a rotating drill bit to grind rock as the drill bit advances and then uses drilling mud to transport the drill cuttings up to the ground surface.
Ore zone	Location of the economic portion of the deposit that is being mined
Permeable	The ability of a material to allow fluids or gases to pass through. Conversely, an impermeable material would not allow fluids and/or gases to pass through it.
Primary containment of mining solution	Primary containment of mining solutions is achieved through well design and operation. Each well will have double containment, wells will be constructed of materials resistant to the mining solution, wells will be pressure grouted from the ore zone to surface, wells will tested for mechanical integrity prior to commissioning to confirm an adequate seal from surface to the well screen at the mining area. Operational monitoring of pressure and flow will provide assurance of proper functioning of wells.
Process precipitate	Process precipitates are radioactive precipitates that contain economic concentrations of uranium and are generated in the process precipitate removal circuit in the processing plant and in stage 1 of the Industrial Wastewater Treatment Plant.
Processing plant	The processing plant will house the tanks and equipment to process the uranium bearing solution recovered from the in situ recovery wellfield into yellowcake.
Project area	The area within which the Project and all components/activities are located. It was developed by applying a buffer around the Project footprint and represents the area of maximum physical disturbance. This area is consistent throughout the environmental impact statement for all valued components and is 169.6 ha.
Project footprint	Anticipated, direct footprint of Project components. This area of direct physical disturbance is estimated to be 74.8 ha.

Term	Definition
Pumphouse	A pumphouse is a small building or container on the surface where pipes from injection and recovery wells in the wellfield are operated and mining solution flows are monitored.
Recovery well	The well that brings the uranium bearing solution from the mining area up to surface.
Secondary containment of mining solution	Secondary containment of mining solutions is via pumping and creating hydraulic gradients to control fluid movement.
Special waste	Includes mineralized core and cuttings from well development that have uranium containing materials.
Uranium bearing solution	Mining solution containing uranium that is extracted from the uranium ore deposit by way of the recovery wells and is then processed into yellowcake in the processing plant.
Tertiary containment of mining solution	Tertiary containment of mining solutions is proposed to be a freeze wall that extends from the surface to the basement rock, isolating the mining area from regional groundwater.
Wellfield	A group of injection and recovery wells, installed, and completed in the ore zone for in situ recovery mining.
Yellowcake	uranium ore concentrate or U_3O_8 (triuranium octoxide)

2 Project Description

Section 2 of the Environmental Impact Statement (EIS) describes the Wheeler River Project (the Project) as it is planned to proceed through Construction, Operation, Decommissioning, and Post-Decommissioning phases. This section provides a timeline for the Project and describes the anticipated Project components and activities. Project alternatives and ancillary projects are discussed. The Project information is presented at a level sufficient to provide confidence in the effects assessments, recognizing that the Project engineering is currently at a prefeasibility-feasibility level and Project design details will be refined over time through to the permitting and licensing phase.

2.1 Purpose of the Project

The purpose of the Project is to construct, operate, and decommission an in situ recovery (ISR) uranium mine and processing plant to provide uranium supply for the increasing demands for nuclear power generation. Denison's goal is to achieve this while continuing partnerships with communities of interest, integrating information from Indigenous and public Interested Parties, and maintaining high standards for environmental protection and worker safety.

2.2 Project Components

The following subsections describe the anticipated Project components. An overview of proposed Project components and site layout is provided in Figure 2.2-1.

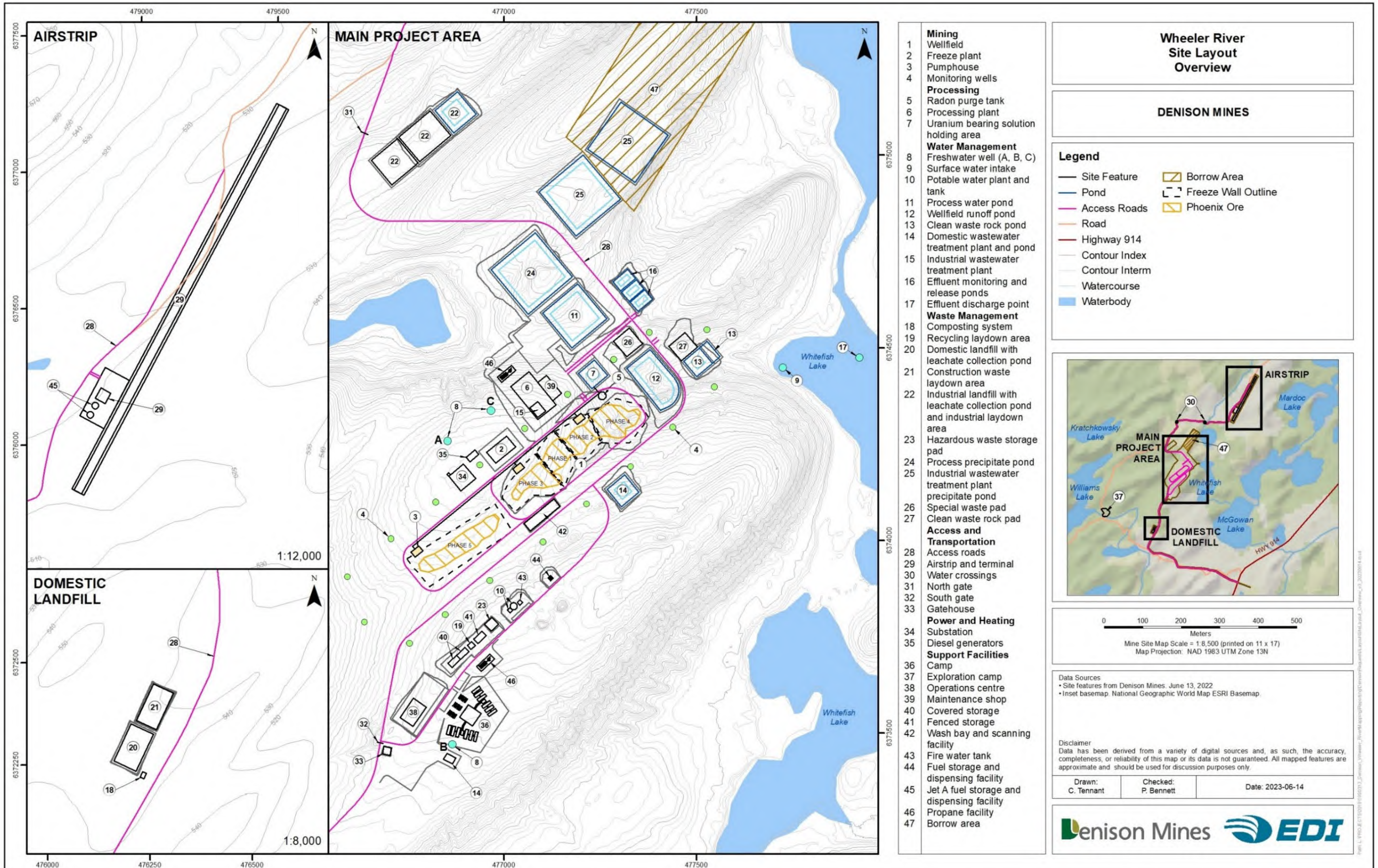


Figure 2.2-1: Wheeler River Project Proposed Site Layout

2.2.1 Mining

In situ recovery of uranium is the mining method proposed for the Project. An overview of the ISR process is provided in Figure 2.2-2 and the details will be provided in this section of the EIS. Figure 2.2-3 provides a to-scale image to illustrate the depth to the deposit (approximately 400 m) and length of wellfield (approximately 750 m) relative to the height of people and a typical transport truck on the ground surface.

Denison discussed potential mining methods early in the engagement process for the Project. In 2018, Denison organized a series of workshops with Communities of Interest and stakeholders. Given the history of uranium mining in northern Saskatchewan, there is a wealth of knowledge on various mining methods, and input was requested on which method would be best suited to efficiently and safely mine the Phoenix deposit. ISR mining for uranium is new to northern Saskatchewan and Canada. Because of this, some participants had reservations about ISR since it has not been previously used to mine uranium in the region. Other comments that the process reminded them of fracking, which carried a negative connotation (18-EN-VB-4.54[1]; see Section 2.2.1.4 for comparison of ISR to conventional oil and gas fracking). Some workshop participants were unsure how to evaluate the potential benefits and/or drawbacks of this mining method (18-EN-VILX-3.69). Other participants were confident in the method, saying they know it works in other countries, there are minimal waste streams, and the method is more economically feasible than other methods (18-EN-VILX-3.68). A participant in the Village of Beauval workshop preferred the small footprint and smaller environmental impacts of ISR compared to other methods (18-EN-VB-4.51). New opportunities are welcomed in the area, as they can support local businesses, provide training and learning opportunities, and keep money within the local economy (16-EN-MLA-109.26, 18-EN-VB-4.51).

[1] See Appendix 2-A for a summary of unique identification numbers from the Engagement Database referenced in this section.

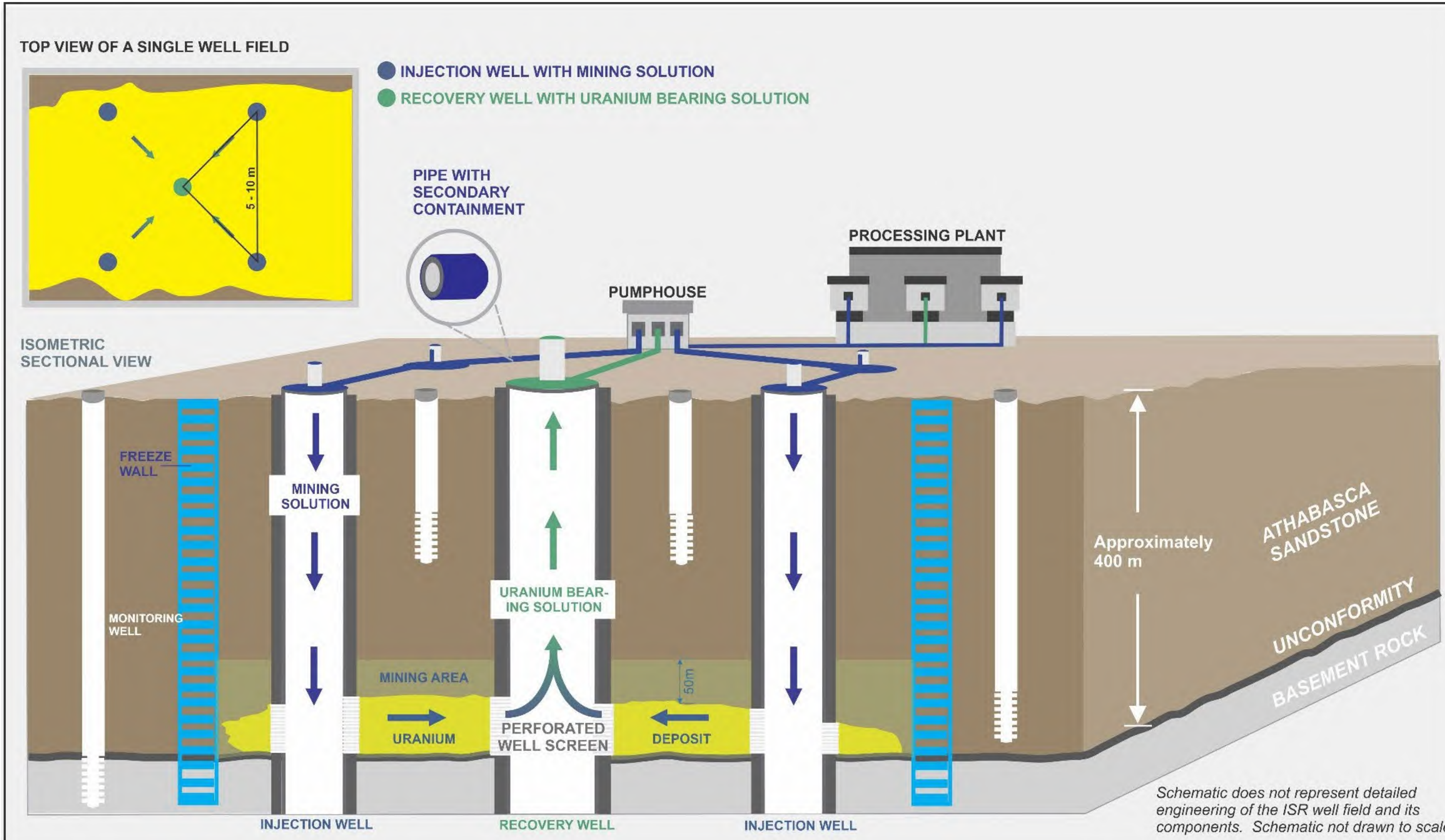


Figure 2.2-2: Overview of the In Situ Recovery Process

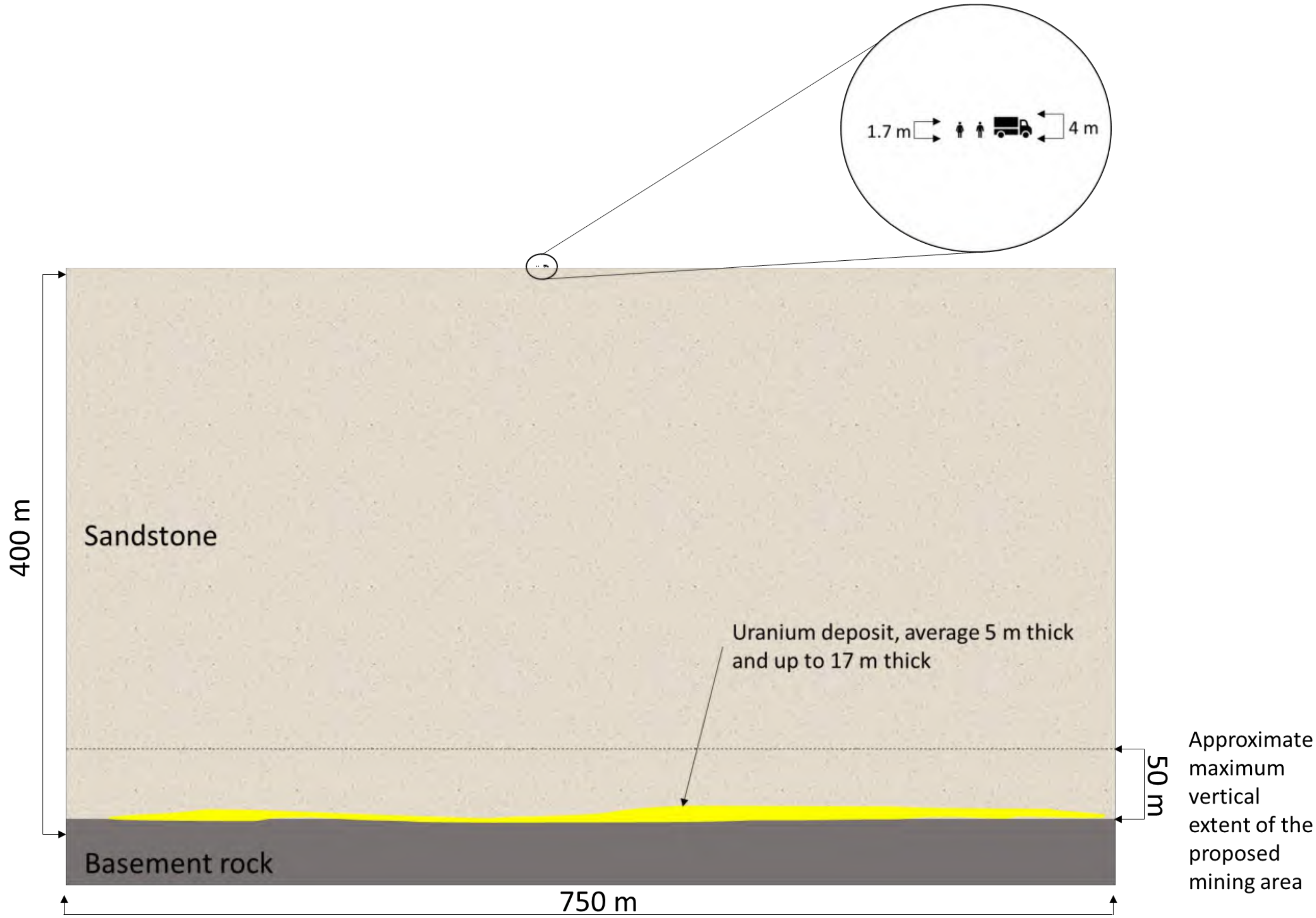


Figure 2.2-3: Approximate Depth to Deposit (400 m) and Length of Wellfield (750 m) Relative to People and Truck on Surface

The next subsection describes Project reserves and production. The general components of the mining process are presented in the subsequent sections and include an overview of drilling, freeze wall, wellfield, and the monitoring well network.

2.2.1.1 Reserves and Production

The Project proposes to use the ISR method to mine uranium from the Phoenix uranium deposit. The deposit is a high-grade (average grade 19% uranium ore concentrate [i.e., triuranium octoxide or U_3O_8]) with approximately 70.2 million pounds (Mlbs) of U_3O_8.

Denison has bound the environmental assessment above the deposit indicated resources of 70.2 Mlbs U_3O_8. The assessment basis for this EIS assumes an annual average production of 9 million pounds U_3O_8, with an annual peak production of 12 million pounds U_3O_8, over an operating period of 15 years. This conservative assessment basis provides operational flexibility from one year to the next and appropriately bounds the assessment of effects.

Note this is different than what was proposed in the Provincial Technical Proposal and Federal Project Description (Denison 2020), which suggested the EIS would evaluate an annual average production of 12 million pounds U_3O_8 over an operating period of 20 years. As reserve estimates and Project definition became refined over the intervening period, the need to assess this higher production was deemed unnecessary and unduly conservative.

2.2.1.2 Drilling

Well-established drilling techniques will be used to create the holes for the injection and recovery wells that make up the wellfield, the holes needed to create the freeze wall, and the holes for various monitoring wells. Considering this, an introduction to drilling techniques are provided here.

Two types of drilling have been successfully tested at the Project as part of Project development and exploration work: mud rotary drilling and diamond drilling. These two main drilling techniques are expected to be used for the ISR wellfield, groundwater monitoring well, and the freeze hole drilling required for the Project.

2.2.1.2.1 Mud Rotary Drilling

Mud rotary drilling is one of the most common methods of well drilling in Canada and may be used for the Project. Mud rotary drilling is generally used to develop larger diameter wells (greater than 7 inches or 17.78 cm) compared to diamond drilling. Mud rotary drilling may be used for installation of injection and recovery wells as the creation of a larger well will facilitate installation and operation of downhole equipment such as pumps.

A drilling bit is threaded onto drilling rods to be pushed down by the drilling rig to create a borehole for the well (Figure 2.2-4). The drilling rig rotates the rods and drilling bit, which grinds the rock, forming the borehole. The rock in the Project Area is sandstone. As the drilling bit grinds the rock, it creates drill cuttings, which are small pieces of the rock that have been broken down by the drilling bit. At the Project Area, the cuttings created are fine sand grains from the broken-up sandstone.

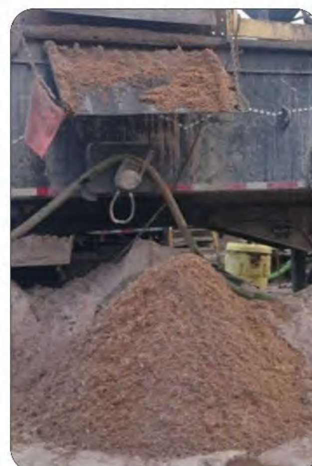
To remove the cuttings, mud must be circulated through the drilling pipe and out through nozzles in the drilling bit. The mud is a mixture of water, clay, and environmentally friendly polymers that clean out the cuttings and help to keep the drilling bit cool. The mud returns to surface on the outside of the drilling rods, carrying the fine sand grain particles with it. Once the mud returns to surface, it is collected by a hose line and run through a centrifuge to remove the solid sand grain cuttings and recover the liquid mud to be sent to the mud tank (Figure 2.2-4) to be reused (i.e., recirculated back down the drilling rods). Because the mud is reused, the volume of water required to drill the well is relatively small, even though the instantaneous flow rates are high through the drilling rods. Drilling a mud rotary well will require approximately 250 m^3 of water. The volume of clean sand grain cuttings produced for one mud rotary drilled well is approximately 16 m^3, or about 32 tonnes.


Mud rotary drilling bit


Drilling rods


Truck mounted mud rotary drilling rig


Centrifuge


Fine grain sand cuttings


Mud tank

Figure 2.2-4: Mud Rotary Drilling Photos

2.2.1.2.2 Diamond Drilling

Diamond drilling uses a hollow bit with a surface containing low quality diamonds. It produces a long cylinder of rock referred to as a core. Diamond drilling is the planned drilling method for installation of freeze holes and may also be used for some injection and recovery wells. This is the most common method of mineral exploration drilling in Saskatchewan and is also a common method of freeze hole drilling at northern Saskatchewan uranium mines. Diamond drilling methods can be used to create wells that are up to 5.5 inches or 13.97 cm in diameter.

A diamond-embedded coring bit is threaded on to drilling rods to be rotated and pushed down by the drilling rig to core a hole in the ground and recover solid pieces of rock (Figure 2.2-5). The drilling rig rotates the rods and drilling bit, cutting rock cores (Figure 2.2-5), which are then recovered and brought to surface. The volume of fine grain sand cuttings produced by the diamond drilling bit is very small because most of the sandstone rock is recovered intact (i.e., core).

To keep the diamond drilling bit cool and to remove sand cuttings from the bottom of the drilling bit, mud must be circulated through the drilling pipe and out through the bit. The mud is a mixture of water, bentonite clay, and environmentally friendly polymers. A single diamond drill hole will require approximately 400 m^3 of water. The flow rates of mud required for diamond drilling are much lower than the rates needed for mud rotary drilling, approximately $1/50^{th}$. Because of this, the mud does not make it back to surface and no fine grain sand cuttings are produced on surface. This also means that the drilling mud cannot be recirculated into the drilling rods and more water is required to create fresh mud. Cores can be saved and stored in core boxes for future study, or they can be placed on the clean waste rock pad if not required for further analysis. The volume of solid sandstone core produced for each hole is approximately 2.4 m^3, or about 6.2 tonnes.

Diamond drilling bit

Sandstone core

Recovered sandstone core stored in a core box

Two diamond drilling rigs

Figure 2.2-5: Diamond Drilling Photos

2.2.1.3 Freeze Wall

ISR mines typically operate without freeze walls, as the containment of mining solution is achieved primarily through hydraulic control of the injected and recovered fluids and secondarily through the well design. Denison is proposing a freeze wall for tertiary containment of mining solution to support a defence in depth strategy as additional, site-specific data is obtained on hydraulic containment. The role of the freeze wall within the broader mining solution containment strategy is discussed in more detail in Section 2.2.1.4; and considered further in Section 2.3.1 Mine Plan (and see Figure 2.3-1).This subsection of the EIS is focused on outlining the steps required to establish the freeze wall.

Ground freezing technology is well established throughout the world. Its use in a mining environment was pioneered in Saskatchewan’s potash mining industry for shaft sinking activities, and later adapted for use in Saskatchewan’s uranium industry. Ground freezing to control and eliminate groundwater from entering the mining areas is a fundamental component of two existing Athabasca Basin underground uranium mines: Cameco Corporation’s McArthur River Operation and Cigar Lake Operation.

The freeze wall will be established by drilling vertical holes from surface to the basement rock (over 400 m below surface). The freeze holes will be spaced approximately 5 to 10 m apart. Over 300 freeze holes are estimated for the Project. The ground will be frozen from surface down to the low permeability basement rock to create a continuous wall around the mining area that is completely contained from the surrounding regional groundwater.

The drill holes for the freeze wall will be made using diamond drill methods. Once the drill holes have been installed, a chilled brine solution (e.g., calcium chloride brine) will be circulated through the cased holes to remove heat from the ground (Figure 2.2-6). A freeze pipe is comprised of an inner injection tube that delivers cold brine to its far end within a sealed steel casing. The brine then returns to the collar of the hole via the annular gap between the injection tube and the casing. Denison received this helpful perspective on the freeze technology during a presentation to high schools: “Isn’t it correct to say the brine is in a closed loop system? Like in an artificial ice rink? The brine doesn’t go into the environment? Is that correct?” (21-EN-YOUTH-445.6).

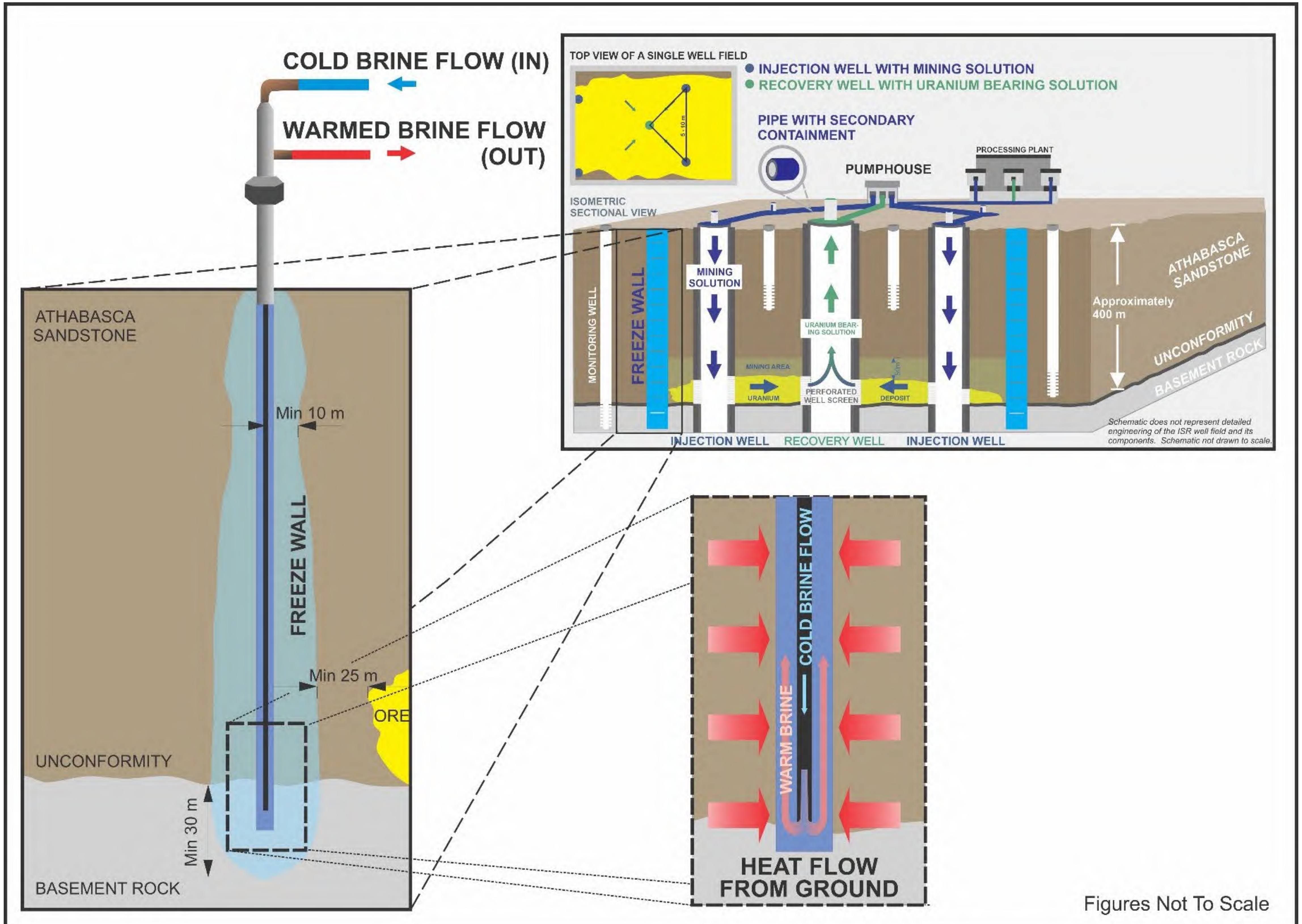


Figure 2.2-6: Illustration of Heat Transfer from Ground to Annular Flow in a Typical Freeze Pipe1

The three stages of ground freezing are column, closure, and wall (Figure 2.2-7). In the early weeks of freezing, initial closure is being established. Initial closure occurs when the frozen ground columns, growing around an individual freeze pipe, intersect with the adjacent pipes' frozen column; the hydraulic connection between the outside of the freeze circle and the inside is cut off; and the frozen columns around each pipe grow together and in thickness to create a wall. The freeze wall is expected to be several metres thick and will be developed around the uranium deposit to minimize freezing of the uranium deposit itself.

The thickness of the freeze wall is controlled by cycling the freeze system on and off once the desired thickness is achieved to prevent overgrowth or unwanted thawing. A monitoring network of continuous fiberoptic cables are installed in specific location both within and on the outside of the wall to monitor the freeze development and guide the freeze system cycling. This system proposed is solar powered and uploads data directly and live to a cloud service for data history and operational purposes.

Current plans are for the freeze wall to be a minimum of 10 m thick, be installed 25 m away from the uranium deposit, and extend 30 m into the basement rock (Figure 2.2-6).

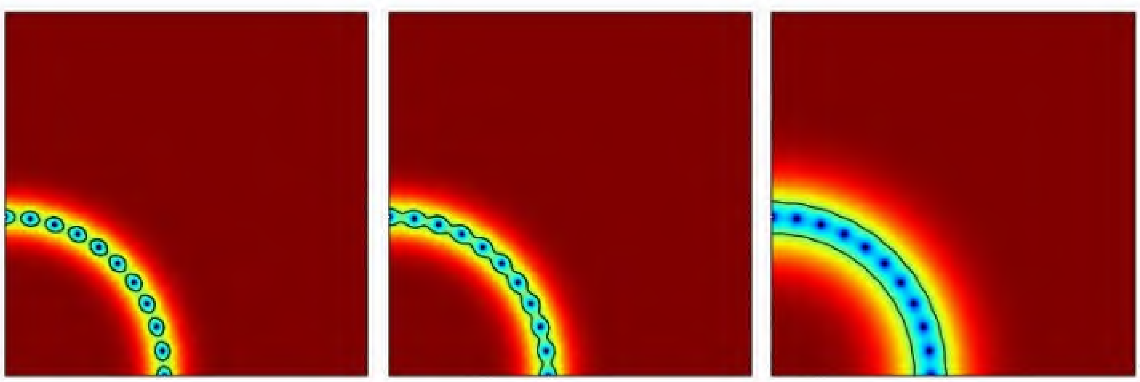


Figure 2.2-7: Stages of Ground Freezing: Column, Closure, and Wall

2.2.1.3.1 Freeze Plant

A freeze plant will be required on surface near the deposit where the freeze holes are collared (Figure 2.2-1). The freeze plant will be modular for easy installation and operation as more chiller units will be added as ground freezing needs increase. Each chiller unit produces about 300 tons of refrigeration and contains an ammonia compound compressor, which is run by a 1,000 horsepower motor. The brine distribution system is handled by a surface brine mixing tank that can move brine to the freeze holes at 300 m^3/hr. The freeze plant capacity is expected to be scaled up throughout the mining phases based on refrigeration requirements, from two chiller units at the start up to a total of six units. The approximate size of the freeze plant with six chiller units is 27 m x 64 m (i.e., under 1,800 m^2).

Piping will be required between freeze holes and the freeze plant. The piping is expected to be insulated polyethylene pipes joined by electrofusion. The piping will be installed in a poly-lined trench on wooden blockings.

The freeze plant will operate using electrical power from the grid, with back-up diesel generators (see Section 2.2.6 for Project power information). The freeze plant will be designed with ammonia safety in mind to monitor for and minimize risks to workers and the environment from potential ammonia leaks.

2.2.1.3.2 Freeze Wall Timeline

Modelling predicts that each section of the freeze wall will require approximately 12 months to be established. The freeze wall will be created in phases to support the mine plan (see Section 2.3.2).

After Decommissioning and remediation is complete (see Section 2.3.3), refrigeration will be turned off and the freeze wall will begin to melt. The removal of the freeze wall will allow groundwater to re-establish its original flow path through the area (22-EN-VB/ERFNLP-619.6). It will take a minimum of 12 months for the freeze wall to thaw, depending on how long the freeze wall was active and ground conditions encountered.

2.2.1.4 Wellfield for In Situ Recovery Mining

The ISR wellfield is a group of wells, installed, and completed in an area where uranium mineralization is present. The Project wellfield will consist of a combination of injection and recovery wells. In general, the arrangement is one recovery well in the centre surrounded by four injection wells. This is referred to as a five-spot pattern. At surface, the spacing between the recovery well and each injection well is anticipated to be approximately 5 to 10 m (Figure 2.2-1). With these configuration options, the wellfield is expected to include approximately 300 wells over an area measuring 90 m wide x 750 m long.

A variety of alternative arrangements or patterns of injection and recovery wells may be used and may include other vertical or horizontal arrangements. The final details of the wellfield design (e.g., pattern on surface, distance between wells, the orientation of wells, number of pumphouses) will be developed as Project engineering advances through engineering design stages. Additionally, continual improvement of the wellfield design will be ongoing throughout Operation.

2.2.1.4.1 Wellfield Installation

Figure 2.2-8 provides an overview of Denison's current conceptual injection and recovery well installation sequence based on current level of engineering. Specific details of well installation and design may change as the Project advances through engineering design stages.

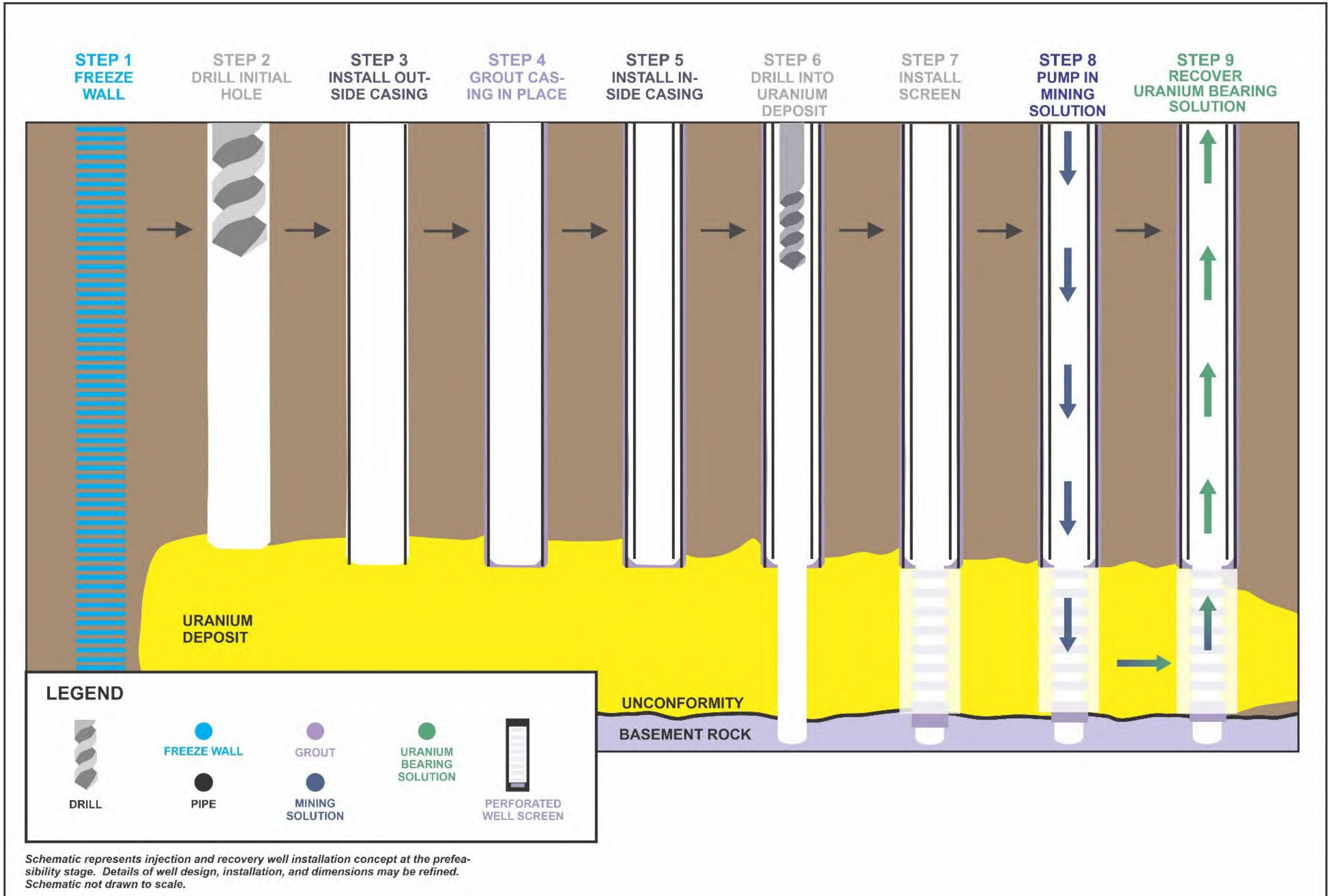


Figure 2.2-8: Proposed Injection and Recovery Well Installation Sequence

The method for drilling the wellfield injection and recover wells is anticipated to be mud rotary drilling. A mud rotary drill will be used to drill from surface to above the ore zone. The outside casing will be installed and grouted in place. Both grout and cement can be used for stabilizing casing during the well installation process. Generally, cement is used when a less viscous material is needed to flow through fine pore spaces and fractures and grout is used when a more viscous material is needed to flow through coarse pore spaces and stabilize the ground. Raw powdered cement and grout mix will be obtained from third party drill contractors and mixed on site within the batch plant tanks for use by drill rigs. The cement and grout process will be the same for both diamond drilling and mud rotary drilling.

Next, the inside casing will be installed inside the outside casing. This design provides secondary containment of mining solution (Section 2.2.1.4.2.2). The inside casing will be constructed of materials resistant to the mining solution. During a virtual presentation to the high school in English River on the Patuanak Reserve, students communicated the importance of avoiding groundwater contamination (21-EN-YOUTH-448.1). Denison then explained the various safeguards that have been incorporated, including the well design and installation process.

The casings will be made of materials resistant to the acidic mining solution and will need to meet other design ratings such as tensile strength and operating pressures. The outer casing may be constructed of fibreglass reinforced plastic or coated mild steel and the inner casing may be coated mild steel, fibreglass, or boreline flex hose.

A drill (diamond or mud rotary) will re-enter the hole and go through the ore zone, creating either a core or drill cuttings which contain uranium and will be recovered, brought to surface, and placed on the special waste rock pad. A perforated well screen will be installed at the ore zone interface. The well screen creates the interface where the mining solution from an injection well enters the ore zone and where the uranium bearing solution enters a recovery well.

The planned water sources for mud rotary drilling include, but are not limited to, freshwater (from a groundwater well or surface waterbody), treated effluent from the domestic or industrial wastewater treatment plant, and water collected at the clean waste rock pond.

After a well has been completed and before it is made operational a mechanical integrity test of the well casing will be completed to make sure the installation has been successful and the well is functioning as designed. Well casings that fail integrity tests will be repaired before the well is placed into service.

Figure 2.2-9 shows photographs of a typical ISR well at surface and a standard type of well cover.

Figure 2.2-9: Typical In Situ Recovery Well at Surface

2.2.1.4.2 Wellfield Operation

The acidic mining solution, injected from surface pumphouses via a series of injection wells, enters the mining area from well screens located at the base of the injection wells (Figure 2.2-2). Uranium is dissolved in place (i.e., in situ) as the mining solution travels from an injection well towards a recovery well (Figure 2.2-10). The mining solution now contains uranium and is referred to as uranium bearing solution (UBS). The UBS is pumped to surface by a recovery well (Figure 2.2-2).

Conceptually, based on an individual five-spot pattern (Figure 2.2-2), four injection wells could each inject mining solution at a rate of 7.5 L/minute and the central recovery well would recover uranium bearing solution UBS at 30 L/minute. In terms of pressures, ISR mining is planned at nominal pressures of 100 psi and intermittent pressures of up 250 psi. Denison has completed laboratory studies to replicate the ISR process. These studies used mineralized drill core from the Project and demonstrated that uranium can be consistently recovered. Laboratory studies found steady-state and average UBS head grades above 15 g/L.

Throughout mining, Denison plans to primarily control the mining solution within the mining area via pumping. To achieve an inward hydraulic gradient and control of solutions within the mining area, an area of lower pressure is created by a recovery well to continuously draw solution from areas of higher pressure (e.g., injection wells).

Figure 2.2-10: Wellfield Operation at the Mining Area

Operational parameters may include injection pressures, injection flow rates, and recovery flow rates. The flow rate in the wellfield pattern will be mainly determined by permeability, hydraulic head of the targeted mining area above the recovery well screens, and spacing between injection and recovery wells. Denison has successfully installed injection and recovery wells which passed mechanical integrity tests, and documented pressure and flow control during a tracer study completed in 2021 and the feasibility field test initiated in 2022.

As Denison advanced the Project as an ISR operation, it was common to receive questions about how the mining method compared to hydraulic fracturing or fracking, most commonly associated with the oil and gas industry. For instance, when mining options were presented at workshops in 2018, some members of the communities had reservations with ISR because it reminded them of fracking and fracking carried negative connotations (18-EN-VB-4.54). Conventional fracking pressures used in the oil and gas industry can vary; however, common pressures to induce fracturing can range up to 15,000 psi and require injection of fracking fluids of up to 16,000 liter per minute over periods of three to four days. Fracking fluids are comprised of a slurry of water, proppant (generally silica sand), and chemical additives to support and maintain the open fracture system after fracking is conducted. Conversely, ISR mining for the Project is planned at nominal pressures of 100 psi, intermittent pressures of up 250 psi, and average flow rates of 30 liters per minute within a recovery well. The ISR mining method proposed for the Project is markedly different than fracking. Looking at intermittent pressures alone, ISR pressures are anticipated to be 60 times lower than fracking pressures.

2.2.1.4.2.1. Primary Containment of Mining Solution – Wells

Primary means of mining solution containment involves the wells themselves. The well designs and operational monitoring of the wellfield will mitigate accidental release of mining solution or UBS in the sandstone above the mining area. Each well will have double containment: mining solution will travel inside an inner casing with the outer casing acting as secondary containment for the mining fluids. Denison received specific questions about well design and if a liner would be included in the wells (21-EN-FDLFN-570.16). As described earlier, wells will be constructed of materials resistant to the mining solution that meet well design specifications. Wells will be pressure grouted from the ore zone to surface and tested for mechanical integrity prior to commissioning to confirm an adequate seal from surface to the well screen at the mining area.

2.2.1.4.2.2. Secondary Containment of Mining Solution - Pumping

In existing ISR operations, mining solution containment is normally achieved through naturally impermeable geological layers (aquitards) or by artificially creating a drawdown of the water table by pumping. At the Project, the very low permeability basement rock below the uranium deposit serves as a natural aquitard; however, the sandstone hosting the uranium deposit is permeable and groundwater can flow horizontally through the deposit.

Hydrogeological studies and models completed show that mining solution within the mining area can primarily be controlled by maintaining an inward hydraulic gradient. The inward hydraulic gradient will be created by recovering more solution than is being injected. In general, the wellfield will operate to draw a minimum of 1% more solution out of the wellfield compared to solutions injected in. This will help avoid increased subsurface pressures from injection pressure build up within the deposit. Inward hydraulic gradient is controlled by instruments installed within the injection, recovery, and monitoring well networks to assess that lower pressures are always present at the recovery wells to produce the inward gradient. If pressures begin to increase within the active mining area or decrease outside of the active mining area, pumping and injection rates can be adjusted accordingly to re-establish the desired gradient. Perimeter pumping wells will be installed vertically, horizontally, and laterally surrounding the mining area both inside and outside the freeze wall with the ability to capture fluids by pumping when required and recycle solutions should the primary containment system not perform as expected. This combination of pumping creates a secondary means to contain mining solution within the mining area. In the case of an upset condition, such as pump failure, or scheduled pump maintenance when a given extraction well would be shut down purposefully, the fluids that would normally be recovered by a particular extraction well would then temporarily be recovered by one of the adjacent extraction wells within the larger extraction well network. When the upset conditions or scheduled maintenance have been completed, the "normal" mining solution recovery pattern would be restored to the original flow path. In this way, and by design, hydraulic containment is maintained at all times.

Groundwater modelling and flow path analysis calibrated to field conditions have evaluated upward solution migration and demonstrated that the maximum height that injected fluids will migrate upwards from the ore zone during active mining is likely between 11 to 13 m. For conservatism, a 50-m vertical zone above the deposit was included in the assessment as potentially disturbed by mining activities. This entire area is referred to as the mining area, although the active mining area is expected to be a smaller area within the broader mining area and is the area immediately within the ore zone. The ore zone has an average thickness is 5 m, with a range of 2 to 17 m.

2.2.1.4.2.3. Tertiary Containment of Mining Solution - Freeze Wall

As a tertiary means of containment for the mining area, the uranium deposit is proposed to be surrounded by freeze wall that extends from the surface to the basement rock, isolating the mining area from regional groundwater. The freeze wall design is discussed in Section 2.2.1.3. Current plans are for the freeze wall to be a minimum of 10 m thick, be installed 25 m away from the uranium deposit, and extend 30 m into the basement rock (Figure 2.2-6).

Using a tracer (salt dissolved in water), feasibility field tests conducted in 2021 showed hydraulic containment was achieved with pumping. For the purposes of the EIS, a freeze wall has been assumed to be in place. The need for tertiary containment of mining solution is an important area of technical study that Denison will advance through Project design and into Operation.

2.2.1.4.3 Permeability Enhancement

In situ recovery relies on fluid movement within the ore zone. Several permeability enhancement techniques have been considered for the Project to essentially enhance the existing fracture network to improve the uranium recovery. These techniques include mechanical, propellant, and hydraulic options. Denison may use permeability enhancement techniques on injection and recovery wells to increase hydraulic connectivity within the wellfield.

Mechanical permeability enhancement uses a downhole tool that produces clean flowpaths radially from an existing borehole into the ore zone (Figure 2.2-9 and Figure 2.2-11). The tool uses mechanical pressure excavation methods to drill ‘penetration tunnels’ out from the borehole. The resulting tunnels can be up to 1.8 m in length and 1.8 cm in diameter. Mechanical permeability enhancement methods can reach pressures up to 4,000 psi and occur intermittently over a 24-to-48-hour period pending the number of penetration tunnels drilled in a given well.

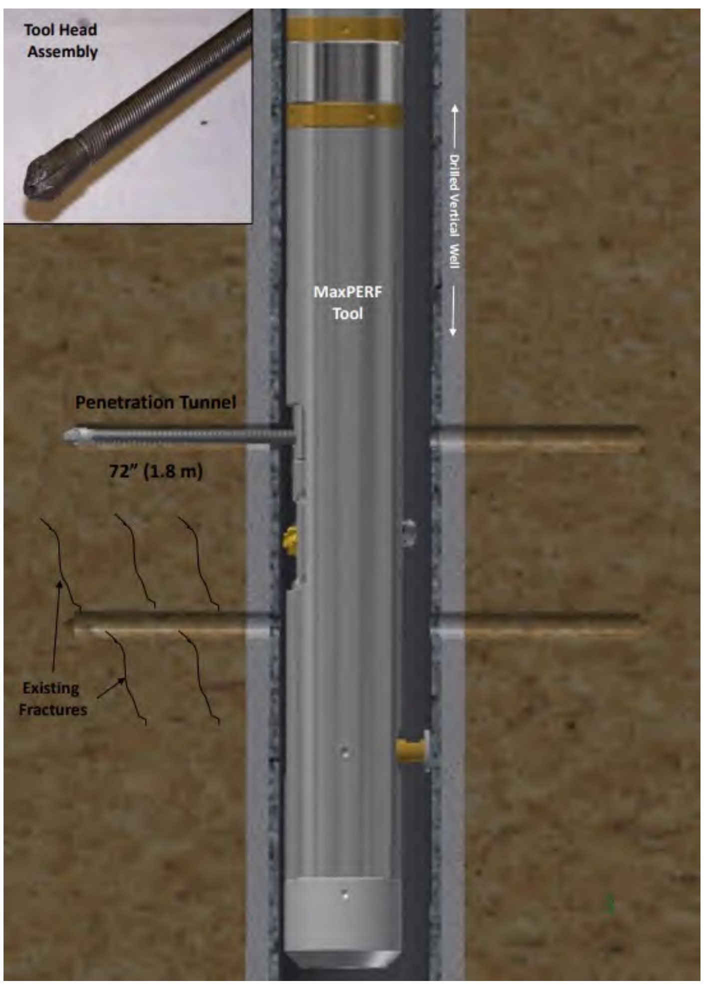


Figure 2.2-11: Example of Permeability Enhancement Technique - Mechanical Option

Propellant permeability enhancement methods are wireline-conveyed tools designed to perforate and stimulate well production using a controlled propellant. These may be progressively burning solid propellants or gas injection. The wireline tools effectively clean out restricted pathways within the well screen, well bore, and the geological formation and provide increased flow rates in the wells by intersecting and connecting to the naturally occurring fractures within the mining area.

Propellants used are typically classified as a low hazard explosive (S.1 special-purpose explosives, low hazard explosives, per *Explosive Regulations*, section 36). Propellants technically do not explode (like classic mine explosives which detonate) but rather burn through a process called deflagration. Deflagration means the material burns slower than the speed of sound, thus no shock waves are generated. Propellant permeability enhancement methods reach injection pressures of up to 8,000 psi and are near instantaneous over periods of milli seconds.

Hydraulic permeability enhancement is a technique involving the flushing of bedrock formations. The process involves injection of water into a wellbore to create access to existing fractures in the defined formations that may not have been previously connected to the main fracture network due to clays, sands, or other materials being present in the fractures themselves. After hydraulic permeability enhancement, mining solutions may flow more freely. Hydraulic enhancement can be used as a means of flushing or cleaning the well and formation in preparation for mining. Hydraulic permeability enhancement pressures can reach up to 250 psi with a consistent duration of 24 to 48 hrs. By comparison, conventional fracking pressures used in the oil and gas industry can range up to 15,000 psi and require injection of fracking fluids of up to 16,000 liter per minute over periods of three to four days. The pressures expected for hydraulic permeability enhancement are well below conventional fracking pressures.

2.2.1.4.4 Pumphouses

Based on the current designs for the Project, approximately three pumphouses will be required. A pumphouse is a small building or container on the surface where pipes from injection and recovery wells are operated and mining solution flows are monitored. See photos in Figure 2.2-12 for examples of components inside an operating ISR pumphouse in the USA.

Figure 2.2-12: Inside a Typical In Situ Recovery Pumphouse

Pumphouses will distribute the mining solution to the injection wells and collect the UBS from the recovery wells. Each pumphouse will be connected to two production pipelines. One of the pipelines will be used for receiving mining solution from the processing plant, and the other will be used for returning UBS back to the processing plant (Figure 2.2-1 and Figure 2.2-2). Each pumphouse will include a manifold, valves, flow meters, pressure meters, and instrumentation, as required, to fully operate, monitor, and control the process. Pumphouse control monitoring systems enable operators to individually adjust each recovery or injection well and allow for sampling. Operators can also use the master control system in the processing plant to remotely control pumphouse production lines.

Ventilation in the pumphouses will be designed with the as low as reasonably achievable (ALARA) principle in mind to provide sufficient worker protection from potential radon and radon progeny exposure. Monitoring systems will be in place to make sure these mitigation measures are meeting design specifications.

2.2.1.4.5 Wellfield Piping System

Pipes will transport the mining solution and UBS between the wellfield and the processing plant. The flow rates and pressures of the individual well lines will be monitored in the pumphouses. These data will be transmitted to the processing plant for remote monitoring through a master control system. Through the master control system, operators will be capable of controlling pumphouse production lines remotely.

Double-walled high-density polyethylene (HDPE), or equivalent, piping will be used in the wellfields. The lines from the processing plant, pumphouses, and individual well lines will be freeze protected and secured to minimize pipe movement. The lines will be designed to have secondary containment or catchment and have leak detection systems in place at key locations.

2.2.1.4.6 Mining Solution

The uranium at the Project is amenable to the same type of leach solution that is used to leach other Athabasca Basin uranium ores in mills: an acidic (i.e., low pH) solution. Communication of the constituents used in the mining solution is very import to the Communities of Interest. As described by an English River First Nation (ERFN) member and local trapper, "*Denison needs to be much more clear that the mining solution is acidic. This is really important. When I was here* [Wheeler River Project site] *in August everyone was talking about water and there was not much mention of acid*" (19-LK-ERFNTrap-134.261). A clear understanding of the constituents used in the mining solution is an important component of ongoing engagement work.

The acidic mining solution will be prepared on site by adding reagents, likely sulphuric acid, hydrogen peroxide, and ferric sulphate, to water. The concentration of reagents required for mining will be based on previous field and laboratory test work. At any one time, it is estimated that 3,500 m^3 of mining solution will be in use in the wellfield. The liquids will be mixed to achieve the optimal parameters for the mining solution, including pH and oxidation reduction potential.

The mining solution will be pumped underground to the uranium deposit via an injection well and recovered as uranium bearing solution (i.e., mining solution now containing uranium) through a series of recovery wells (Figure 2.2-1). Once UBS is recovered to surface, it will be pumped from the wellfield into the processing plant where uranium will be removed from the UBS (Section 2.2.2). The treated solution created can be refortified with reagents as required and pumped back into the mining area to maximize water recycling during the life of the mine. Water requirements to create the mining solution will be preferentially sourced from site runoff and recycled where possible; however, to be conservative, the assessment has included options for obtaining all required water from either a shallow groundwater well or a nearby lake (Whitefish Lake). No water recycle has been included in the water balances, although it is expected to occur.

2.2.1.5 Monitoring Well Network

Groundwater monitoring wells will be installed at various depths and locations in and around the wellfield. The monitoring wells have a variety of purposes including groundwater sample collection, measurement of groundwater levels, and detection of changes in pressure and temperature in the groundwater environment.

Small groundwater observation wells will be installed and screened at various depths, from shallow sandstone to basement rock. These are polyvinyl chloride-lined wells with a bentonite clay sealed annulus, sealed at surface with cap, and have secondary containment. These wells can be used to collect groundwater samples and can be fitted with pressure/temperature sensors.

Vibrating wire piezometers (VWP) have pressure/temperature sensors grouted in place at multiple levels. These VWPs provide real time data on pressure responses as an indicator for water movement within the formation and allow Denison to make informed decisions about groundwater movement and injection and recovery well performance.

The monitoring wells network consisting of observation wells and VWPs will be configured to demonstrate effective containment of mining solutions and liquid residues within the mining area and provide early warning of any excursions. Monitoring of groundwater pressures and quality will be conducted outside of the mining area. The mining area has been defined for this Project as inside the freeze wall and up to 50 m above the ore zone. Groundwater samples taken outside of the mining area during Operation are expected to be comparable to regional groundwater quality.

Regarding the freeze wall and freeze wall monitoring, the alignment of the freeze wall is located 25 m offset from the lateral extent of the recoverable ore and the freeze wall will grow in thickness both towards the ore and away from the ore. The freeze wall will solidify all liquid porewater and develop into a contiguous impermeable barrier many metres thick. Ground temperature monitoring will be installed through a series of continuous fiberoptic temperature and pressure wells from surface to the depth of impermeable basement rock below the unconformity. Such monitoring wells/systems will be installed on both the ore (inside) and non-ore (outside) sides of the freeze wall to confirm the thickness of frozen ground. There will be sufficient operational controls in place to verify that the freeze plant is operating, to measure the temperature in the ore zone, and to measure the temperature on opposite sides (inside and outside) of the freeze wall so that early detection of any upset conditions can be identified and addressed. Options for addressing issues include: lowering the temperature of the freeze system to draw more heat out; increasing the freeze coolant flow rates in freeze wells nearer to active ISR cells; and/or to adaptively manage the lixiviant injection and recovery rates in cells located nearest to the freeze wall.

2.2.1.6 ISR Mining-Related Inputs for the EIS

It is important to note that Denison is completing a sequential EA and licensing process for the Project (see Section 1). Detailed ISR mining related information needed to support licensing and permitting has not been included in the EIS; it will be provided to regulators as part of permitting and licensing.

For the EIS, an understanding of ISR design is needed to describe potential effects related to Project activities within the biophysical environment (EIS Part II, Section 6 to 9), human environment (EIS Part III Sections 10 to 13), and accidents and malfunction (Section 14) assessments. Denison used the ISR mine design and the 3D hydrogeology and contaminant transport numerical modelling of the injection and extraction wells to determine the potential interactions between mining activities and the environment. Two key outputs from the ISR mine design and 3D hydrogeology modelling work were used as inputs for the groundwater assessment (Section 7): 1) The extent of mining solution migration away from the injection and recovery well screens, as defined by the mining area (50m above the ore zone and within the freeze wall) and 2) groundwater quality of the mining area following remediation. Monitoring will be completed during operations and decommissioning to confirm these inputs.

Importantly, since the mine design includes the freeze wall, movement of mining solution is restricted and contained horizontally during operations. Wellfield pumping provides the hydraulic containment to keep mining solution within the 50 m mining area (see Section 2.2.1.4.2). During the operation phase, and under normal operational conditions there is no interaction between the mining zone and surface water or down gradient groundwater environments, and the groundwater assessment (Section 7) focuses on the post-decommissioning period following removal of the freeze wall, once the groundwater flow paths return to pre-mining conditions. During mining area remediation (see Section 2.3.3.1.1), the freeze wall will remain in place until decommissioning objectives are achieved. Refinement of the mining area decommissioning objectives and associated modelling will be done through updates to the Decommissioning Plan, and will be bounded by the objectives evaluated in the EIS.

2.2.2 Processing

The recovery of uranium from the UBS obtained in the wellfield will be undertaken in a two-stage precipitation process. The two-stage process creates a low-grade uranium precipitate and a concentrated uranium product known as yellowcake.

Denison’s processing plans are based on numerous metallurgical tests completed as part of engineering activities. A detailed metallurgical testing program was developed and implemented in collaboration with the Saskatchewan Research Council (SRC) under the supervision of several third-party consultants and Denison. Around 1,000 L of UBS was produced by leaching over 64 kg of core samples recovered from the Phoenix deposit and the UBS produced was tested using variations of several parameters to define the processing plant design and its components.

2.2.2.1 Processing Plant Components

The processing plant will house the tanks and equipment to process the UBS recovered from the ISR wellfield into yellowcake. The building will be constructed adjacent to the wellfield to minimize piping distances and is anticipated to be approximately 63,000 ft^2 (5,850 m^2) in size (Figure 2.2-1).

The processing plant will contain a control room, laboratory, and men's and women's dries (change rooms), laundry facilities, and maintenance shop. Bulk storage tanks for various process chemical will be located within a dedicated room within the processing plant. This includes tanks for the mining solution chemicals (e.g., sulfuric acid, iron sulphate, hydrogen peroxide), milling (e.g., magnesium hydroxide, hydrogen peroxide) and the water treatment (e.g., barium chloride, calcium hydroxide also known as lime. The industrial wastewater treatment plant (IWWTP) will be located inside the processing plant and is discussed further in Section 2.2.3.8.

The processing plant will be designed using engineering best practices, taking into account potential environmental and health and safety effects and mitigating interactions to the extent possible. For instance, the floor will be graded as required and sumps will be installed to collect spills. Ventilation in the processing plant will be designed to be consistent with the ALARA principle to provide sufficient worker protection. The heating, ventilation, air conditioning (HVAC) monitoring systems will be in place to confirm worker health and safety. Dust control equipment and good housekeeping practices throughout the processing plant will also form a critical component of the Radiation Protection Program developed for the Project. The processing plant exhaust, mainly from drying and packaging areas, will be cleaned with venturi scrubbers then directed through a stack and released outside of the building. The stack height will be designed based on results of air dispersion modelling to be an appropriate height for optimal dispersion; the air dispersion model assumed stacks were at 45 m above grade or approximately 22 m above the processing plant building.

2.2.2.2 Processing Steps

Refer to Figure 2.2-13 for an overview of the proposed processing plant design.

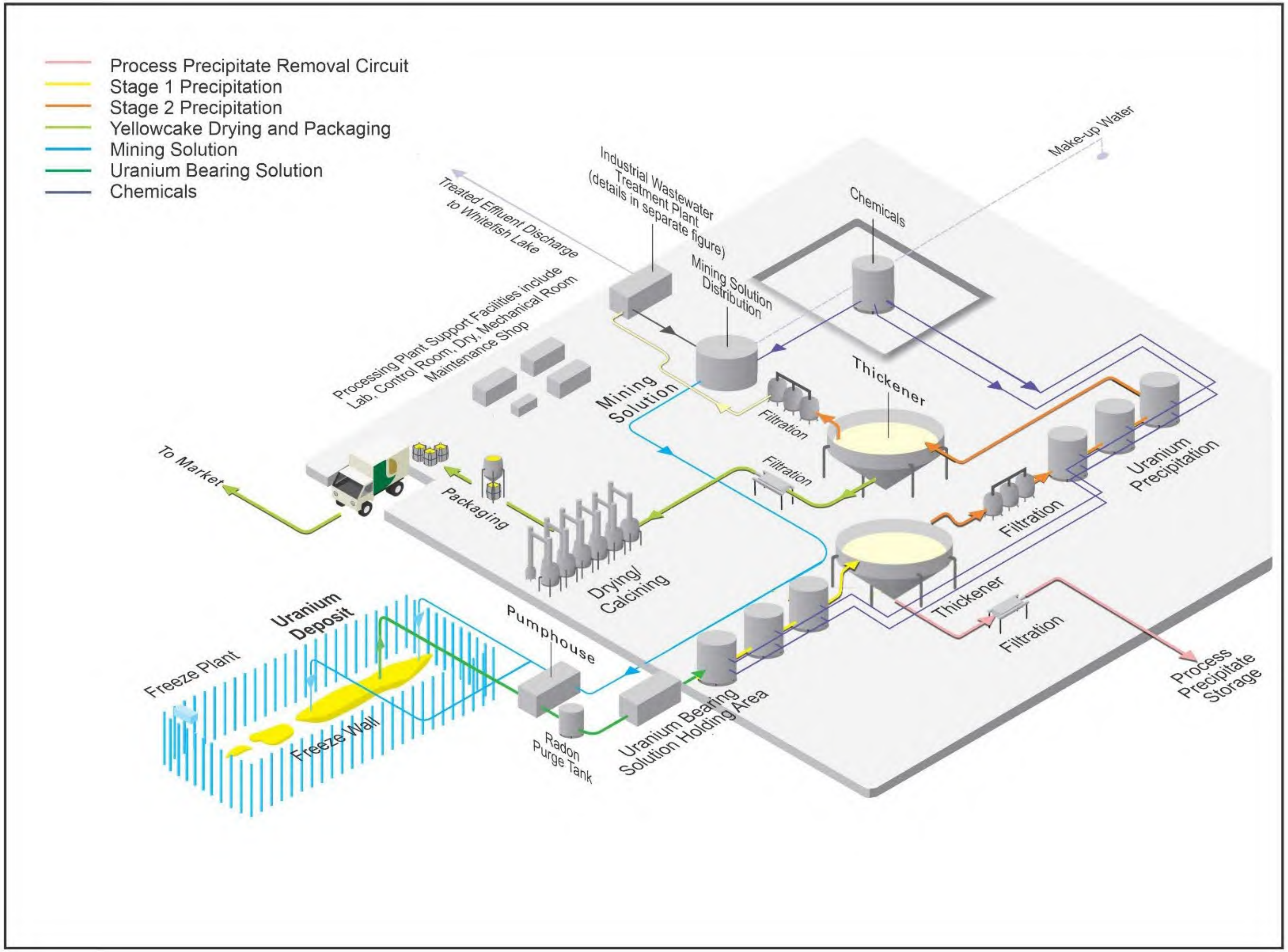


Figure 2.2-13: Processing Plant Overview

Chemicals, fresh water, and treated water from the IWWTP will be mixed to generate the mining solution that will be injected into the mining area and recovered as UBS.

The UBS will be pumped from the wellfield pumphouse(s) through the following areas and circuits that are adjacent to or inside of the processing plant.

2.2.2.2.1 Radon Purge Tank

When the uranium bearing solution comes to surface, radon gas will naturally move out of solution and into the atmosphere. To keep worker radiation exposure ALARA, a radon purge tank will be used to remove this initial volume of radon before the solution enters the processing plant. The radon purge tank will contain a mechanical ventilation system to facilitate the aeration of the solution and the removal of radon gas from the UBS to the air outside of the plant.

2.2.2.2.2 Uranium Bearing Solution Holding Area

The ISR mining and subsequent processing of uranium will not always occur at the same rates. Additionally, there will be times when parts of the processing plant are down for routine maintenance. For these reasons, Denison has incorporated a UBS holding area into the current design of the processing plant. It will be a controlled area where UBS can be safely stored on surface, prior to processing. The UBS holding area will be adjacent to the processing plant and under a fabric tension building system. The fabric tensioned roof will help to keep precipitation from entering the uranium bearing solution. The volume of the UBS holding area is anticipated to be 5,000 m^3. The area will be contained by a double composite liner system with leak detection (Figure 2.2-18). Options to use tanks instead of holding area will be evaluated as engineering advances.

2.2.2.2.3 Two-Stage Precipitation Process

The UBS from the holding tanks will be introduced into the processing plant based on target production rate requirements.

In Stage 1 precipitation reagents such as hydrogen peroxide, barium chloride, flocculant, and lime are added and the pH is increased through agitator tanks to remove process precipitates which are iron-hydroxides, associated metals, radium-226, and thorium-230. The process precipitates also contain low-grade uranium at approximately 2 to 3% grade. The process precipitates will be temporarily stored on site prior to sale and transportation to a licensed offsite facility for processing as part of Decommissioning. The overflow product from Stage 1 precipitation is a purified UBS that will be further processed in Stage 2 precipitation.

In Stage 2 precipitation, additional pH adjustments and flocculant additions are made to the solution, which is then allowed to settle and dewater as uranium oxides within the yellowcake precipitation thickener. This form of uranium concentrate is yellow, giving it the term yellowcake. The precipitated uranium will be transferred to the yellowcake drying and packaging area, and the overflow liquid solution will be filtered and transferred to the industrial wastewater treatment circuit.

2.2.2.2.4 Yellowcake Drying and Packaging

Following Stage 2 precipitation, the uranium solids are transferred from the thickener underflow to a filter system to further reduce the moisture content prior to drying. The removal of moisture is important to reduce the energy demand required for the drying process. The removed water is recycled to the precipitation circuit to recover any remaining uranium. The filtered uranium solids are transferred through an enclosed conveyor to the dryer where any remaining moisture will be evaporated. The exhaust air from the drying process is controlled through a scrubber system to remove particulates and moisture prior to release to the environment. Any water collected from the drying process will be condensed and reused in the plant for reagents preparation. Denison has assessed the use of low temperature dryers and calciners for the drying step in the processing plant. The low temperature dryer will be indirectly heated by electric power and outfitted with a venturi scrubber allowing separation of yellowcake dust from the process gas exhaust. The yellowcake slurry created in the venturi scrubber will be sent to the yellowcake thickener and the process off gas will be further cleaned using mist eliminators prior to be released to atmosphere through a stack. Calcining allows for additional removal of impurities from the produced yellowcake to meet certain purchasers' requirements. The calciner will be indirectly heated by propane, therefore the products of combustion will not be in direct contact with the products being calcined. The combustion products will consist of nitrogen, carbon dioxide, water, oxygen and minor amounts of CO and NOx. Low NOx burners will be used and no post-combustion control is expected. The process off gas created during the calcining of the product will be ducted through a venturi scrubber with mist eliminators allowing process off gas cleaning and recycling of slurry to the yellowcake thickener. Once the moisture is removed from the yellowcake product, the yellowcake is packaged into 55 gallon steel drums via gravity.

The yellowcake drying and packaging area will be outfitted with hygiene systems to capture dust generated during the material handling of the yellowcake product and sent to either the dryer or calciner venturi scrubbers. All equipment located after the dewatering of the yellowcake will be selected to provide minimal dust generation and outfitted with dust collection systems where required. The ventilation system in this area of the processing plant will also be adequately designed to provide safety of workers and control fugitive dust emissions. The packaging of the yellowcake into drums is planned to be automated so it requires minimal manual worker intervention other than moving the barrels full of yellowcake from the equipment offloading area by forklift to a truck loading area for shipment to customers. The yellowcake storage area will be located in an enclosed area with secondary containment outfitted with a sump to facilitate any cleaning when required.

2.2.2.2.5 Industrial Wastewater Treatment Plant

The IWWTP is located inside the processing plant building and is discussed in Section 2.2.3.8.

2.2.3 Water Management

Denison intends to recycle process water to the greatest extent possible, thereby reducing the demand for fresh water supply and volume of treated effluent. In an effort to develop a conservative assessment basis for the EA, the water recycle flows from the industrial wastewater treatment plant back into the processing plant and wellfield have not been incorporated into the estimates for freshwater withdrawal and treated effluent discharge.

An overview of the site water balance during Construction, Operation, and Decommissioning are provided in Figure 2.2-14, Figure 2.2-15, and Figure 2.2-16, respectively. These figures provide a summary of the water needs for certain Project activities, plans for water treatment (both potable and wastewater), and the general flow of managed water at the site. The estimated flows in the site water balances do not account for water recycle back into the processing plant and wellfield. This results in a conservative estimate of both freshwater withdrawal needs and treated effluent discharge rates. Water consumption rates, water supply locations, proposed water treatment practices, and water sampling locations were common questions during engagement meetings with communities where Project information was being shared (18-EN-VB-4.22) (22-EN-SUR-652.4).

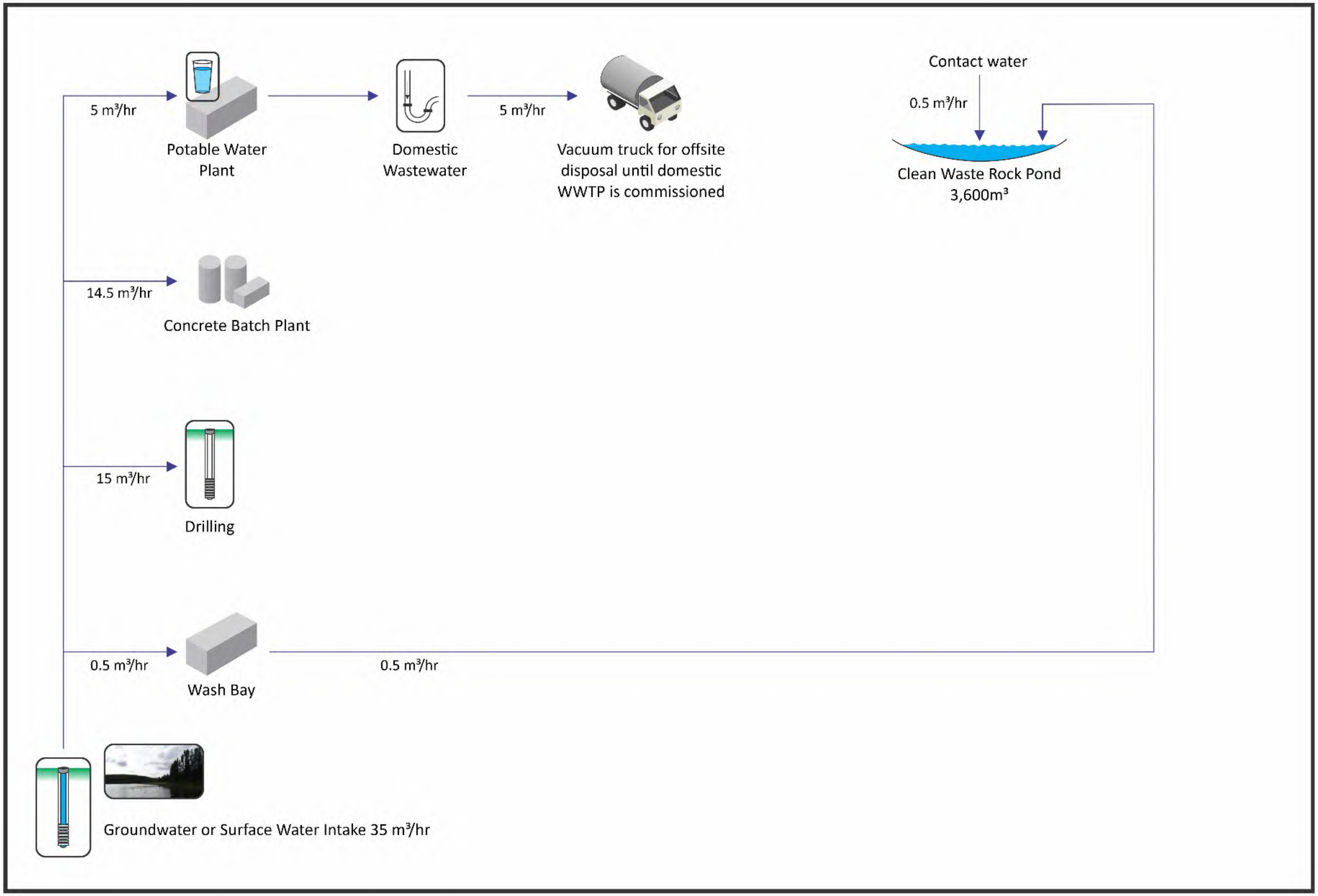


Figure 2.2-14: Construction Water Balance for the Project

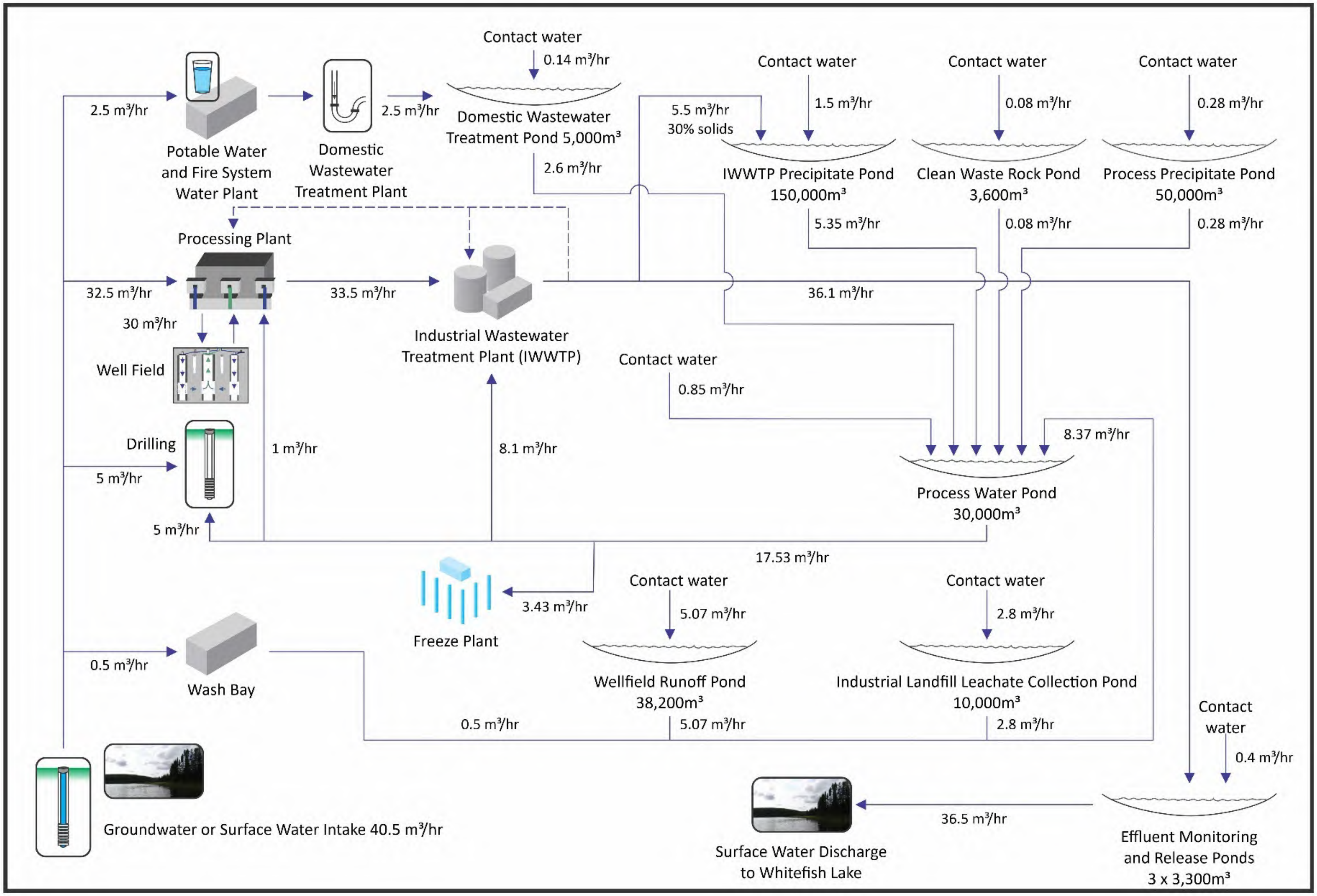
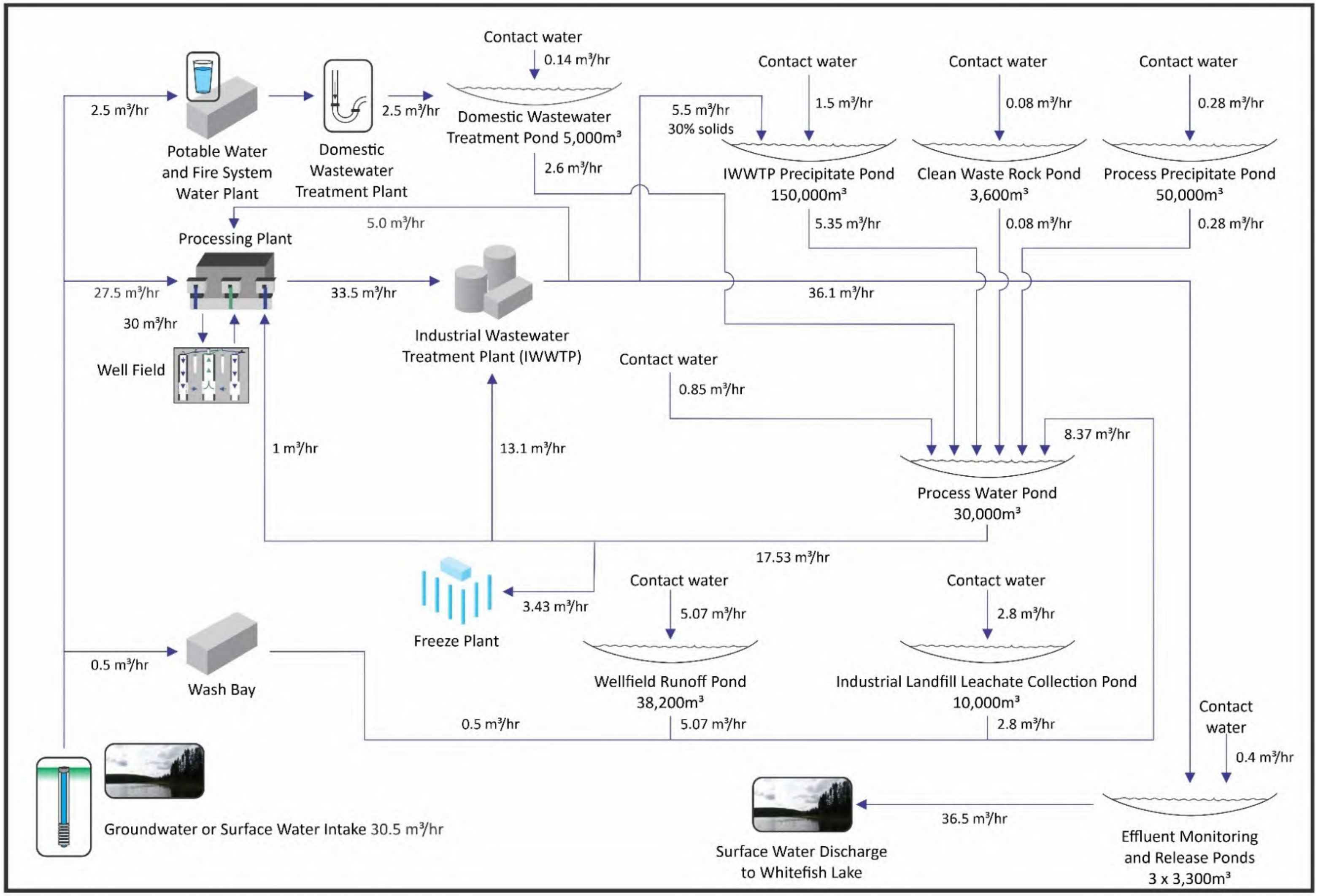


Figure 2.2-15: Operation Water Balance for the Project



Note: the freshwater withdrawal rates used in the groundwater (Section 7) and surface water quantity (Section 8.1) assessments are higher than those shown here and were 35.5 m^3/hour

Figure 2.2-16: Decommissioning Water Balance for the Project

2.2.3.1 Site Drainage

Clean, non-contact runoff will be diverted around Project components where possible. Contact water, including, for example, runoff from the wellfield and around the processing plant, will be collected in various ponds and eventually routed through the IWWTP for treatment prior to release to Whitefish Lake. Figure 2.2-17 provides an overview of the potential site drainage plan with flow directions and culvert locations.

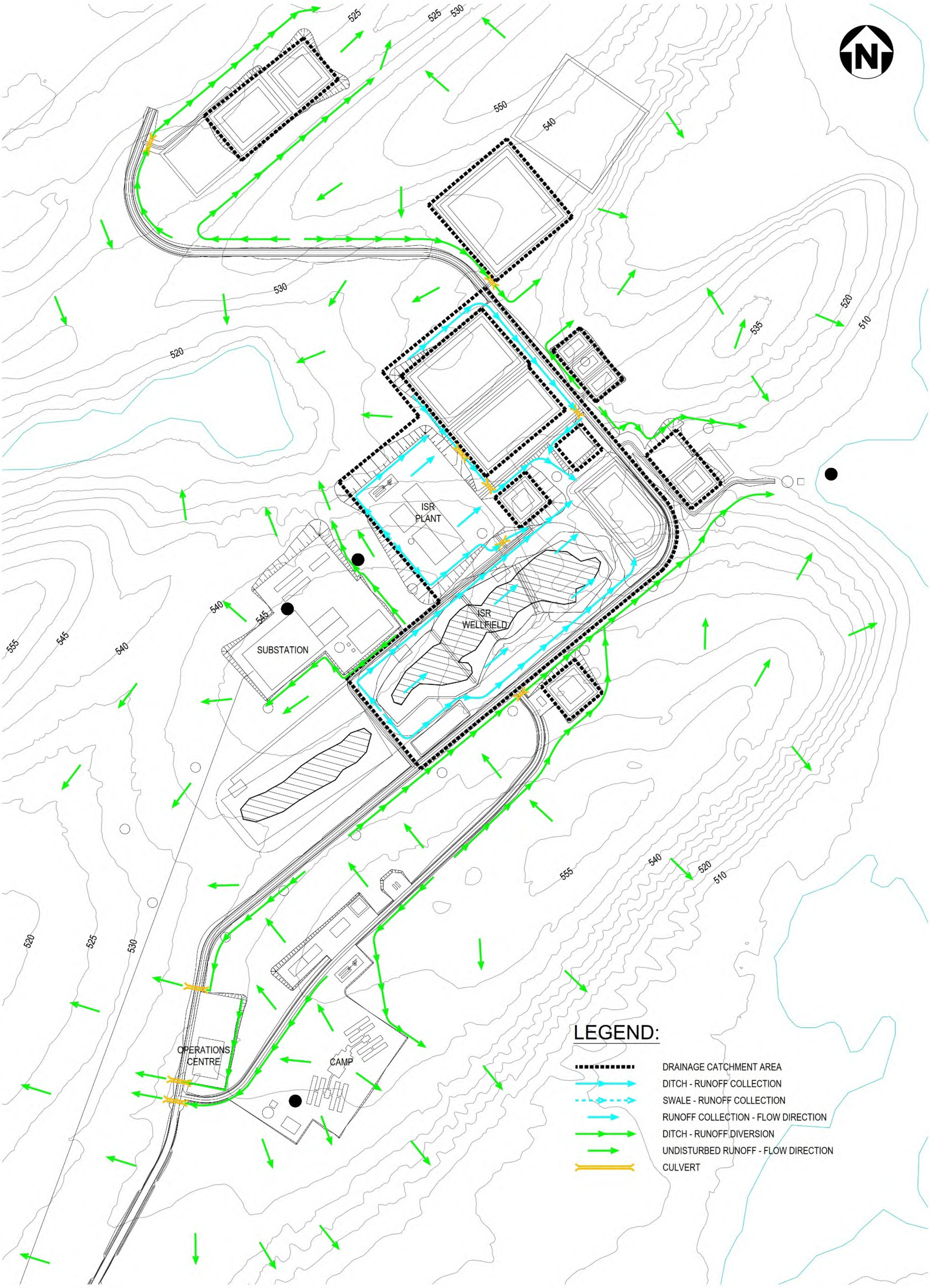


Figure 2.2-17: Site Drainage Plan with Flow Direction and Culvert Locations

2.2.3.2 Freshwater Supply and Distribution

A freshwater distribution system will be designed to provide fresh water for, the potable water treatment plant (WTP), the fire water system, the processing plant including mining solution preparation, the wash bay, drilling, and batch plant operation. Fresh water will likely be sourced from a shallow groundwater well(s); however, to be conservative, the freshwater withdrawal bounding case for this assessment was an assumed maximum water withdrawal of 40.5 m^3/hr from both a groundwater source and a surface water (Whitefish Lake) source for a total freshwater withdrawal of 81 m^3/hr for Project needs during Operation. The fresh water well(s) and surface water intake will be located, designed, installed, and operated according to applicable standards and best practices to minimize effects on the groundwater and surface water environments. Refer to Figure 2.2-1 for the proposed locations of freshwater wells A, B, and C and Section 7, Appendix 7-C for details.

Water usage and maximum water withdrawal was discussed during a virtual engagement meeting with the Ya'thi Nene Land and Resources Office and Leadership representing communities throughout the Athabasca Basin (21-EN-FDLFN-570.17). Denison intends to recycle process water to the greatest extent possible, thereby reducing the demand for fresh water supply. In an effort to develop a conservative assessment basis for the EA, the water recycle flows from the industrial wastewater treatment plant back into the processing plant and wellfield have not been incorporated into the estimates for freshwater withdrawal and treated effluent discharge.

2.2.3.3 Potable Water Treatment Plant and Distribution

Potable water will be generated on site by a prefabricated modularized potable water treatment plant (WTP) comprised of a treatment plant, a 2,000 L storage tank, and a bottle filling station.

Potable water will be piped to the camp, the fire water tank, the operations centre, and the processing plant to provide water for food preparation, hygienic usage, safety showers, eyewash stations and fire suppression requirements. Other locations, such as the airstrip terminal and satellite lunch trailers (during Construction), will receive bottled water as required.

Ultrafiltration or reverse osmosis with ultraviolet (UV) filtration are proposed for Potable water treatment. Chlorination will be needed prior to water distribution. Chemical requirements for the potable WTP will be standard and may include sodium hypochlorite, antiscalant, and bisulfite. The modular plant will be capable of all necessary processes and will contain required HVAC and lighting. The potable WTP will be placed on a concrete pad and will generate 2.5 m^3/hr (60,000 L/day) of potable water based on the assumed consumption rate of 200 people using 300 L per person per day.

2.2.3.4 Process Water Pond

A double-lined process water pond with leak detection has been designed to capture water from a variety of areas, including the process precipitate storage pad and special waste pad. During an open house information session with ERFN specific information regarding the process water pond were discussed to answer questions about the pond liners and concerns on groundwater contamination caused by potential breaches (22-EN-ERFN-618.17). Details on the liner system cross-section is provided in Figure 2.2-18. The pond will be designed to hold up to 30,000 m^3 of water and will be located next to the processing plant. The pond will be surrounded by a 2.0 m berm, have capacity for 0.5 m storage from a probable maximum precipitation (PMP) event estimated to be 493 mm, and allow for maintenance of 1.0 m of free board.

The pond will be able to receive water from all site ponds and monitoring wells. If required, water in this pond can be used directly in the processing plant or be directed to the IWWTP.

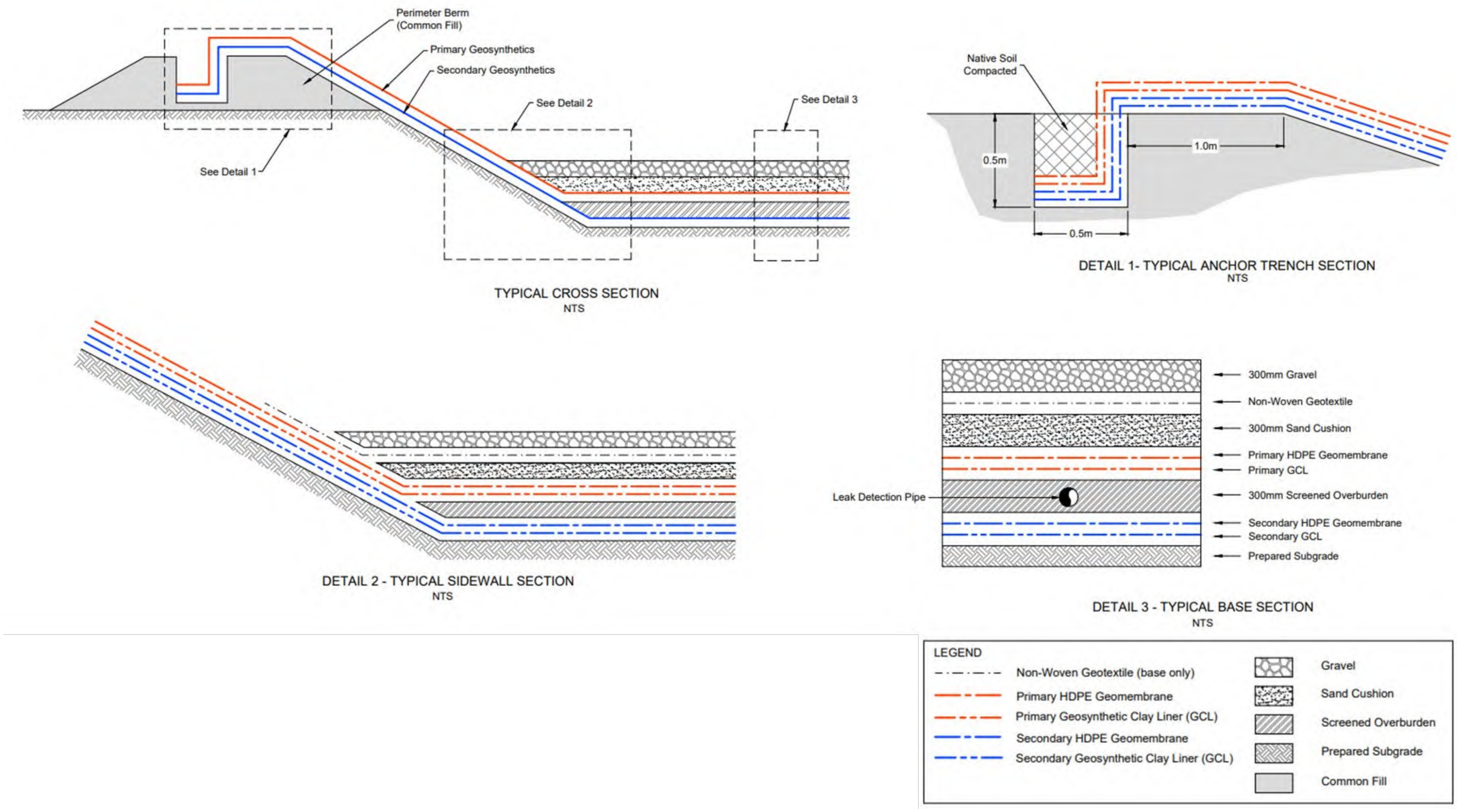


Figure 2.2-18: Pond Double Composite Liner System with Leak Detection Proposed for Uranium Bearing Solution Holding Area, Process Water Pond, Wellfield Runoff Pond, Landfill Leachate Collection Ponds, Process Precipitate Pond

2.2.3.5 Wellfield Runoff Pond

The wellfield runoff pond has been designed to capture runoff from the wellfield and the special waste pad. It will be designed to hold up to 38,200 m^3 of water and have a double composite liner system with leak detection (Figure 2.2-18).

The water in this pond will routed to the process water pond for recycle through the processing plant and eventual treatment at the IWWTP.

2.2.3.6 Clean Waste Rock Pond

A pond may be constructed beside the clean waste rock pad (Section 2.2.4.8) to collect runoff, if required. The pond would be a single geomembrane lined pond (Figure 2.2-26). Water collected in the clean waste rock pond would be routed to the process water pond.

2.2.3.7 Domestic Wastewater Treatment Plant and Pond

Greywater (e.g., water drained from sinks, showers, washing machines) and blackwater (i.e., sewage), collectively referred to as domestic wastewater, will be generated at the camp, processing plant, airstrip terminal, and the operations centre. Domestic wastewater was assumed to be generated at the rate of 300 L per person per day.

At the central facilities, such as the camp and processing plant, domestic wastewater will be piped directly to the on-site treatment domestic wastewater treatment plant (DWWTP). Sewage from facilities located away from the camp (airstrip terminal and satellite lunch trailers during Construction) will be collected in septic tanks and transported by a vacuum truck to the DWWTP.

The DWWTP will be a modular facility comprised of two heated and insulated units, a holding tank, ancillary filtration, ancillary treatment process equipment, and sludge handling system. A 5,000 m^3 pond with a composite liner system (Figure 2.2-19) will be designed to receive treated effluent from the DWWTP. This design is based on providing three months of capacity for 200 people generating 300 L of domestic wastewater per person per day.

Treated effluent from the DWWTP pond will be routed to the process water pond. Reject solids from the DWWTP will be collected, dewatered, and disposed of at an on-site landfill or in the site composting system.

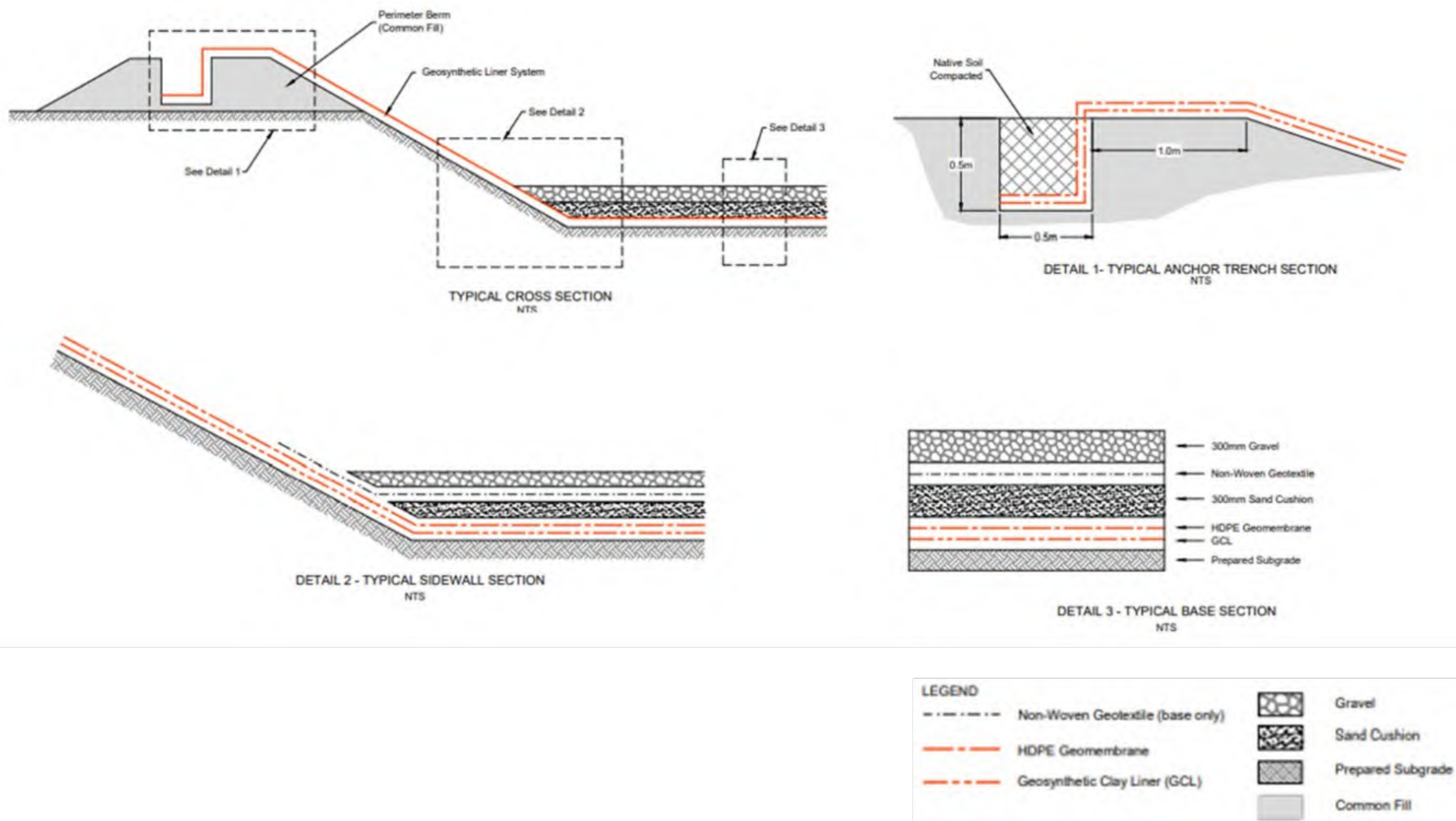


Figure 2.2-19: Pond Composite Liner System Proposed for Industrial Wastewater Treatment Plant Precipitate Pond, Effluent Monitoring and Release Ponds, Domestic Wastewater Treatment Plant Pond

2.2.3.8 Industrial Wastewater Treatment Plant

A metallurgical test program was completed at SRC to help define the IWWTP design and performance criteria. A three-stage IWWTP is proposed to treat contaminated waters produced during ISR process and other various sources (e.g., wash bay sump water, leachate from the industrial landfill, wellfield runoff pond), routed to the IWWTP through the process water pond (Figure 2.2-20). The three stages are: low pH treatment, high pH treatment, and neutralization. Water treatment will involve the addition of various chemicals, which may include sulphuric acid, barium chloride, flocculant, calcium hydroxide (also known as lime), sodium hydroxide, iron sulphate, and zero valent iron. The IWWTP will be located inside of the processing plant and anticipated to be designed to treat approximately 40 m^3/hr.

Stage 1: Low pH Treatment

The first water treatment step will precipitate the majority of remaining radioactive materials from the water. This will be achieved by reagent additions and pH adjustment through agitated tanks then through a clarifier. Over the life of mine an expected 10,000 m^3 of solids are expected to be produced and will be blended with the other radioactive solids in the process precipitates pond. Management of the process precipitates are discussed in Section 2.2.4.5.

Stage 2: High pH Treatment

The second step of the IWWTP will consist of removing remaining acidity from the solution by reagents and pH adjustment through agitated tanks then through a clarifier to allow for precipitation of the IWWTP precipitates. Over the life of mine, an expected 150,000 m^3 of IWWTP precipitates are expected to be produced and will be send to the IWWTP pond. The majority of the IWWTP precipitates are gypsum and these precipitates are not expected to be radioactive. Management of the IWWTP precipitates are discussed in Section 2.2.4.6.

Stage 3: Neutralization

The third step of the IWWTP is anticipated to further neutralize and improve the remaining water quality to allow for release to the environment (i.e., Whitefish Lake). This is proposed to be achieved with further pH adjustments through agitated tanks and a clarifier with negligible solids generation expected at this stage. Several additional technologies including ion exchange are being evaluated as part of an ongoing Best Available Technology Study to be complete as part of future permitting.

It is Denison's intent to incorporate treated water back into the mining water balance as make-up water in the processing plant and to generate mining solution, to the extent possible. Any excess treated water from the IWWTP will be pumped to the effluent monitoring and release ponds (Section 2.2.3.9). The recycle design helps reduce the volume of both freshwater and treated effluent, which were important topics coming out of engagement activities (18-EN-VB-4.40; 21-EN-VILX-443.24).

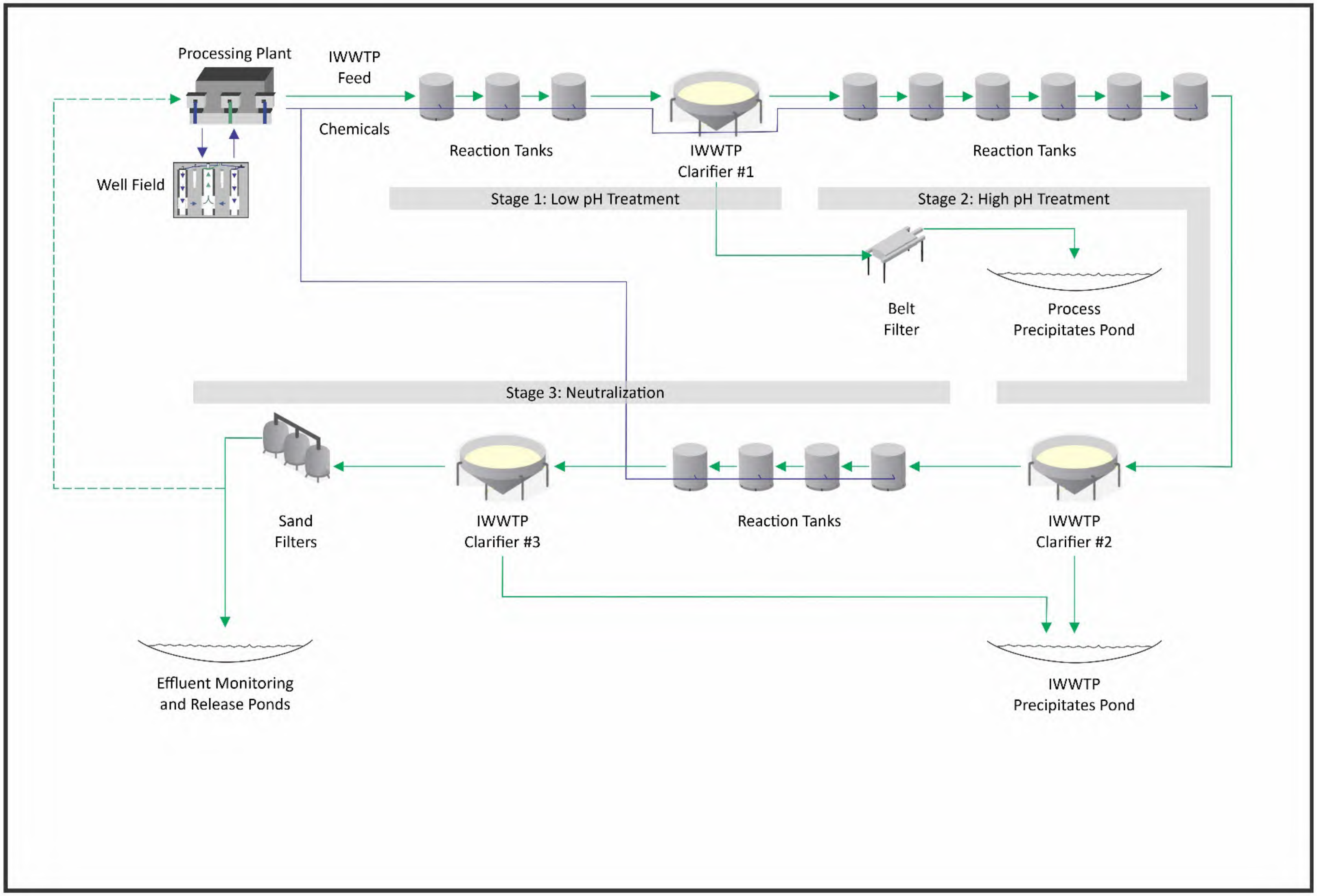


Figure 2.2-20: Three-Stage Industrial Wastewater Treatment Plant Circuits

2.2.3.9 Treated Effluent Monitoring and Release Ponds

Denison plans to construct and operate three treated effluent monitoring and release ponds (Figure 2.2-1). The effluent monitoring and release ponds will receive treated water from the IWWTP. As described earlier, there will be an option to recycle water from this pond back into the processing plant via the process water pond. Details of Denison's plans for effluent monitoring and release ponds were discussed during a virtual meeting with ERFN in response to questions like, "*Are there reservoirs for water treatment?*" (21-EN-ERFN-447.42).

Each of the three ponds will have capacity for 3,300 m^3 of water and a composite liner system (Figure 2.2-19). The ponds have been designed to hold effluent for a period of 80 hours for testing before discharge to the environment. Having three ponds allows for increased operational flexibility, as one pond can be undergoing maintenance when required. A minimum of two ponds are required to be operational at all times to make sure all effluent released to surface water meets federal and provincial discharge limits. Each pond will be operated with the following stages: 1) filling, 2) holding while awaiting quality confirmation; and 3) releasing to Whitefish Lake once water quality is confirmed to meet discharge limits.

Table 2.2-1 presents upper bound estimates of constituent concentrations in treated effluent. This representation of an upper bound effluent quality provides a conservative basis for the assessment of potential Project-related effects that is presented in subsequent sections of the EIS.

The effluent quality information developed for the purposes of the EIS was determined to be achievable through laboratory test results conducted by Denison at SRC. In the laboratory tests, effluent treatment feed solution was prepared by leaching drill core material from the Phoenix deposit. These solutions were further processed through the processing steps described previously (process precipitate removal and yellowcake precipitation) prior to effluent treatment testing. Effluent treatment tests incorporated three stages: low pH, high pH, and neutralization. A combination of reagents (sulfuric acid, lime, barium chloride, and iron sulfate) was used to facilitate precipitation of constituents within the solution. All liquids and solids were assayed to characterize the treatment process and confirm effluent quality targets.

During the EIS review process, the initial list of effluent quality parameters presented in the draft EIS was updated to address comments from the federal government to include, for example, Metal and Diamond Mining Effluent Regulations (MDMER) Schedule 4 and Schedule 5 parameters. These parameters were not initially included because they were not associated with the geology, mining method, and processing plant design. Denison fully understands its obligations with respect to the MDMER and will comply with the MDMER end of pipe effluent discharge criteria and other requirements of the regulation. Section 2 of the EIS is where the Project is described; the subsequent evaluation and assessment of effluent in the receiving environment is presented in EIS Section 8.2, including Table 8.2-10 near-field receiving water quality results and the associated appendix (Appendix 8-E). Additionally, comparison of effluent quality to water quality guidelines is not appropriate. Surface water quality guideline comparisons were completed in Section 8.2 following the process outlined there, in consideration of background water quality, effluent discharge rates, and under three flow scenarios.

With further reference to the upper bound effluent quality, it is noted that Denison intends to continue to refine effluent quality predictions to define a more accurate and precise representation of the expected final effluent as part of the best available technology economically achievable (BATEA) assessment and licensing/permitting phase of the Project. Nevertheless, the effluent quality predictions provided in the EIS serve to bound the assessment, and provide a conservative representation of risk to human health and the environment. The actual effluent quality will meet prescribed limits developed through licensing and permitting, as informed by the BATEA evaluation process and meeting the requirements of REGDOC-2.9.2.

Table 2.2-1: Upper Bound Industrial Wastewater Treatment Plant Effluent Quality

Parameter	Units	Proposed Effluent Quality [1]
General Chemistry, Nutrients and Anions		
Alkalinity [4]	mg/L	12.4
Ammonia as Nitrogen [4]	mg/L	3.9
Un-ionized ammonia [4]	mg/L	0.0129
Hardness [4]	mg/L	> 250
Conductivity (µS/cm) [4]	µS/cm	21.7
Nitrate (concentration in units of nitrogen) [4]	mg/L	<0.249
pH [4]	pH units	7
Phosphorus [4]	mg/L	0.01
Sulphate	mg/L	2600
Total Dissolved Solids	mg/L	6420
Temperature [4]	°C	16.5 [2]
Total Suspended Solids [4]	mg/L	6.0
Chloride	mg/L	600
Metals		
Aluminum [4]	mg/L	0.051
Arsenic	mg/L	0.006
Cadmium	mg/L	0.0018
Chromium	mg/L	0.025
Cobalt	mg/L	0.0027
Copper	mg/L	0.0222
Cyanide [4]	mg/L	NA

Parameter	Units	Proposed Effluent Quality [1]
Iron [4]	mg/L	0.0039
Lead [4]	mg/L	0.0003
Manganese [4]	mg/L	0.03
Mercury [4]	mg/L	<0.00001
Molybdenum	mg/L	2.5
Nickel [4]	mg/L	0.0138
Selenium	mg/L	0.0419
Strontium [4]	mg/L	1.68
Thallium [4]	mg/L	0.0006
Uranium	mg/L	0.057
Vanadium [4]	mg/L	0.059
Zinc	mg/L	0.042
Radiological		
Lead-210 (Bq/L)	Bq/L	0.419
Polonium-210 (Bq/L)	Bq/L	0.150
Radium-226 (Bq/L)	Bq/L	0.150
Thorium-230 (Bq/L)	Bq/L	0.900
Uranium-238 (Bq/L)	Bq/L	0.704 [3]
Uranium-234 (Bq/L)	Bq/L	0.704 [3]

Notes:

All parameters listed as total concentrations unless otherwise specified

1 The effluent quality presented here provides a bounding scenario of the basis of the assessment of Project effects. The actual effluent quality will meet prescribed limits developed through licensing and permitting, as informed by the BATEA.

2 Temperature was assumed to be 1.5°C above the background average annual temperature of 15°C

3 Estimated from uranium using the specific activity of 12356 Bq/g and assuming secular equilibrium between uranium-238 and uranium-234 (https://www.wise-uranium.org/rup.html)

4 Indicates parameter was added during EIS review to address comments from reviewers including those related to the MDMER and were not the initial focus of effluent characterization based on Project geology, mining, and processing methods

2.2.3.10 Treated Effluent Discharge

The treated effluent discharge line will run from the effluent monitoring and release ponds into Whitefish Lake (Figure 2.2-1). Effluent release into surface waters is of interest to Indigenous groups. Through a variety of engagement initiatives, Denison has become aware that treated effluent discharge is a topic of importance to Communities of Interest (18-EN-VPL-2.15) (18-EN-VB-4.51) (18-EN-ERFN-5.35) (18-EN-VPL-2.11) (18-EN-VPL-2.15). The effluent discharge line will be double walled with heat tracing to prevent operational issues with cold weather temperatures. A small trail will be constructed parallel to the line so it can be checked by Denison staff as part of routine inspections.

The discharge line will be located in a suitable area of the lake bottom to minimize disruption of fish habitat. A diffuser will be installed at the end of the line for effluent mixing within the lake. The assumed average effluent discharge rate for the EIS was 36.5 m^3/hr, with a maximum bounding scenario of 81 m^3/hr. Modelling of treated effluent discharge is provided in Appendix 10-A in Section 10.

In-water works will be limited to placement of the discharge and intake pipeline (if required, Section 2.2.3.2) infrastructure which will not expected to include any major works requiring excavation or substantial noise disturbance.

2.2.4 Waste Management

Conventional waste, radiologically contaminated waste, and hazardous waste will be managed at the Project. Denison is committed to conducting stringent waste characterization throughout the life of the Project. This includes physical, radiological, and chemical characterization to maintain accurate waste inventories and determine how wastes will be dispositioned through either re-use, recycling, temporary storage, or permanent disposal (on or off site). This includes clearance of material that meets unconditional release requirements and can be safely removed from site.

A waste management program will be developed for the Project to support licensing and permitting. The waste management program and associated plans developed to support licensing will be based on the 4 R’s: Reduce, Reuse, Recycle, and Recover, and will detail how each type of waste generated on site will be managed. Resources used to develop the waste management program will include, but are not limited to, the CNSC’s REGDOC-2.11 series, related Canadian Standards Association (CSA) standards, and the Hazardous Substances and Waste Dangerous Goods Regulations (Government of Saskatchewan 2000). The conceptual decommissioning plan for each waste stream or Project component, if applicable, is provided in Section 2.3.3.

Denison is proposing to design pond, pad, and landfill liners systems and develop appropriate performance monitoring (e.g., leak detection, groundwater monitoring) based on the characteristics of the material being stored. This will be discussed in more detail below, but broadly was as follows:

- Ponds or pads designed to temporarily or permanently store non-radioactive materials will be lined with a single geosynthetic composite liner system. This is a primary HDPE geomembrane (GM) over a Geosynthetic Clay Liner (GCL). The GCL will include a low permeable layer of bentonite clay. Examples of Project components proposed to have this type of liner include: the industrial wastewater treatment plant precipitate pond, hazardous waste storage pad, and effluent monitoring and release ponds.

- Ponds or pads designed to temporarily or permanently store potentially radioactive materials will be lined with a double geosynthetic composite liner system. This is a primary HDPE GM over a GCL and a secondary HDPE GM over an additional GCL. The GCL will include a low permeable layer of bentonite clay. In between the primary and secondary liners, a leak detection and collection system will also be installed. The selected design is the most robust currently known and offers a life of several hundred years with proper installation and maintenance. Examples of Project components proposed to have this type of liner include: wellfield runoff pond, process precipitate pond, landfill leachate collection ponds, process water pond, UBS holding area, and special waste pad.

Table 2.2-2 provides an overview of expected waste volumes throughout the life of the mine.

Table 2.2-2: Waste Predictions for Life of Mine and Description of Associated Waste Management Component

Waste				Associated On-site Waste Management Component (temporary storage or permanent disposal)				
Type	Volume (m^3)	Examples of Wastes	Disposal Method	Waste Management Component	Temporary (T) Storage or Permanent (P) Disposal	Volume (m^3) or Area (m^2)	Design Notes	Waste Management Component Liner Design Figure (if applicable)
Organic waste	2,170	Food waste, kitchen scraps	On-site composting	Brome composting system	P	n/a	Composting system with pad near domestic landfill for final curing.	n/a
Recyclables	8,000	Steel, cardboard, paper, plastic, common household recyclables	Off-site recycling	Recycling laydown area	T	n/a	Recycling laydown area with recycling bins will be located near the camp and operations centre. No liner system is planned.	n/a
Construction waste	7,000	Steel, wood, plastics, concrete	Temporary laydown area for construction wastes. Recyclables will taken off site and any nonrecyclable waste will be permanently disposed of in the domestic landfill, once constructed	Construction waste laydown area	T	7,000 m^3	Temporary laydown area to receive construction waste. Adjacent to the future domestic landfill. No liner system is planned.	Figure 2.2-23
Domestic waste	34,400	Wood, plastics	On-site disposal in domestic landfill	Domestic landfill with associated leachate collection pond	P	34,400 m^3	Domestic landfill will have a composite liner system with leachate collection. The leachate collection pond will have a double composite liner system with leak detection.	Landfill: Figure 2.2-21 Leachate collection pond: Figure 2.2-18
Radiologically and other contaminated waste	6,000	Radiologically contaminated material that can be cleaned to meet unconditional clearance level requirements	Cleaned on site and then sent off site for recycling or reuse	Industrial laydown area	T	2,500 m^2	Radiologically contaminated components can be cleaned via dry blasting, sand blasting, and/or high pressure washing at the industrial laydown area, adjacent to the industrial landfill. The laydown will be placed within the industrial landfill double lined area in close proximity to the industrial landfill leachate collection pond. Any wash water generated during cleaning will drain to the industrial landfill leachate collection pond.	Figure 2.2-22

Waste				Associated On-site Waste Management Component (temporary storage or permanent disposal)				
Type	**Volume (m^3)**	**Examples of Wastes**	**Disposal Method**	**Waste Management Component**	**Temporary (T) Storage or Permanent (P) Disposal**	**Volume (m^3) or Area (m^2)**	**Design Notes**	**Waste Management Component Liner Design Figure (if applicable)**
Radiologically and other contaminated waste	41,270	Radiologically contaminated material from operational activities that cannot be cleaned to pass radiological clearance, e.g., used wellfield piping, laboratory waste	On-site disposal in industrial landfill	Industrial landfill with associated leachate collection pond	P	100,000 m^3	Industrial landfill will have a double composite liner system with leak detection and leachate collection capabilities. The leachate collection pond will have a double composite liner system with leak detection.	Landfill: Figure 2.2-22 Leachate collection pond: Figure 2.2-18
Hazardous waste	1,900	Fuel, paint, used oil, chemicals	Off-site recycling or disposal	Hazardous waste storage pad	T	250 m^2	Hazardous waste storage pad will have a composite liner system.	Figure 2.2-24
Process precipitates	50,000	Iron/radium-226 precipitates	On-site temporary storage on process precipitate pond, followed by off-site processing and permanent disposal	Process precipitate pond	T	50,000 m^3	Process precipitate pond will be double lined with leak detection capabilities. Any runoff from the pad will be directed to the process water pond.	Figure 2.2-18
Industrial wastewater treatment plant (IWWTP) precipitates	150,000	Gypsum	On-site disposal in IWWTP precipitate ponds	IWWTP precipitate ponds	P	150,000 m^3	Ponds will have composite liner system. Water from the ponds will either be recycled through the processing plant via the process water pond, or routed to the effluent monitoring and release ponds.	Figure 2.2-19
Special waste rock	150	Mineralized drill cuttings produced during drilling	On-site temporary storage on special waste pad, followed by reprocessing in the processing plant or disposal off site	Special waste pad	T	2,500 m^2	Special waste pad will be constructed with a double composite liner system with leak detection capabilities. Any contact water coming off the special waste pad will be directed to the wellfield runoff pond.	Figure 2.2-25
Clean waste rock	7,800	Sandstone cuttings or core produced during drilling	On-site temporary storage on clean waste rock pad, used in construction as possible and balance decommissioned on site	Clean waste rock pad with associated pond	T/P	2,500 m^2	Clean waste rock pad will have a single geomembrane liner with protection. Adjacent pond will also have a single geomembrane lined with protection. Runoff will go to the process water pond, or effluent monitoring and release ponds.	Figure 2.2-26

2.2.4.1 Organic Waste

Denison is proposing to use a composter for disposal of organic waste which is anticipated to primarily be food waste. A contained and partially automated composter, such as the Brome composting system, is the preferred option. The composting system is expected to be in a seacan. After composting is complete, an outdoor curing phase will be required during summer months. Based on experience with the Brome composting system at other mine sites, the finished compost is not foreseen to be a wildlife attractant. Prior to any compost being used on site for remediation purposes, the compost will be tested to determine its suitability for unrestricted or restricted use based on the Canadian Council of Ministers of the Environment guidelines for compost quality (Canadian Council of Ministers of the Environment 2005).

2.2.4.2 Recyclables

Recyclable materials include steel, plastics, common household recyclables, cardboard, and paper.

The recycling laydown area with recycling bins will be located close to the camp and be accessible by trucks. Any recyclable material from the camp, operations centre, and airport terminal will go directly to the recycling bins at this laydown.

Recyclable material generated at the wellfield and processing plant that may have radiological contamination will be moved to the industrial laydown area, which will be located near the industrial landfill. Any suspect recyclables will be scanned prior to release to the recycling laydown. Any recyclables that do not meet radiological clearance criteria following reasonable cleaning efforts will be disposed of in the industrial landfill.

The emptying of the recycling bins will be managed through third-party waste management service providers. All recyclables will be shipped off site to approved recycling facilities. Adherence to the recycling program will be managed through training of all site personnel and oversight by Denison staff.

2.2.4.3 Landfills

Two waste landfills are included as part of the proposed Project. The design of these facilities is consistent with best management practices both at northern Saskatchewan mine sites and from comparable jurisdictions. The two landfills are the:

- Domestic Waste Landfill
- Industrial Waste Landfill

Laydown areas will be adjacent to each landfill to provide temporary areas for storing or staging material prior to cleaning and off-site disposal or on-site disposal. The design of these facilities is discussed in the sections below.

2.2.4.3.1 Domestic Landfill

Denison plans to construct, operate, monitor, and decommission a domestic landfill on site to manage non-recyclable, inert wastes. Examples of materials destined for the domestic landfill include wood, non-recyclable plastics, broken furniture, textiles, and non-recyclable items from the camp and operations centre.

The total volume of domestic waste to be received at the domestic landfill over the life of mine is approximately 34,400 m^3, which includes approximately 6,400 m^3 of waste during Construction and 4,000 m^3 of waste during Decommissioning.

The domestic landfill will have a composite liner system with leachate collection (Figure 2.2-21). The design consists of a HDPE liner directly over a GCL, with leachate collection system. The leachate collection pond associated with the domestic landfill will have a double composite liner system with leak detection (Figure 2.2-18). The leachate will be collected by vacuum truck and treated in the IWWTP.

The landfill will be fenced and the surface contoured to direct runoff away from the facility. The domestic landfill will require regular covering with clean soil to prevent wind borne litter leaving the landfill and to avoid attracting wildlife and birds. Performance of the domestic landfill and leachate containment system will be monitored through a network of groundwater monitoring wells, including at a minimum one upgradient and two downgradient wells.

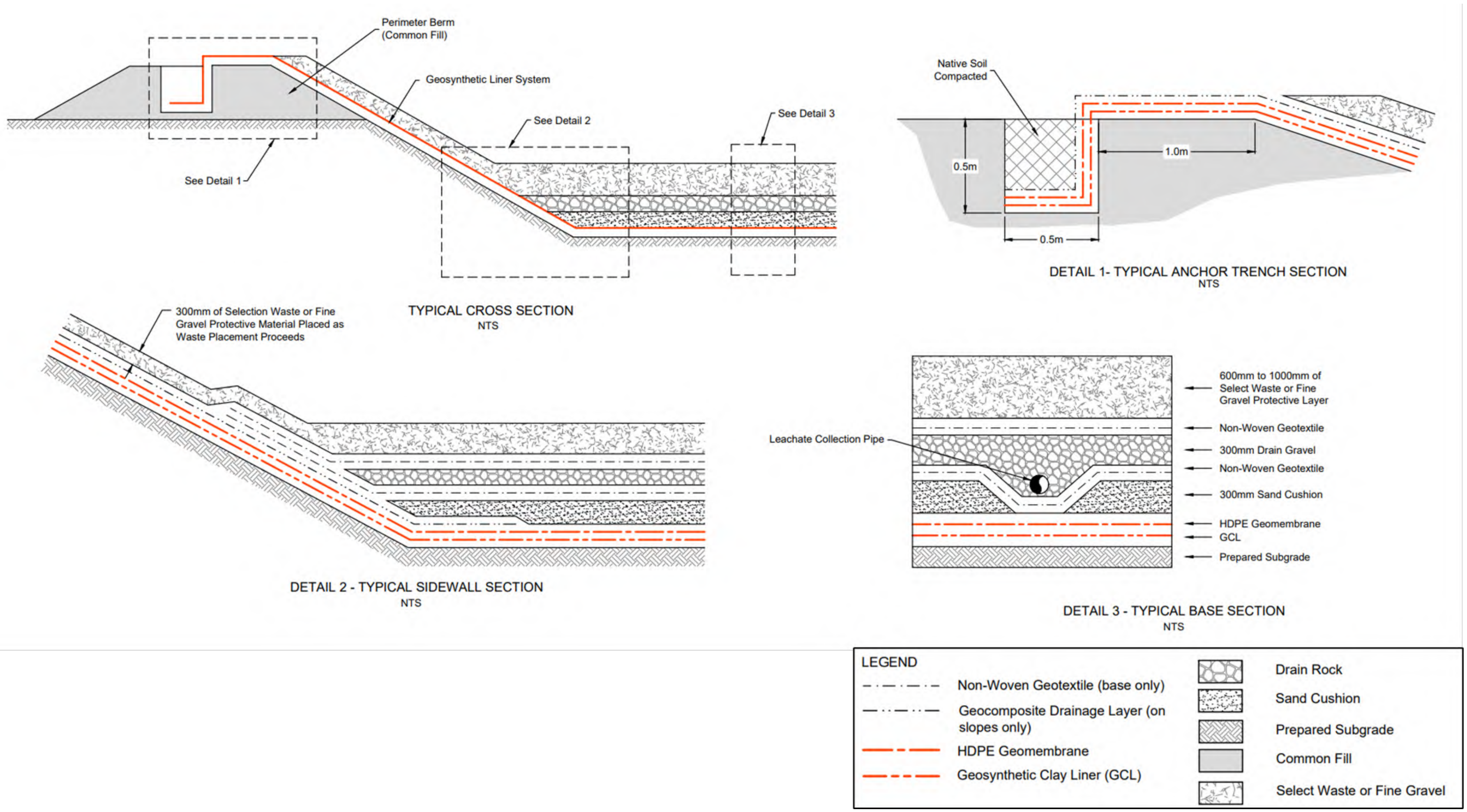


Figure 2.2-21: Domestic Landfill Composite Liner System with Leak Detection

2.2.4.3.2 Industrial Landfill

The industrial landfill will be designed to accept industrial wastes generated at site including waste with chemical and/or radiological contamination. It will initially be sized to be 50,000 m^3 with room to expand to 100,000 m^3 at Decommissioning to accept decommissioning wastes. There will be an associated leachate collection pond immediately north of the industrial landfill.

Radiologically contaminated material that can be cleaned (e.g., via dry blasting, sand blasting, and/or high pressure washing) at the industrial laydown area (see below) to meet unconditional clearance level requirements will then be sent off site for recycling or reuse (Table 2.2-2). Radiologically contaminated material from operational activities that cannot be cleaned to pass radiological clearance, e.g., used wellfield piping, laboratory waste, will be disposed of in the industrial landfill and classified as low level radioactive material. Radioactive waste in Canada is defined as any material (liquid, gaseous, or solid) that contains a radioactive nuclear substance, as defined in section 2 of the *Nuclear Safety and Control Act*, for which no further use is foreseen. Following a graded approach that is commensurate with risk, Denison has broadly characterized radioactive waste as being temporarily on site or permanently on site.

The double liner design proposed for the industrial landfill is shown on Figure 2.2-22. It consists of a double geosynthetic composite liner system including a primary HDPE GM over a GCL and a secondary HDPE GM over another GCL. A leak detection and collection system is planned to be installed between the primary and secondary geosynthetic composite liners. The GCL includes a layer of bentonite clay, which has very low permeability and very good longevity. This type of design is the most robust currently known and offers a life of several hundred years with proper installation and maintenance. Published information predicts a life of 446 years for a single properly selected and installed geomembrane (Koerner et al. 2011).

Leachate generated from the waste in the industrial landfill will be collected, removed, and sent to a leachate collection pond, located immediately north of the landfill. The leachate collection pond will have a double liner system with leak detection (Figure 2.2-18). Leachate will be pumped via dedicated piping from the collection pond to the process water pond. The landfill will be fenced, and the surface contoured to direct runoff away from the facility.

The industrial landfill will be designed to be several metres above the groundwater table to which will minimize any leachate infiltrating into the shallow groundwater system. Upon closure of the site, the industrial landfill will be covered with an engineered impermeable liner system to minimize infiltration of precipitation into the containment system.

Performance of the containment system will be monitored through a network of groundwater monitoring wells located around the industrial landfill.

Industrial Laydown Area

The industrial landfill will contain a 2,500 m^2 industrial laydown area where radiologically-contaminated components will be cleaned via dry blasting, sand blasting, and/or high pressure washing. The industrial laydown area will be placed within the footprint of the industrial landfill's double liner and in close proximity to the industrial landfill leachate collection pond. Any wash water generated during cleaning will be drained to the industrial landfill leachate collection pond and routed to the process water pond via dedicated piping. If, after cleaning, the material passes radiological clearance for off-site removal, it will be moved to the recycling laydown (if recyclable) or taken off site for re-use. If material on the laydown does not meet radiological clearance to remain inside the industrial landfill, it will be recleaned to remain inside the industrial landfill or disposed off site at an approved facility.

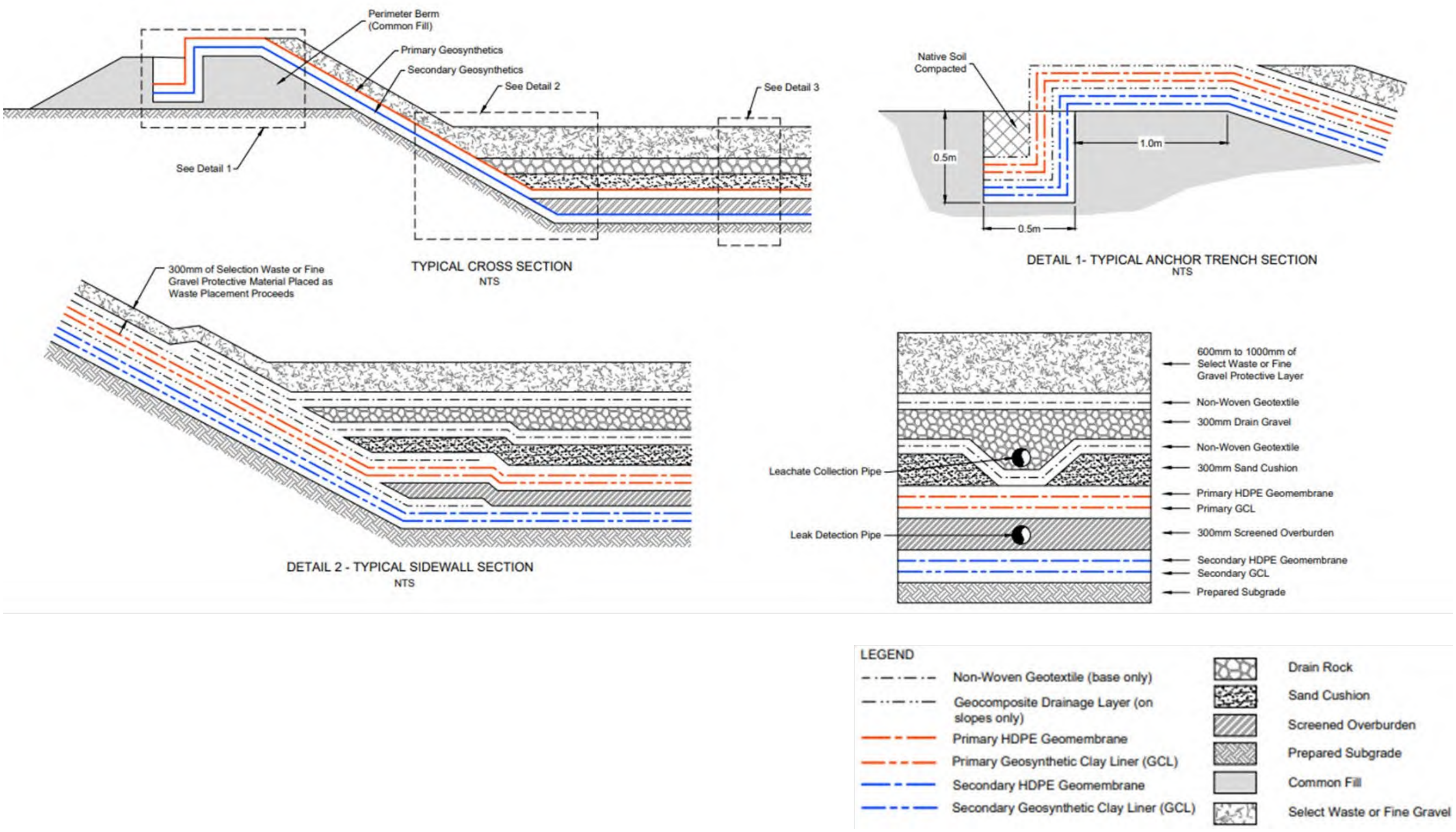


Figure 2.2-22: Industrial Landfill Double Composite Liner with Leachate Collection and Leak Detection

2.2.4.3.3 Construction Laydown Area

During Construction, Denison plans to create a laydown area next to the future domestic landfill to temporarily store construction waste. Examples of materials include clean wood, plastics, metal, and concrete. The construction laydown area will not be lined, but it will have a berm surrounding the area to minimize run-on and runoff. The base of this laydown will be scarified and recompacted prior to waste placement (Figure 2.2-23). This laydown will be monitored by the domestic landfill groundwater monitoring well network. Material stored here will be moved to the domestic landfill once it is constructed, or taken off site for recycling or reuse, as applicable.

2.2.4.4 Hazardous Waste Management

Denison identified a need to have a small (250 m^2) pad designated for temporary storage of hazardous waste such as paints, solvents, hydrocarbons, and used oil. The temporary storage pad will have a composite liner system (Figure 2.2-24). Hazardous wastes will be taken off site by waste management service providers for proper recycling as soon as practical.

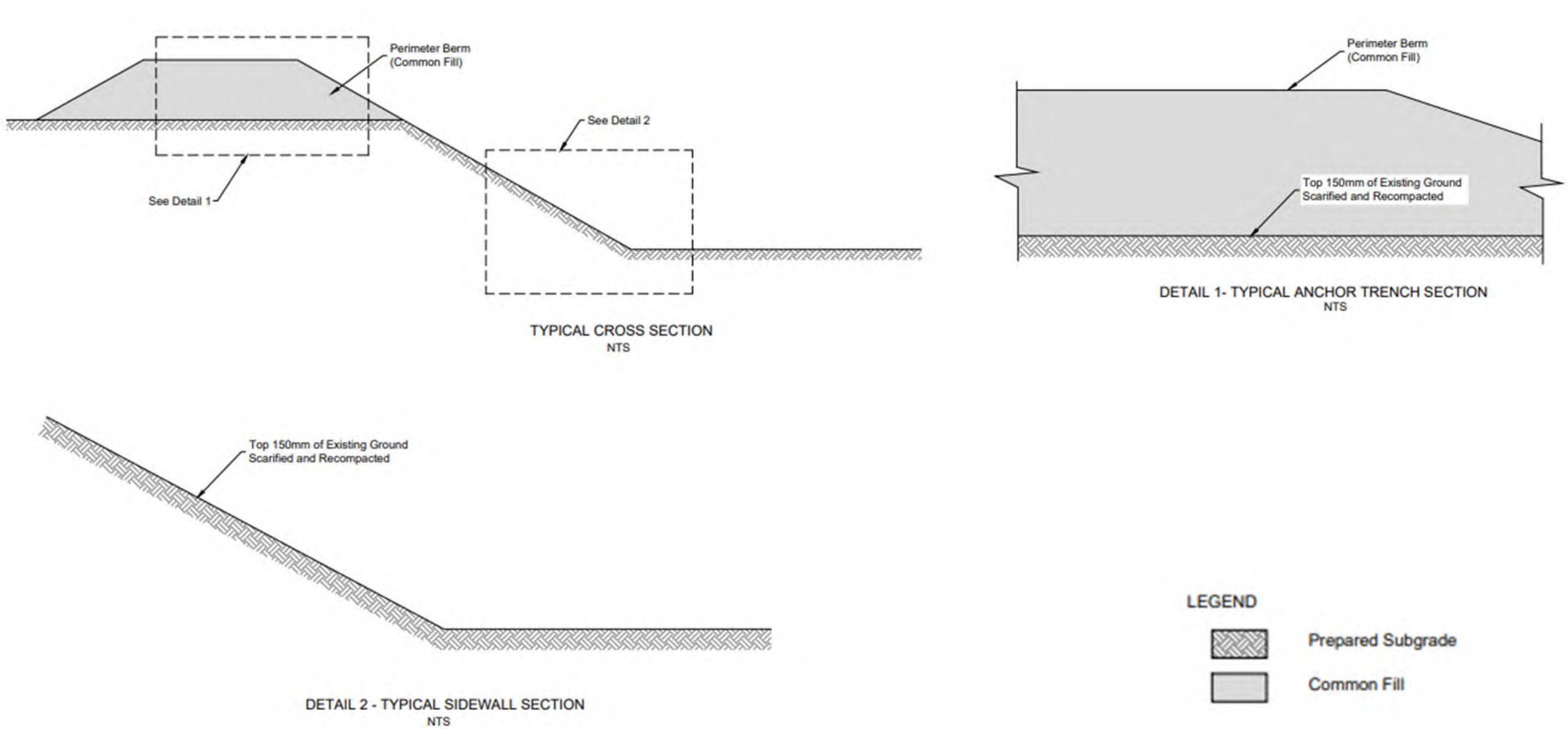


Figure 2.2-23: Construction Laydown Area

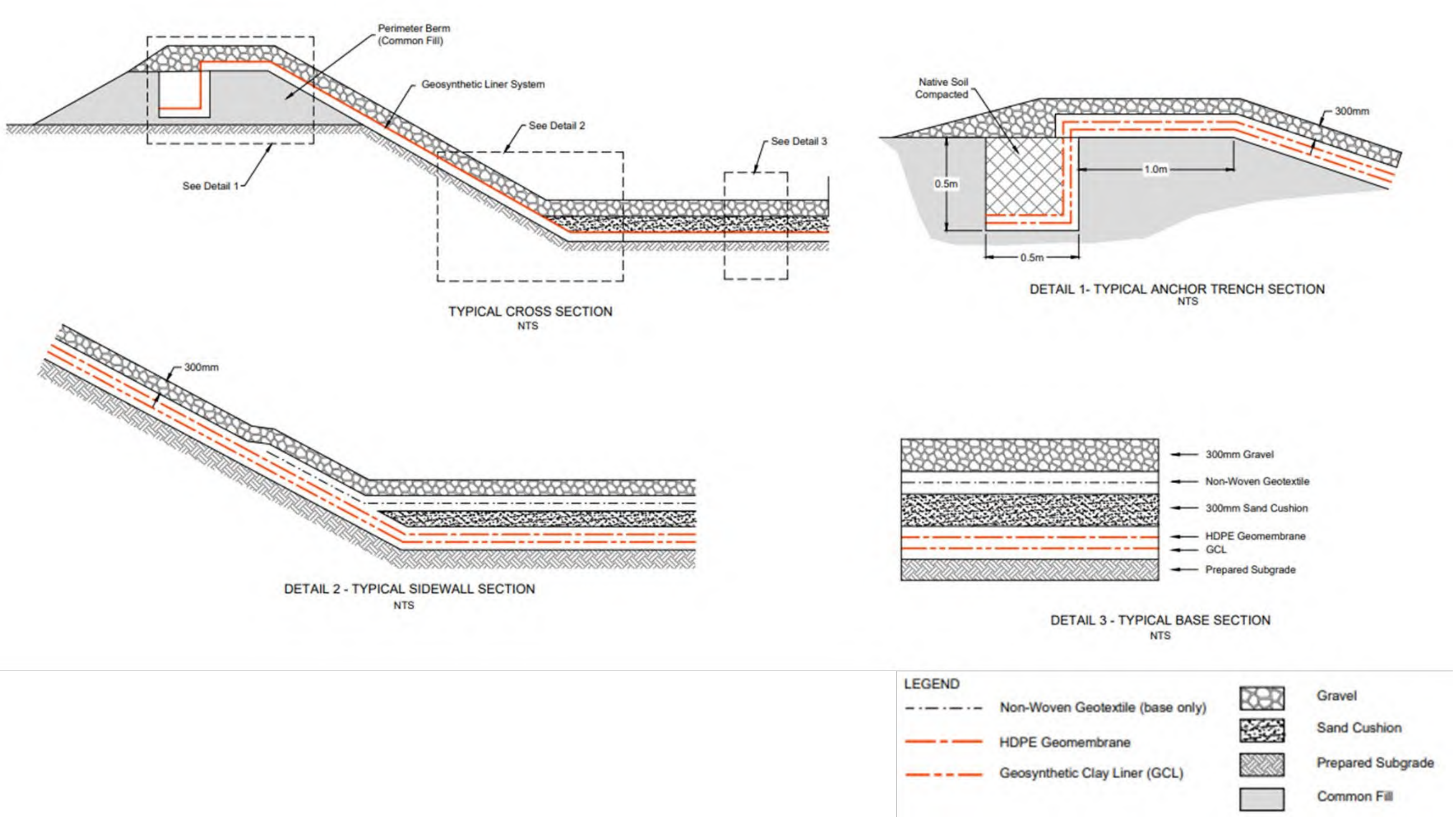


Figure 2.2-24: Pad Composite Liner System Proposed for the Hazardous Waste Storage Pad

2.2.4.5 Process Precipitate Pond

The precipitates generated in the processing plant (Section 2.2.2.2) will be transferred to the process precipitate pond. Any radioactive precipitates generated during the first stage of the IWWTP will also be directed to the process precipitate pond. The precipitates may be stored in totes inside the pond. This pond design will allow the precipitate totes to be stacked below ground level. The pond will be double lined with leak detection capabilities; refer to Figure 2.2-18. It will be designed to hold up to 50,000 m^3 of precipitates. Any runoff collected in the pond will be directed to the process water pond (Section 2.2.3.4) and recycled through the plant.

The metallurgical test work completed at SRC has also allowed Denison to estimate volumes of process precipitates that could be generated during the LOM confirming the 50,000 m^3 LOM volume allotted for the process precipitate pond is sufficient for the environmental assessment and provides a conservative assessment basis. In addition, metallurgical test program completed at SRC indicates that the process precipitates will contain approximately 2 to 3% uranium. This makes the process precipitates of economical value, allowing for sale and removal for processing at an off-site facility as part of Decommissioning. Transport of any radiological material off site during Decommissioning will adhere to the *Transportation of Dangerous Goods Regulations*.

Discussions surrounding mine waste management were discussed in detail during numerous community engagement meetings (21-EN-LLRIB-392.21). Denison communicated that the proposed ISR mining method for the Project will produce very minimal volumes of waste and detailed the steps by which waste streams will be managed (18-EN-VPL-2.49; 18-EN-VILX-3.68; 19-EN-YNLR-84.1; 21-EN-ERFN-447.40; 21-EN-YOUTH-448.7).

2.2.4.6 Industrial Wastewater Treatment Plant Precipitate Pond

The main precipitate generated in the IWWTP process is expected to be a non-radioactive, gypsum-type material (calcium sulphate mineral). Denison plans to manage these precipitates separately from the process precipitates because of the difference in their composition, particularly radioactivity.

The non-radioactive IWWTP precipitates will be transferred from the IWWTP to the IWWTP precipitate pond. The IWWTP precipitate pond will initially be sized to hold 50,000 m^3 with room for expansion to 150,000 m^3. The metallurgical test work completed at SRC has allowed Denison to characterize the precipitates composition and estimate volumes IWWTP precipitates that could be generated during the LOM confirming the 150,000 m^3 LOM volume allotted for the IWWTP precipitate pond size provides a conservative assessment basis.

The liner design proposed for the IWWTP precipitate pond is shown in Figure 2.2-19. It consists of a geosynthetic composite liner system including a primary HDPE GM over a GCL. The GCL includes a layer of bentonite clay, which has very low permeability and very good longevity. This type of design is the most robust currently known and offers a life of several hundred years with proper installation and maintenance. Published information predicts a life of 446 years for a single properly selected and installed geomembrane (Koerner et al. 2011). Water from the ponds will be recycled through the processing plant via the process water pond. The IWWTP precipitate pond will be installed several meters above the water table and will be decommissioned on site as the ponds will be covered with an impermeable liner during physical decommissioning.

2.2.4.7 Special Waste and Special Waste Pad

During Operation, the special waste pad is expected to contain special waste that is primarily mineralized core, cuttings from wellfield development, basement rock, and any waste rock determined to be potentially acid generating (PAG). Special waste from drilling activities is defined as uranium containing materials that cannot be disposed of in the clean waste pile, including PAG waste rock. Special waste will be determined by Denison geologists based on ore zone intersection expectations, probe reading taken during wellfield drilling activities, and results of systematic assays to characterize the acid generating potential of waste rock. Based on the current wellfield and freeze wall design, approximately 2,000 m^3 of special waste rock will be generated.

Denison will examine opportunities to reprocess the mineralized core and cuttings generated during wellfield development to recover uranium. This reprocessing may be done by placing the material in tanks with mining solution or placing the material underground into the mining area at the end of a well's production.

The special waste pad may be used to temporarily store other materials that may be radioactive (e.g., contaminated soil) prior to final disposal in the industrial landfill or a licensed off-site facility.

The special waste pad is estimated to be 2,500 m^2 in size and will be constructed with a double composite liner system with leak detection capabilities (Figure 2.2-25). Any contact water coming off the special waste pad will be directed to the wellfield runoff pond (Section 2.2.3.5).

2.2.4.8 Clean Waste Rock and Clean Waste Rock Pad

Clean waste rock (non-mineralized and non-potentially acid generating [PAG] rock) will be generated as sandstone cuttings and core from drilling activities. Based on the current wellfield and freeze wall design, approximately 7,800 m^3 of clean waste rock will be generated. Clean waste rock will be stored on a 2,500 m^2 single geomembrane liner (Figure 2.2-26) and can be used for road construction and/or concrete production. The clean waste rock will be assayed and tested for PAG during Operations to ensure the material can be reused when required. A pond may be constructed beside the pad to collect runoff, if required, and would also have a single geomembrane lined with protection (Figure 2.2-26).

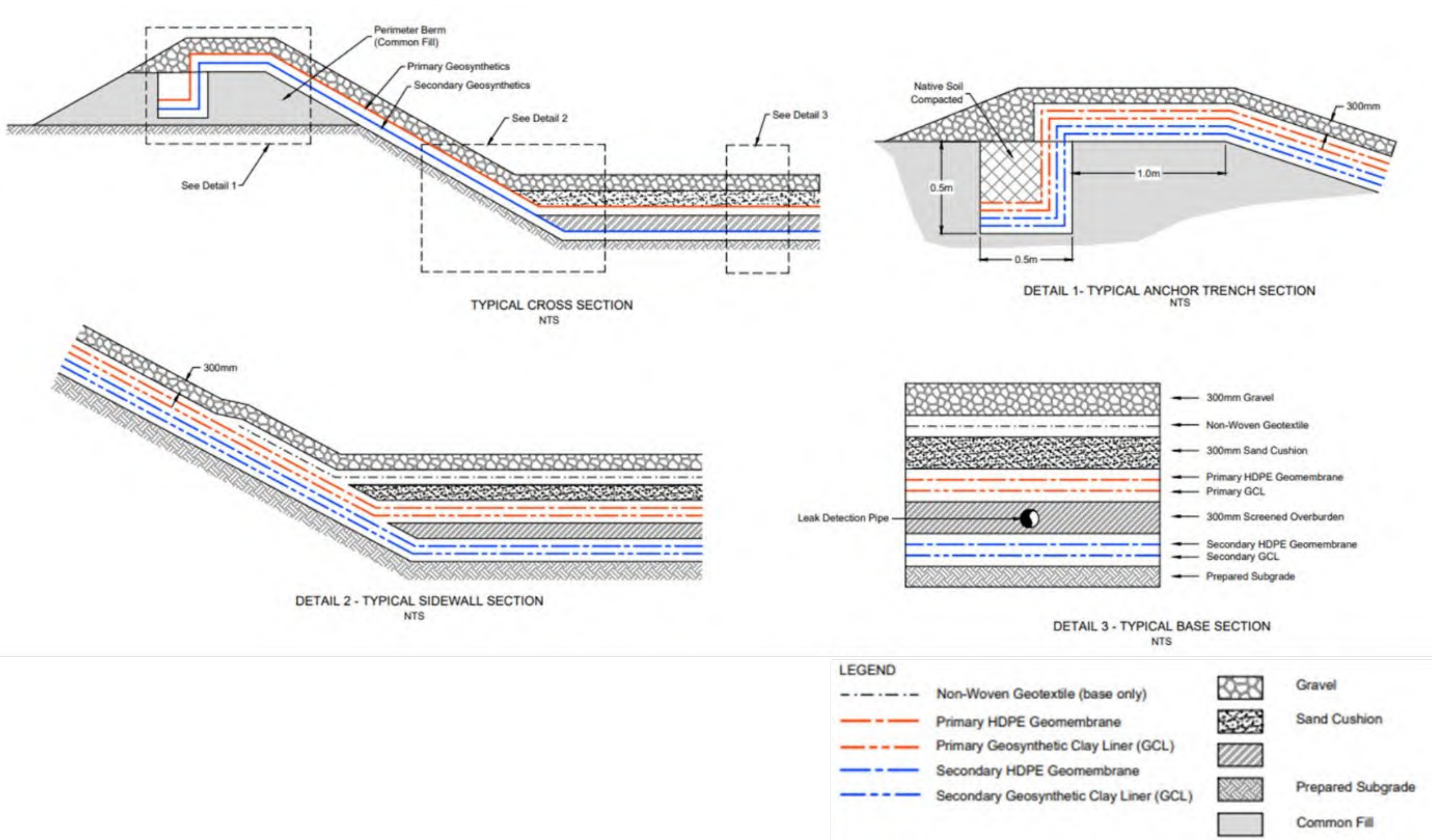


Figure 2.2-25: Pad Double Composite Liner System with Leak Detection Proposed for the Special Waste Pad

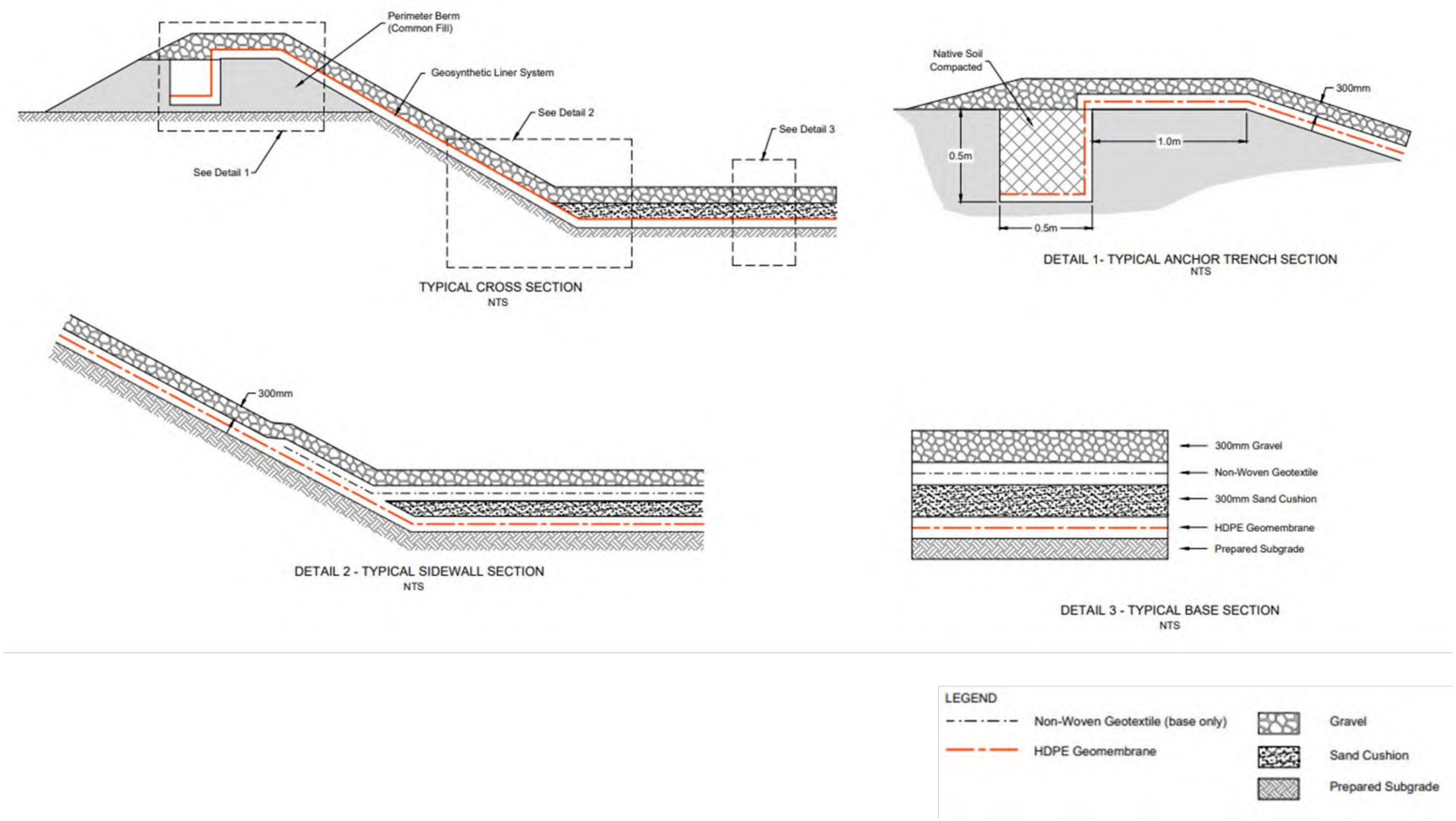


Figure 2.2-26: Single Geomembrane Liner Design Proposed for Clean Waste Rock Pad and Pond

2.2.5 Access and Transportation

2.2.5.1 Roads

Mainland access to the site will be from Highway 914. A 7-km section of road will be constructed from the highway to the Project site and a 5-km long road will also be constructed from the Project site to the airstrip (Figure 2.2-1); the total road length is 12 km. Additional site roads will include a service loop to the camp and a short service road to the runoff pond and the potential treated effluent discharge point. Many of the proposed roads will be developed along previously disturbed areas, including roads currently used for exploration activities, thereby minimizing terrestrial habitat disturbance.

Two water crossings will be installed along the road from the Project site to the airstrip. Access routes to the airstrip and proposed safeguards to support site safety were discussed in detail with ERFN (21-EN-ERFN-473.4) (21-EN-ERFN-473.7). The crossings will be designed, constructed, and maintained to avoid causing harm to fish and fish habitat and will be clear span bridges. The approximate locations of the proposed water crossings are provided in Figure 2.2-27.

During a meeting with ERFN, Denison provided a detailed discussion on the need for restrictions through the Project site for safety reasons, and where those proposed restrictions would be (i.e., gate houses). The locations of the north and south security gates are shown in Figure 2.2-1. Generally, ERFN agreed with the concepts of check points in key areas of safety concern, provided that Members could access areas that were not subject to the need for restrictions (21-EN-ERFN-473.4). Denison confirmed the importance of providing access to the greatest degree possible for ERFN and other Indigenous people, while respecting the need for safety for all in the area.

During engagement activities, comments and concerns were raised regarding access including for example:

> "*If the gate at Key Lake is removed or the road is redesigned to go around Key Lake allowing unimpeded access to the north, there would be lots of concerns about the increase in the number of people coming north into this area*" (19-LK-ERFNTrap-134.230).
>
> "*I am concerned with how Denison will access their mine on the same road as Cameco uses from the Key Lake mine to McArthur. Presently, Cameco has gates which restrict access to that section of road. If these gates are to be removed or altered by Denison so that everyone has access to the section of road between Key Lake and McArthur that would be disastrous to the region. The theft, vandalism and crime would increase astronomically and the region would lose its remoteness, tranquility and quality of fishing and a lot more*" (20-LK-LEASESUR-267.62).

The Project does not propose any changes to the current access to Highway 914 north of Cameco's Key Lake Operation gate.

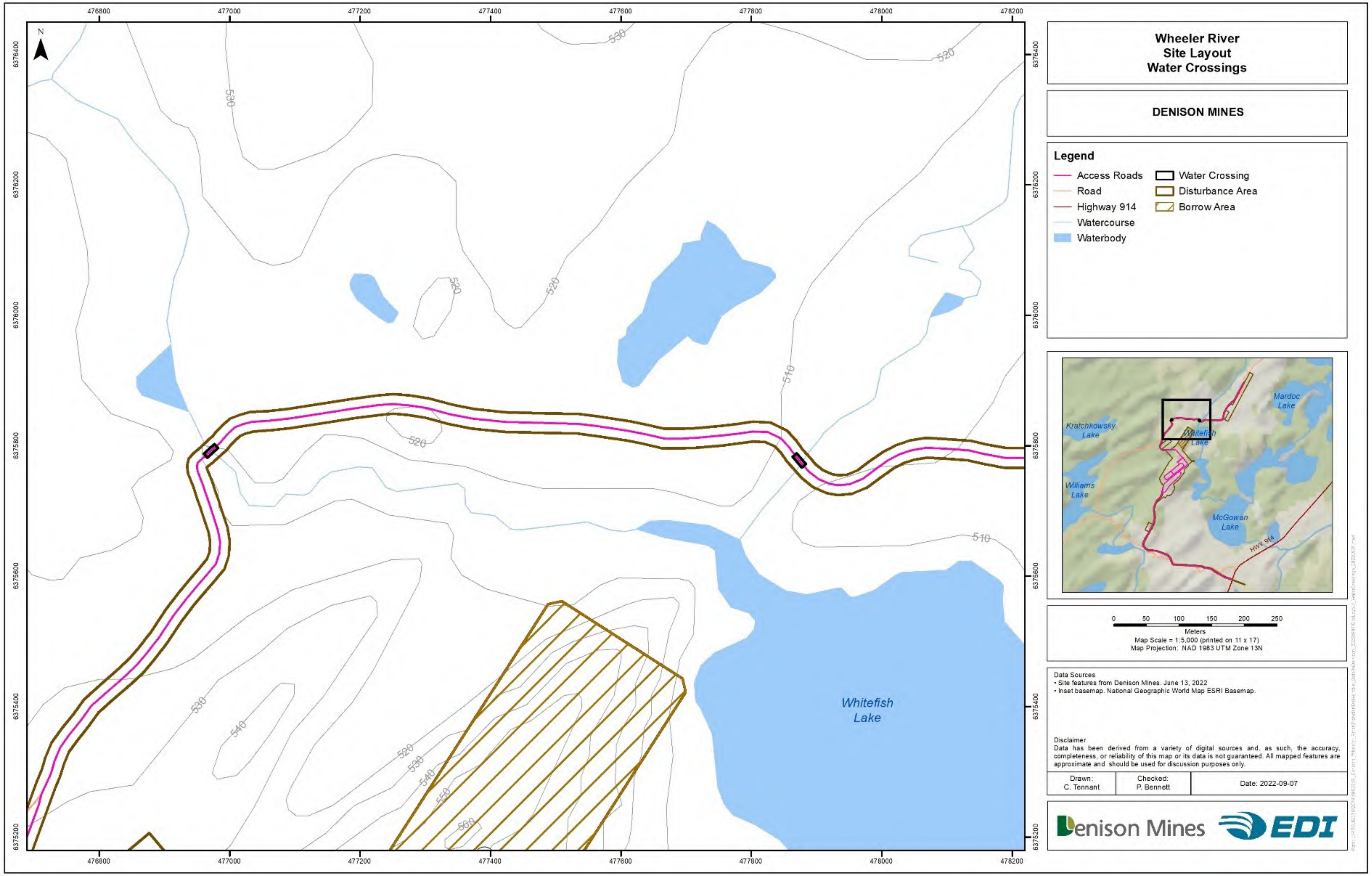


Figure 2.2-27: Water Crossings Associated with the Project

2.2.5.2 Traffic

Estimates of traffic are provided by Saskatchewan Ministry of Highways by road segments and are broken down by total traffic and truck traffic. Truck traffic, reported as Truck Annual Average Daily Traffic (TAADT), is a subset of all traffic, which is reported as Annual Average Daily Traffic (AADT).

An estimate of the Project-related traffic during Construction and Operation is available in Table 2.2-3 and details are provided in Appendix 2-B.

The Project-related traffic is associated with transportation of required supplies such as equipment, materials, reagents, food, and fuel.

Table 2.2-3: Estimated Project-related Traffic During Construction and Operation

Phase	Truck Annual Average Daily Traffic	Annual Average Daily Traffic
Construction	14	22
Operation	18	18

Note: These traffic volumes assume travel to site and return occur on the same day.

2.2.5.3 Air Strip and Terminal

The Project is proposed as a fly in-fly out operation. As such, the Project will require an airstrip to bring personnel to and from the site. A 1,600-m long airstrip is proposed to be positioned in a natural and relatively flat valley to the northeast of the Project site (Figure 2.2-1). The magnetic headings are 03/21. The runway has been designed to accommodate the aircraft presently used by existing mining operations in northern Saskatchewan to transport personnel into and out of site. The approach line to the airstrip from the southwest clears the Project surface facilities by 500 m.

An airstrip terminal building and two double-walled Jet A fuel tanks, to provide site service to aircraft as required, will be constructed near the airstrip. All fueling and de-icing activities will occur in specifically designed areas to collect any hydrocarbons and de-icing fluids. Collected waters will be characterized and brought to the Project site for treatment, shipped off site to an approved facility or released to environment if water quality allows. For the EA, a small diesel generator, to power the airstrip and terminal and provide terminal building services, communications, and runway lighting, was assessed. Bottled water will be supplied to the terminal. Domestic wastewater generated at the terminal will be collected in septic tanks and transported by a vacuum truck to the DWWTP.

2.2.5.4 Site Security

Road access to the property will be controlled by both a north and south security gate (Figure 2.2-1). The main, south gate will be located close to the operations centre and staffed as required. A weigh scale will be installed and will allow for verifying incoming and outgoing loads. The north gate is a simple gate and will not be staffed.

Hazardous areas will be fenced for the health and safety of the public.

2.2.6 Power

2.2.6.1 Primary Power Supply

Electrical service to the Project will be provided via an approximate 5-km extension tap from the existing 138 kV overhead transmission line that runs along Highway 914. Optimization of the precise line route will be completed as the Project advances and will likely follow the access road alignment.

Power transmission to the site (e.g., assessment, obtaining necessary permits, and construction) will be led by SaskPower and is not considered part of this Project (refer to Section 2.4).

An electrical substation will be built on site (Figure 2.2-1). Distribution will include a combination of overhead and underground lines. Site infrastructure anticipated to draw power from the provincial power grid includes the freeze plant, processing plant, industrial landfill, camp, and operations centre.

The airstrip and terminal will not be connected to the substation; a small diesel generator will be used to provide terminal building services, communications, and runway lighting.

2.2.6.2 Back-up Power Supply

Based on historical data provided by SaskPower, the outage rate of the existing line is approximately six outages per year. To provide electrical service during times of utility outages, diesel generators will be installed to service the site and maintain essential functions. The generators will be used to maintain power to the processing plant and the camp, as well as to maintain other essential services as required.

2.2.7 Support Facilities

2.2.7.1 Camp

Located southwest of the wellfield, the proposed camp or accommodations facility is anticipated to be a turnkey building manufactured off site and assembled and commissioned on site. The building’s design will be sized to accommodate a peak load of about 190 individuals during Operation; however, due to its modularized design, additional modules can be easily installed should additional beds be required in the future.

The camp will include a central services complex with:

- kitchen with food preparation area and serving area;
- dining room;
- camp office;
- commissary;
- recreation area; and

- exercise facilities.

The building will be heated with propane and connected to all utilities for potable water, electricity, and sewage management.

2.2.7.2 Operations Centre

The operations centre is planned to be a standalone, multi-functional building that will serve the administrative needs of the site.

The operations centre will have offices, meeting rooms, a boardroom, washrooms, lunchroom, small change areas (the main dries will be located in the processing plant), a nursing station with a waiting area, space for storing emergency response equipment and supplies, environment department storage area, and services rooms. Adequate parking will be available, including a dedicated area for emergency response vehicles.

2.2.7.3 Covered and Fenced Storage

Warehousing activities are planned to be completed inside a covered area, along with a fenced storage area, located east of the operations centre (Figure 2.2-1).

2.2.7.4 Wash Bay and Radiological Clearance Scanning Area

A wash bay will be available to clean items, equipment, and vehicles that may have been in contact with potential contaminants. The wash bay area will have an impermeable floor and a lined water collection sump. Rinse water from the wash bay sump will be routed to the wellfield runoff pond or directly to the process water pond. Items that are too large for the wash bay can be cleaned at the industrial landfill laydown area.

Radiological scanning will be located near the wash bay and will confirm clearance criteria are met for any items, equipment, or vehicles leaving the site.

2.2.7.5 Fire Water System

The on-site fire water system will include a 500 m^3 fire water tank, to meet National Fire Protection Association requirements. The fire water system location is shown in Figure 2.2-1 and will include two electric fire water pumps, and a back-up diesel fire water pump for on-site fire suppression needs.

2.2.7.6 Hazardous Substances Management for Support Facilities

Hazardous substances associated with support facilities include fuel, paint, used oil, and chemicals. These hazardous substances will be managed in a safe and secure manner in line with Safety Data Sheets, permit conditions, and applicable regulations such as the *Hazardous Substances and Waste Dangerous Goods Regulations*. Denison will maintain an up-to-date record of the various hazardous substances on site and will maintain Safety Data Sheets and appropriate procedures for spill management, handling, and clean up in an accessible location. Communities of Interest want assurance that appropriate emergency response plans (with specific focus on spill response) will be developed for the Project (18-EN-VILX-3.33) (21-EN-VPL-444.25). Denison will identify and reduce the potential for accidents and emergency situations, and implement emergency response plans that will protect the health and safety of its workers, contractors, the public and the environment.

Denison identified a need to have a small (250 m^2) pad designated for temporary storage of hazardous waste such as paints, solvents, hydrocarbons, and used oil. The temporary storage pad will have a composite liner system (Figure 2.2-24). Hazardous wastes will be taken off site by waste management service providers for proper recycling as soon as practical.

No fuels, oils, or other hazardous substances will be stored within 100 m of any water body. No equipment maintenance or re-fuelling will be conducted within 100 m of a water body.

2.2.7.6.1 Fuel Storage and Dispensing Facility

Because the site's primary power supply will be the provincial electrical grid, fuel consumption at the Project may be limited to diesel for mud rotary and diamond drill rigs, fuel for auxiliary vehicles (i.e., all-terrain vehicles [ATVs] and snowmobiles), miscellaneous equipment (i.e., portable pumps), back-up power supply, and freight and personnel transportation to site. This will reduce Project fuel consumption and minimize direct greenhouse gas emissions.

Jet A fuel for airplanes will be stored in tanks at the airstrip and managed by Denison, although the dispensing is the responsibility of the air carrier. Emissions associated with use of Jet A fuel are not included in the air dispersion model for the Project and the emissions are considered Scope 3 for Denison.

Tanker trucks will deliver diesel, gasoline, and Jet A fuel to the site on an as-needed basis. Fuels will be stored in approved, above-ground, 25,000 L double-walled storage tank(s) equipped with secondary containment in accordance with provincial regulations and standards. Fuel storage and distribution infrastructure will be constructed and operated in accordance with applicable legislation requirements (e.g., *Hazardous Substances and Waste Dangerous Goods Regulations*). Stationary equipment will be fuelled with a fuel-dispensing truck.

The anticipated greenhouse gas emissions associated with the Project are included in Section 2.5.

2.2.7.6.2 Propane Storage Areas

Propane may be used as a primary or back-up means to support the calciner or dryer, mining solution heating, comfort heat for buildings, and camp kitchen.

The propane storage will be sized to meet the needs of the site activities and will feature a storage tank (assumed to be 30,000 Unites States water gallons [uswg]), vaporizers, a propane bottle fill station, and a propane bottle weigh station. Propane will be delivered to site on an as-needed basis. The anticipated greenhouse gas emissions for this Project component are included in Section 2.5.

2.2.7.6.3 Other Hazardous Substances

Chemicals required for water treatment, ISR mining, and processing constitute the ‘other’ hazardous substances anticipated for use at the Project.

Sulfuric acid, iron sulphate, hydrogen peroxide, magnesium hydroxide, barium chloride, calcium hydroxide (lime), sodium hydroxide, and flocculant are the main chemicals anticipated to be used in mining, processing, and water treatment (Table 2.2-4). Bulk storage tanks for these chemicals will be located inside the processing plant, in a separate room from the processing equipment. The storage tanks will sit inside appropriately designed and sized concrete secondary containment basins. The secondary containment basin for each applicable chemical system will be physically separated from the containment basins for other chemical systems.

The various lubricants and coolants required for regular maintenance of equipment will be stored on site in the maintenance shop and processing plant. Each one of these materials will be stored, handled, recycled or disposed of in an appropriate manner and meet the requirements of the *Hazardous Substances and Waste Dangerous Goods Regulations*.

Table 2.2-4: Planned Chemical Use for the Project

Chemical	Planned Use at the Project						Dedicated Storage Tank Within Processing Plant
	Mining Solution	Processing		Industrial and Domestic Water Treatment (Operation and Decommissioning)	Remediation Solution (Decommissioning)	Freeze Plant	
		Stage 1 Precipitation	Stage 2 Precipitation				
Ammonia						✓	
Barium chloride		✓		✓			✓
Flocculant		✓	✓	✓			✓
Hydrogen peroxide	✓	✓	✓				✓
Iron sulphate	✓			✓			✓
Lime (calcium hydroxide)		✓		✓			✓
Magnesium hydroxide			✓				✓
Sodium bicarbonate					✓		
Sodium hydroxide		✓			✓		✓
Sulphuric acid	✓			✓			✓
Zero valent iron				✓			

2.2.7.7 Borrow Area

A borrow area is planned for an area northeast of the processing plant. The borrow material or overburden will be used in Construction for roads, airstrip, and pads. The borrow material will also be used in the batch plant for concrete production needs (e.g., foundations) during Construction. Borrow material may be needed during Operation for ongoing maintenance of various Project components. During Decommissioning, borrow material will be needed for fill and cover material.

2.2.8 Project Area

The total footprint of Project components (infrastructure footprint) is anticipated to be 74.8 ha. By applying a buffer around these components, the maximum footprint of the Project was estimated to be 169.6 ha (Figure 2.2-28). This spatial area with the buffer is referred to as the Project Area in the biophysical and human environment assessments of the EIS. The decision to assume a larger area of disturbance than is anticipated contributes to Denison's goal to have a conservative assessment basis in the EA.

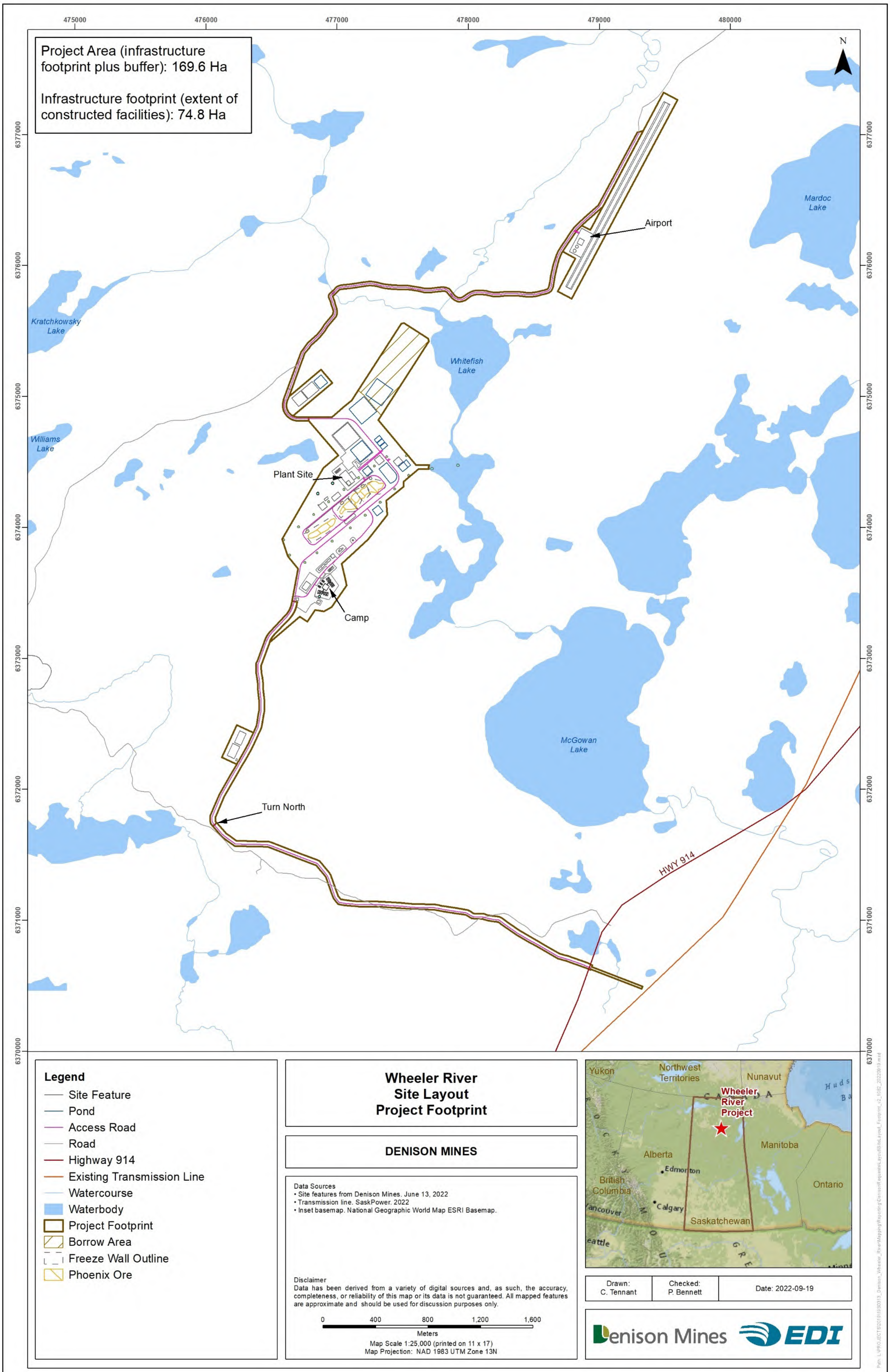


Figure 2.2-28: Project Area

2.3 Project Activities

A summary of the anticipated key activities for Construction, Operation, Decommissioning and Post-Decommissioning of the Project are provided in Table 2.3-1.

Table 2.3-1: Key Activities for the Wheeler River Project

Phase and Year	Description of Activities	
Construction Year 1 to 3	• Development of access roads and air strip • Site preparation and earthworks; clearing, leveling and grading of the Project Area. • Power generation – generators • Installation of main substation and distribution of power around site • Wellfield and freeze hole drilling; ground freezing • Batch plant operation (concrete); crusher at borrow area • Development of surface infrastructure (camp, operations centre, plants, ponds, pads and support facilities) • Waste management (composting, domestic and industrial landfill operation, recycling)	• Water management (including treatment and site run-off) • Groundwater supply • Surface water withdrawal • Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel) • On-site and off-site operation of vehicles and transport of materials • Air transportation for workers • Regulatory site inspections • Engagement - site visit from Interested Parties • Employment and expenditures
Operation Year 3 to 18	• Operation of the ISR wellfield • Wellfield and freeze wall drilling • Operation and expansion of freeze wall • Batch plant operation (grout and cement); crusher at borrow area • Expansion of pond and pads • Operation of the processing plant and production of uranium concentrate • Water withdrawal from groundwater or surface water body • Management of surface water (including seepage and site run-off) • Water treatment, both domestic and industrial • Water release to surface water body • Waste management (composting, domestic and industrial landfill operation, recycling) • Hazardous waste management (temporary storage, handling, and off-site transportation)	• Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates • On-site and off-site operation of vehicles and transport of materials • Power supply – primarily power from the grid, also generators and back-up generators • Package and transport of nuclear substances • Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel) • Air transportation for workers • Progressive decommissioning and reclamation • Regulatory site inspections • Engagement - site visit from Interested Parties • Employment and expenditures
Decommissioning Year 18 to 23	• Site water management, treatment and release • Mining area remediation and thawing of freeze wall	• Power generation – generators • Waste management (composting and landfill operation)

Phase and Year	Description of Activities	
	• Process water treatment and release • Closure of ISR and freeze wells and related infrastructure • Decontamination of surface facilities and injection, recovery and monitoring wells • Asset removal (including site power transmission lines and electrical infrastructure) • Demolition and disposal of non-salvageable surface infrastructure and materials • Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and processing plant area)	• Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal) • On-site and off-site operation of vehicles and transport of materials • Reclamation of disturbed areas • Regulatory site inspections • Engagement - site visit from Interested Parties • Employment and expenditures
Post-Decommissioning Year 23 to 38	• Environmental monitoring • Regulatory site inspections	• Engagement - site visit from Interested Parties • Employment and expenditures

2.3.1 Construction

Construction activities will follow industry best management practices to minimize effects of the Project on the environment and keep risks to workers as low as reasonably achievable.

The sequence for Construction activities will occur in a logical manner based on Project execution plans. As one example, Denison will prioritize bringing power into the site, allowing the freeze plant operation to start early in the construction process and the Phase 1 freeze wall can be established.

2.3.1.1 Pre-Construction Activities

2.3.1.1.1 Mineral Surface Lease Agreement

Before constructing any permanent surface facilities, Denison must obtain a mineral surface lease agreement. A mineral surface lease agreement is the legal authorization for a mining company to occupy Crown land. Surface leases are coordinated through the Ministry of Government Relations, Northern Engagement Branch and the Saskatchewan Ministry of Environment (SK MOE), Lands Branch, with input from other ministries or branches as required. Issuance of a surface lease agreement is tied to the successful outcome of the provincial EA process.

2.3.1.1.2 Licensing and Permitting

Denison will require various licences and permits prior to initiating construction. This includes, but is not limited to, a licence to prepare site and construct from the CNSC, an approval to construct a pollutant control facility from SK MOE, and permit to construct a facility to handle hazardous substances or waste dangerous goods from SK MOE.

2.3.1.1.3 Pre-Clearance Surveys

Prior to commencing any site clearing during the nesting season, bird nest surveys will be conducted. Should the Project footprint change, additional surveys may be required for rare plants and/or heritage resources.

A baseline radiological scan of the Project footprint will be conducted to provide a benchmark for future remediation efforts.

2.3.1.2 Construction Camp

During early stages of Construction, the existing Project exploration camp will be used by Denison staff and contractors. Additional, temporary sleeper units may be brought to the camp area, as required. Installation of the new permanent camp will be prioritized in the construction sequence to add capacity. Domestic wastewater generated at the new camp will have to disposed of off site using a vacuum truck, until the permanent infrastructure, including the DWWTP, is online.

2.3.1.3 Site Preparation and Earthworks

Site clearing and other works that involve disturbance of vegetation and/or soil will be conducted outside of the nesting season, whenever practicable. The Heritage Resources Management Plan (Appendix 11-B in Section 11) will be followed should any archeological sites be discovered.

Clearing and leveling of the surface facilities will be contracted out to a suitable contractor. Topsoil and brush will be stockpiled on site for future use during reclamation; the location of the topsoil stockpile will be determined closer to Construction.

Construction of foundations and general earthworks will be required for various Project components. Construction of roads, foundations, pads, ponds, and the airstrip will be initiated during site preparation. Suitable construction fill material will be sourced from a proposed borrow area and any suitable clean sandstone generated during freeze wall and well drilling (Section 2.2.7.7). It is estimated that 11,000 m^3 of subgrade fill will be needed.

Temporary security checkpoints will be established early in the site preparation phase.

Construction activities are expected to be completed without the use of explosives for blasting.

2.3.1.4 Wellfield

Denison has been drilling on the property since 2004; this experience and knowledge will be applied to the drilling of the freeze and wellfield holes. Suitably qualified and experienced contractors will be overseen by Denison personnel to complete drilling activities.

Ground freezing requires the establishment of a pattern of freeze wells, refrigeration units, and corresponding electrical and mechanical services. Freeze well drilling, using diamond drilling methods, will be initiated as early as possible. The freeze plant chiller units will arrive at site and be physically installed and used when the appropriate tie-ins to the site power distribution system are complete.

Holes for wellfield injection and recovery wells may be drilled using techniques described in Section 2.2.1.2 and well installation will proceed as described in Section 2.2.1.4.

Pump tests will be completed in the wellfield as part of wellfield commissioning to confirm the hydraulic connectivity in the mining area.

2.3.1.5 Processing Plant

While the processing plant is likely the most complex construction activity for the Project, it is relatively simple when compared to other full-service uranium mills, as there are a limited number of vessels and minimal piping. Most of the equipment and materials inside the plant are small in size, enabling the shipment of tanks and other vessels pre-assembled, with current engineering activities focusing on modularization. Processing plant construction will begin immediately following earthworks at the site. After foundations are completed, building construction can begin.

A short commissioning period for the processing plant begins post-construction, prior to first uranium production and receipt of operating licences and permits.

2.3.1.6 Water Management

Construction, installation, and commissioning of the water management components, described in Section 2.2.3, will proceed in a logical sequence. This includes components for groundwater and/or surface water withdrawal, treated effluent release, various ponds, the potable WTP, the DWWTP, the IWWTP in the processing plant, and piping between facilities.

For surface water withdrawal and treated effluent release to Whitefish Lake the works proposed in and around water will be conducted to avoid fish habitat, be of short duration, of a small spatial scale, and constructable during appropriate timing windows.

Water management of runoff during Construction will follow industry best management practices for erosion control.

2.3.1.7 Waste Management

Construction of various waste management Project components (e.g., ponds, pads, landfills) required for operations, as outlined in Section 2.2.4, will be completed.

Waste generated during Construction will be recycled off site to the extent possible. Any remaining wastes will be temporarily piled or stored in laydown areas and placed in the appropriate landfill once construction of the landfills are complete.

2.3.1.8 Access and Transportation

Construction of the site roads will proceed in a logical fashion, with the initial priority on completing the access road connection to Highway 914. Following construction of the main access road corridor, the remaining site roads and the airstrip will be constructed. This includes installation of two stream crossings. Information received from several engagement meetings with local communities informed the selection of the proposed access road alignment (21-EN-YOUTH-445.11).

Transportation of staff and deliveries of supplies to the Project will be ongoing throughout Construction. Transportation will be by ground until the airstrip and terminal are completed.

2.3.1.9 Power

Until electrical power is available, power for Construction activities will be from diesel generators.

The main substation will be installed early in the Construction phase. A powerline will be constructed from the existing provincial power line adjacent to Highway 914 into the new substation; this will be completed by SaskPower. Overhead and underground distribution lines around site will be installed as required to provide electricity for Project needs.

Diesel generators needed for primary and back-up power during Operation will also be installed during Construction.

2.3.1.10 Support Facilities

Other surface infrastructure including the camp, operations centre, the airstrip terminal building will be constructed. With the exception of the operations centre and processing plant, all buildings are expected to be pre-fabricated buildings to reduce costs and simplify construction activities.

The operations centre is planned to be completed ahead of commissioning. This will allow the operations team to conduct activities in a suitable building. The camp is to be completed in a similar time frame, along with basic services, such as communications and fire systems.

A batch plant will be used during Construction to create concrete. Concrete will be required for construction of foundations and containment walls in select surface infrastructure.

2.3.1.11 Commissioning

Commissioning of the Project facilities is expected to be supported by engineering and/or supply vendors, along with the assistance of the construction team. This will help to make sure the constructed facilities adhere to the designs and specifications set forth.

2.3.1.12 Construction Management

Project and construction management during the capital development phase of the Project will be managed by a small, dedicated Project management team. During Construction, Denison will provide general and administrative services to operate the site and support the contractors (e.g., room and board, flights, general supplies, freight haulage). It is expected that a mix of employees, contractors, and engineering service providers will support site construction efforts.

2.3.2 Operation

Operation of the Project is planned to last up to 15 years. Denison anticipates operating the site with mine employees and a limited number of external contractors. Denison will require a licence to operate from the CNSC and an approval to operate a pollutant control facility from SK MOE.

The Operation phase is generally focused on operating the Project components that were presented in Section 2.2. As such, the operational activities for the Project include, but are not limited to:

- operation of the ISR wellfield;
- wellfield drilling as the mining phases advance;
- operation and expansion of the freeze wall as the mining phases advance;
- operation of the processing plant and production of uranium concentrate at an average production rate of 9 Mlbs U_3O_8/year and a peak production rate of up to 12 Mlbs U_3O_8/year;
- water management, including management of seepage and site-runoff, freshwater withdrawal, potable water treatment and distribution, domestic and industrial wastewater treatment, managing contact water, effluent monitoring, and discharge of tested water to a Whitefish Lake that meets discharge limits;
- waste management, including management of organic waste, recyclables, domestic and industrial landfills, hazardous wastes, mining wastes, and processing wastes;
- maintenance activities at the wellfield, processing plant, roads, airstrip, and other support facilities;
- environmental monitoring as outlined in the Environmental Management System;
- package and transport of nuclear substances;
- reporting to regulators;
- engagement with local Indigenous and non-Indigenous communities; and
- systems for maintaining site security.

2.3.2.1 Mine Plan

Denison is proposing a five-phase approach to mining at the Project (Figure 2.3-1). Each phase is intended to target a specific area of the deposit and reduces the upfront capital expenditure requirements and initial ground freezing requirements. Development of the freeze wall is also planned to occur in phases, with a limited initial freeze wall, and new mining phases brought on throughout the mine life by expanding the extent of the freeze wall. The freeze wall will be used to partition off each mining phase. The frozen cross walls (see isometric view in Figure 2.3-1) may be thawed as the freeze wall expands to accommodate subsequent phases. The outer freeze wall will remain in place until mining is complete and through to Decommissioning until remediation is completed. The plan, longitudinal, and isometric views of the five mine phases and the proposed freeze wall are shown in Figure 2.3-1.

Mine sequencing and scheduling is based on confidence levels of potentially mineable resources based on a number of factors including geology, hydrogeology, and mineral resources. Table 2.3-2 below illustrates a conceptual mine plan based on mining phases with larger reserves allocated to earlier phases. As noted in Section 2.2.1.1, Denison has bound the EA above the deposit indicated resources to provide operational flexibility from one year to the next and appropriately bound the assessment of effects.

Table 2.3-2: Conceptual Mine Plan for the Project

Mine Phase	Production (Mlbs)
1	22
2	16
3	8
4	9
5	5
Total	**60**

Denison Mines

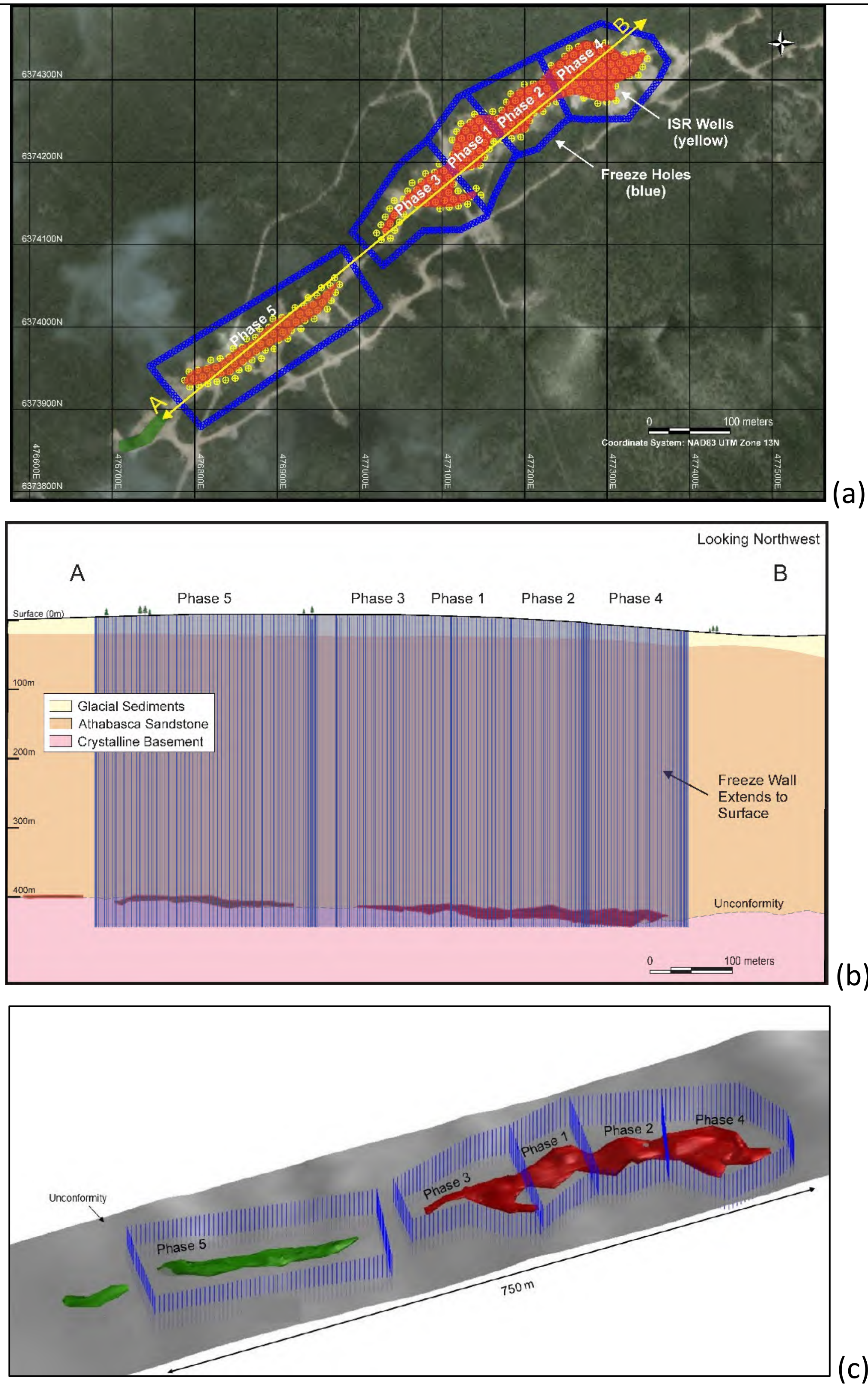


Figure 2.3-1: Plan (a), Longitudinal (b), and Isometric (c) Views of Proposed Mine Phases With Freeze Wall

2.3.3 Decommissioning

This subsection outlines a conceptual decommissioning plan (CDP) to support the EA for the Project. Denison's decommissioning commitment is to return the land back to the Province of Saskatchewan for unrestricted surface land use post-closure. The CDP outlines how radiological, physical, and chemical risks will be managed during Decommissioning so no unreasonable risks remain. Denison will prioritize passive versus active controls to reduce long-term risk.

Additional decommissioning details will be provided in the preliminary decommissioning plan (PDP), which will submitted to regulators as part of Project licensing and permitting. The PDP will be prepared considering provincial, federal, and international documents relevant to decommissioning and reclamation. Examples of key reference documents for development of the PDP are CNSC's REGDOC-2.11.2, Decommissioning (CNSC 2021a) and the SK MOE's Northern Mine Decommissioning and Reclamation Guideline (SK MOE 2008). The PDP will include an associated estimate for the decommissioning costs and Denison will provide financial assurance to confirm the identified decommissioning activities can be completed as planned.

Prior to executing Decommissioning activities, Denison shall prepare and submit a detailed decommissioning plan (DDP) to regulators for acceptance, which builds on the preliminary decommissioning plan.

Broadly, the CDP outlines physical decommissioning activities, followed by reclamation. Decommissioning is expected to take approximately 5 years.

The three main physical decommissioning activities include:

- mining area remediation;
- asset removal; and
- decontamination, demolition, and disposal.

Physical decommissioning activities are followed by reclamation.

Progressive decommissioning and reclamation will be completed throughout the life of the Project, whenever feasible, and reported to the regulatory agencies as part of the annual reporting requirements throughout Operation. Progressive decommissioning activities will focus on the decontamination, demolition, and disposal of unused buildings and infrastructure, as well as the removal of unused equipment and machinery. Reclamation of inactive areas will take place when these areas become available.

Closure of the entire Project will be completed in accordance with provincial and federal regulations and guidance documents with the fundamental considerations being to confirm physical and chemical stability of the site to protect human health and the environment. The importance of successful decommissioning was raised frequently in engagement activities, including for example:

> *Who is responsible for restoring the environment?* (21-EN-ERFN-447.33)
>
> *Who is responsible for cleaning up contaminants?* (21-EN-ERFN-447.34)
>
> *What happens if the environment gets contaminated? How can you restore it to its original state?* (21-EN-ERFN-447.35)

2.3.3.1 Physical Decommissioning

2.3.3.1.1 Mining Area Remediation

The objective of mining area remediation is to restore the groundwater within the confines of the freeze wall to reach an acceptable remediation target, prior to turning off the freeze wall.

As discussed in Section 2.2.1.4, during Operation, mining solutions will be contained within the mining area that has been defined as inside the freeze walls and up to 50 m vertically from the ore zone. This will be confirmed during Operation by a robust groundwater monitoring network comprised of numerous wells located at various vertical depth horizons above the ore zone (both within and outside of the freeze walls).

Remediation of the mining area will involve injecting water into the mining area via injection wells and recovering groundwater through the recovery wells, similar to how mining was conducted during Operation. Reagents such as sodium bicarbonate and sodium hydroxide (Table 2.2-4) may be added to the injected water to accelerate groundwater quality recovery. Produced water will be processed through the processing plant until non-economic uranium concentrations are observed. Non-economic produced waters will be treated and mixed with fresh water for continued circulation in the mining area. Water treatment and treated effluent discharge release will continue during the Decommissioning phase (Figure 2.2-16). Information obtained during Operation from the wellfield, such as flow rates, will inform the remediation plans and rates.

Mining area remediation will continue until recovered water reaches and is demonstrated to be stabilized (maintained) at acceptable mining area decommissioning objectives (Table 2.3-3). Meeting the acceptable mining area decommissioning objectives will be based on statistically demonstrating that the water quality meets acceptable target values with associated levels of uncertainty (i.e., central tendency and 95% confidence intervals) and is stable over sufficient time for there to be confidence that conditions will not change.

The mining area decommissioning objectives have been developed through groundwater modelling work and are achievable based on metallurgical testing. Metallurgical testing, including column tests and core flooding tests, have been undertaken at SRC to understand the anticipated evolution of groundwater hydrochemistry as groundwater quality in the mining is restored. Numerical groundwater modelling was applied to evaluate the fate and transport of the groundwater in the remediated mining area (see Section 9 and Section 10). Groundwater flow and geochemical reactive transport modelling were applied to help understand the migration and attenuation of remediated groundwater from the mining area toward Whitefish Lake, the primary surface water receptor. Refinement of the mining area decommissioning objectives will continue as the Project progresses. The final acceptable mining area decommissioning objectives will be developed prior to initiation of groundwater remediation, as part of the DDP.

Once the mining area decommissioning objectives have been met, the perimeter freeze wall will be turned off and allowed to thaw. This will allow the eventual re-establishment of the pre-operational groundwater flow regime in the former mining area.

Table 2.3-3: Mining Area Decommissioning Objectives

Parameter	Units	Restored Solution
pH		4.3
Aluminum	mg/L	7
Arsenic	mg/L	0.06
Cadmium	mg/L	0.015
Cobalt	mg/L	2
Chromium	mg/L	0.05
Copper	mg/L	0.17
Iron	mg/L	100
Molybdenum	mg/L	0.1
Nickel	mg/L	9.7
Lead	mg/L	3.1
Sulphate	mg/L	703
Selenium	mg/L	0.08
Zinc	mg/L	1.4
Uranium	mg/L	100
Vanadium	mg/L	0.51
^{226}Radium	Bq/L	2.00E+02

2.3.3.1.2 Asset Removal

Salvageable machinery, equipment, and other materials at the Project site will be dismantled, decontaminated, and taken off site for resale or recycling. Remaining items will either be managed at a facility licenced to manage radioactive wastes or disposed of in the industrial landfill.

Process precipitates temporarily stored at the process precipitate pond during Operation will be transported off site to an approved facility for reprocessing and permanent disposal.

Any mineralized core or drill cuttings remaining on the special waste pad at Decommissioning will be trucked off site to an approved facility for reprocessing and permanent disposal.

2.3.3.1.3 Decontamination, Demolition, and Disposal

Surface facilities, together with injection, recovery, and monitoring wells, will be systematically surveyed and decontaminated as necessary. Decontamination can include cleaning via dry blasting, sand blasting, and/or high pressure washing. Surplus chemicals and other hazardous materials will be removed and stored in designated temporary storage facilities. Sumps will be cleaned. Hazardous materials will be disposed of at approved off-site facilities. Radiologically contaminated material will be disposed of on site in accordance with licence conditions.

Empty tanks will be removed from the sites and sold as scrap or reused. Otherwise, they will be transported to an approved waste management facility. Fuel tanks will be managed by a contractor licenced to handle these types of tanks. Any remaining fuel and tanks will be removed by the contractor from the site. Any waste hauled off site will be disposed of at appropriate licenced facilities.

Permanent structures that remain after asset removal will require demolition. Most process equipment and non-supporting structures will be removed from buildings prior to demolition and the buildings will be demolished.

During demolition, an initial wash of the structures to be demolished will be required along with dust control using water. The requirement and duration of misting will be determined on a case-by-case basis.

A review prior to the start of demolition will identify areas requiring additional procedures. Where possible, dust generating materials will be removed prior to demolition. Appropriate personal protective equipment and personnel decontamination procedures will be employed.

Valuable recyclable materials will be separated and processed for transport and sale concurrent with demolition. Excavators equipped with grapples will sort the recyclable products from the non-recyclables. Shears will be used to size recyclables for shipping and sale. Cleaning procedures of recyclables will be integrated into demolition, as necessary.

Concrete foundations will be left in place. Any portions of concrete foundations remaining above grade will be levelled and rebar will be cut-off at grade. Large slabs will be perforated on a 2-m grid to permit drainage. Concrete slabs will be covered with 0.5 m of development rock or locally stockpiled till.

The demolition process will produce:

- saleable recyclable materials (e.g., steel, stainless steel, copper, steel sections, and sheet metal);
- hazardous materials, including contaminated material that cannot be decontaminated;

- roofing materials and insulation;
- wood;
- concrete; and
- contaminated soils.

Saleable recyclable materials will also be transported off site as scrap or recycled.

Hazardous materials will be handled and disposed of in accordance with the appropriate regulations and good practice. Where possible, chemicals will be mixed to produce a neutral solution and disposed of in an approved manner at site. Hazardous materials, such as spent chemicals (that cannot be managed on site), waste oil, and sludges, will be disposed of off site at licenced facilities.

Non-hazardous waste materials, such as roofing materials, insulation, wood, co-mingled concrete, and light steel (i.e., hand railings), may be disposed of on site or off site in a licensed landfill. Soil testing will be conducted in any areas of known contamination and/or potential spills, including areas around chemical, fuel, and explosive storage areas. Testing will be conducted according to industry standard procedures and compared to provincial and federal soil standards.

Closure of the ISR wellfield and associated infrastructure will require the following activities:

- decommissioning of all injection and recovery wells: a plug will be placed at the base of the casing to provide containment from the bottom of the well. The lower 50 m within the casing will be grouted with a bentonite clay-cement blend and further capped at this level with an additional plug. The well casings will be cut off about 1 m below the current ground surface and a cement–grout plug will be placed immediately over top of the casing near surface to inhibit water flow down the outside of the casing. The ground surface will then be built up by about 0.5 m with a combination of low permeability material and/or local fill amended with 5% bentonite to reduce hydraulic conductivity. These mounds will be graded away from each former well, to make sure no standing water accumulates immediately above the casings. Wellheads will also be removed as part of the decommissioning process prior to abandonment.
- removal, decontamination, and disposal of all surface piping;
- decontamination and removal of the pumphouses;
- decontamination, removal, and/or disposal of the processing plant;
- thawing of the freeze wall and decommissioning of all freeze pipes and the freeze plant. The freeze holes will be decommissioned in the same manner as the ISR wellfield injection and recovery wells. The freeze pipes, which will be located inside the freeze holes, will simply be unthreaded and removed from site after the freeze wall is no longer required; and
- placement of waste in the industrial landfill or an off-site licensed facility.

Demolition and disposal of remaining infrastructure components involves the decommissioning and removal of components such as power transmission lines and electrical infrastructure, water pipelines, and water treatment plants. Ponds will be decommissioned once they are no longer required for water management. Any contaminated liners will be removed and hauled to an approved landfill or disposed of in the industrial landfill.

The industrial landfill will have an engineered impermeable cover installed to limit water infiltration into the industrial wastes. Similarly, the material in the IWWTP precipitate pond will be covered and decommissioned in place. The industrial landfill will be designed to have two HDPE geomembrane liner over two Geosynthetic Clay Liner and the IWWTP precipitate pond will be designed to have a single HDPE geomembrane liner over a Geosynthetic Clay Liner. A single liner system is expected to remain in place for over 400 years (Koerner et al. 2011). Further reducing the potential for groundwater movement through the liner, the industrial landfill and IWWTP will be installed several meters above the water table. The physical location of the industrial landfill and IWWTP precipitate pond along with the impermeable cover and liner design will reduce the likelihood of any infiltration post decommissioning.

2.3.3.2 Reclamation

Once the asset removal, decontamination, demolition, and disposal are completed, and the site has been cleared and leveled, reclamation activities, including replanting, will take place. Currently this would largely be jack pines, but the mix of plants will depend on location and available species. This reclamation will be monitored for a period until it is deemed self-sustaining and viable wildlife habitat.

Future discussions will be held with Indigenous and general public Interested Parties to determine the amount of access to the area they wish to maintain in the future (post-decommissioning). Based on results of these discussions, transportation corridors associated with the Project site that are no longer needed will be graded and scarified to promote natural revegetation. Access roads or trails required for post-closure monitoring or deemed useful by Interested Parties may be left to facilitate continued access. Access to the site may be restricted by gates and/or berms.

Laydown areas will be scarified, covered with 0.5 to 1.0 m of stockpiled overburden, and vegetated with native, self-sustaining species. The footprints of other infrastructure, such as the camp, will be scarified and vegetated with native, self-sustaining species as required. The topsoil and brush stockpiled during pre-construction activities will be used during reclamation.

Lessons learned from progressive decommissioning and any site-specific reclamation studies will be incorporated into the detailed reclamation design. Additionally, information from other northern Saskatchewan mine sites will be examined to help Denison select the reclamation tools, including revegetation options, that will contribute towards decommissioning success.

2.3.4 Post-Decommissioning

Post-Decommissioning extends from the end of physical decommissioning until transfer of the site into the provincial Institutional Control Program (Government of Saskatchewan 2009) or direct release of the land back to the Crown. This phase of the Project is expected to last fifteen years.

Following Decommissioning, physical, chemical, and biological monitoring of the site will be conducted to confirm that the site is chemically and physically stable. The importance of this phase of the Project is clear based on questions and comments from engagement activities, such as o*nce the mine is closed how will the community know that the environment is restored*? (21-EN-ERFN-447.36) and *is the environment monitored after the closure of the mine? Who monitors it?* (21-EN-VILX-443.17). The Post-Decommissioning monitoring program will be designed and conducted in accordance with the provincial and federal regulations and licence conditions. The monitoring program will be conducted until the site-specific decommissioning and reclamation objectives for the Project are met. Monitoring reports will be developed and submitted to both the provincial and federal regulators, in accordance with licence conditions.

2.4 Ancillary Projects

SaskPower proposes to tap the existing I3P 138 kV line near Highway 914 and build approximately 4.5 km of new 138 kV line from the I3P tap to the Project site. SaskPower will be responsible for conducting activities such as line routing, environmental studies, and permitting, public consultation, and engineering design work as applicable to the load interconnection.

2.5 Greenhouse Gas Emissions

The Government of Canada requires that greenhouse gas (GHG) emissions be assessed in support of any project seeking federal approval. Concerns related to climate change were raised during engagement and consultation activities completed by Denison. It should be noted that these concerns pertain to climate change rather than GHG emissions specifically, although these are closely related topics. The concerns included observations of climate-related changes that have been noticed by the English River First Nation (e.g., depth of permafrost; 16-EN-ERFN-100.17) and observations by the English River First Nation Trapper who provided local knowledge in support of the EIS (19-LK-ERFNTrap-134.232 to 19-LK-ERFNTrap-134.235). In addition, the Village of Pinehouse Lake posed questions regarding the potential effects of the Project on climate change (21-EN-VPL-444-4 and 21-EN-VPL-444.18).

Environment and Climate Change Canada (ECCC) has developed the *Strategic Assessment of Climate Change* (SACC) report (ECCC 2020) to assist proponents in developing GHG emissions estimates in a consistent manner. The SACC report defines the information that must be submitted, including quantification of direct GHG emissions (e.g., combustion sources) and GHG emissions from acquired energy (e.g., energy purchased from a third party such as provincial hydro providers). To assist in the quantification of GHG emissions, and to provide consistency across all projects, ECCC has developed the *Draft Technical Guide Related to the Strategic Assessment of Climate Change* (SACC guide; ECCC 2021a). The SACC guide was applied in the quantification of GHG emissions for the Project in this assessment.

The GHGs that are included in emissions reporting include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), which are reported on an annual basis. The SACC guide identifies the *National Inventory Report* (NIR; ECCC 2021b) as the primary source of emission factors that are to be used in the calculation of these releases, based on fuel consumption for combustion sources. Combustion sources are the main source of direct GHG emissions anticipated at the Project, with a minor contribution from the loss of a carbon sink associated with the development of the Project Area during the first year of Construction. In addition to direct emissions, ECCC requires that emissions associated with the generation of electricity required to power the Project also be accounted for in the emissions inventory, where the emissions are being generated by a third party (i.e., provincial provider such as SaskPower). Emission factors for this calculation are provided in the SACC guide (ECCC 2021a).

In addition to individual reporting of GHGs (i.e., CO_2, N_2O, and CH_4), emissions of GHGs are reported as CO_2 equivalent (CO_2e), which is a normalized unit used to describe a mixture of GHGs in terms of the relative radiative forcing of CO_2 for each component of the mixture. These CO_2e emissions are calculated using Global Warming Potential (GWP) factors, which are identified in the NIR (ECCC 2021b) as being consistent with those applied in the Fourth Synthesis report from the Intergovernmental Panel on Climate Change (IPCC; Pachauri and Reisinger 2008). Nitrous oxide has a GWP of 298, meaning that the calculated N_2O emissions in tonnes are to be multiplied by 298 to determine the CO_2e emission (i.e., one tonne of N_2O is equivalent to 298 tonnes of CO_2 in terms of warming potential). The GWP for methane is 25 (ECCC 2021b) and is applied in the same manner.

Project activities involve the use of combustion equipment such as on-road mobile equipment (e.g., trucks, vans), off-road mobile equipment (e.g., dozers, loaders), and stationary equipment (e.g., generators, propane heaters). Airstrip and road development, as well as site clearing activities during Construction, were also included in the analysis as they contribute to the conversion of land use from vegetated to developed (i.e., existing biomass removed).

Information from the *Prefeasibility Study Report for the Wheeler River Uranium Project* (Denison 2018) pertaining to projected vehicle usage and associated equipment fuel consumption, as well as projected fuel consumption required for propane heating and operation of the generators, was used to calculate the annual fuel volumes anticipated for each source type and Project phase (i.e., Construction, Operation, and Decommissioning). No GHG emissions are associated with Post-Decommissioning.

Per the SACC guide, the emission factors from the NIR were applied, specifically from Table A6.1-14 for on- and off-road mobile combustion sources, from Table A6.1-5 for generators, and from

Table A6.1-4 for propane heating (ECCC 2021b). For combustion sources, the annual fuel estimates for each source were multiplied by the appropriate emission factors (provided in units of g/L) to estimate the associated emissions. The detailed combustion emissions calculations are provided in the *Climate Baseline and Greenhouse Gas Emissions Report* that has been prepared for the Project (Appendix 6-C in Section 6).

The SACC guide specifies that carbon emissions associated with changing land use characteristics are to be included in the GHG inventory (ECCC 2021a). For the Project, these emissions are associated with the 169.6 ha representing the Project Area (or disturbed area), which are currently vegetated and will be cleared and developed during Project activities. The carbon stock associated with the removed vegetation will be calculated and converted to GHG emissions in CO_2e. The SACC guide recommends procedures from the NIR and the *Guidelines for National Greenhouse Gas Inventories, Volume 4* (IPCC guidelines; Eggleston et al. 2006). The current vegetative cover of the Project Area was characterized based on information included in Section 9.2 of this EIS. According to Table 9.2-5 in Section 9, vegetation in the Local Study Area (i.e., LSA for Vegetation and Ecosystems) primarily consists of low and tall shrubs, young forest, and mature forest. These vegetation types make up approximately 90% of the LSA, and it was assumed that the full Project Area was similarly vegetated. The ratio of the area of forested lands and shrub-covered lands in the LSA was applied to the 169.6 ha that comprise the Project Area for the purposes of the calculation, and default values for the typical above-ground mass of the boreal plains in Saskatchewan from the SACC report were applied (ECCC 2021a). The typical carbon content of the above-ground mass was referenced from the IPCC guidelines for conifer-type vegetation in boreal areas (IPCC 2006). The calculation assumed that all living biomass in the removed material would be instantly oxidized (ECCC 2021a). The detailed combustion emissions calculations are provided in the *Climate Baseline and Greenhouse Gas Emissions Report* that has been prepared for the Project (Appendix 6-C in Section 6).

The contribution of acquired energy to the total GHG emissions associated with the Project were calculated using Emission Intensity (EI) projections (in tonnes CO_2e/GWh) from Annex C of the SACC report (ECCC 2021a), in conjunction with the estimated annual power requirement for the Project from the *Prefeasibility Study Report for the Wheeler River Uranium Project* (Denison 2018). The total emissions associated with acquired energy were then calculated by multiplying the EI by the power requirement. This is expected to be a conservative calculation as the maximum EI value was applied, which is expected to trend downward over time due to policy decisions and technology improvements (ECCC 2021a), and most of the energy being used by the Project is expected to be produced at the SaskPower Island Falls Plant, which is a hydroelectric plant with no associated GHG emissions. The detailed combustion emissions calculations are provided in the *Climate Baseline and Greenhouse Gas Emissions Report* that has been prepared for the Project (Appendix 6-C in Section 6).

The calculated annual GHG emissions for the Project are provided in Table 2.5-1. These are maximum bounding total annual emissions for each Project phase.

Table 2.5-1: Summary of Predicted Greenhouse Gas Emissions

Scenario	Annual Greenhouse Gas (GHG) Emissions (tonnes/year)			
	CO_2	CH_4	N_2O	CO_2e
Direct GHG Emissions (Combustion, Land Use Change)				
Construction	30,767	0	1	31,039
Operation	11,752	0	1	12,002
Decommissioning	24,794	0	1	25,019
Post-Decommissioning	0	0	0	0
Acquired GHG Emissions (Purchase of Electrical Power)				
Construction	-	-	-	0
Operation	-	-	-	18,700
Decommissioning	-	-	-	0
Post-Decommissioning	-	-	-	0
Total GHG Emissions (Direct and Acquired)				
Construction	-	-	-	31,039
Operation	-	-	-	30,702
Decommissioning	-	-	-	25,019
Post-Decommissioning	-	-	-	0

Notes: CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; CO_2e = CO_2 equivalent.
The annualized GHG intensity during operations is estimated at 7.5 tonnes of CO2e / tonnes of U_3O_8.

Assessment of upstream GHGs under the SACC guide are required for projects that are likely to exceed the upstream threshold of 500 kt of CO_2e per year. The upstream GHG emissions for the Project are expected to be well below this threshold. Parker et al. (2016) identified that for uranium mining and milling in Canada, direct emission and acquired energy are the main contributors to total GHG emissions compared to other value chain (including upstream) emissions. The total emissions estimated above for the Project are less than 31.1 kt of CO_2e per year, and based on Parker et al. (2016) it is assumed that 1. the upstream GHG emissions would be well below the annual total GHG emissions and 2. the upstream GHG emissions would be well below the SACC 500 kt of CO_2e per year threshold. Additionally, the CNSC (2017) guidance for assessing total GHG production from nuclear facilities follows a cradle-to-grave analysis that starts with mining and milling. The Project represents the start of the cycle and the emissions estimated here would be considered the most upstream in the cycle. Under this guidance, an assessment of upstream emissions would not be applicable.

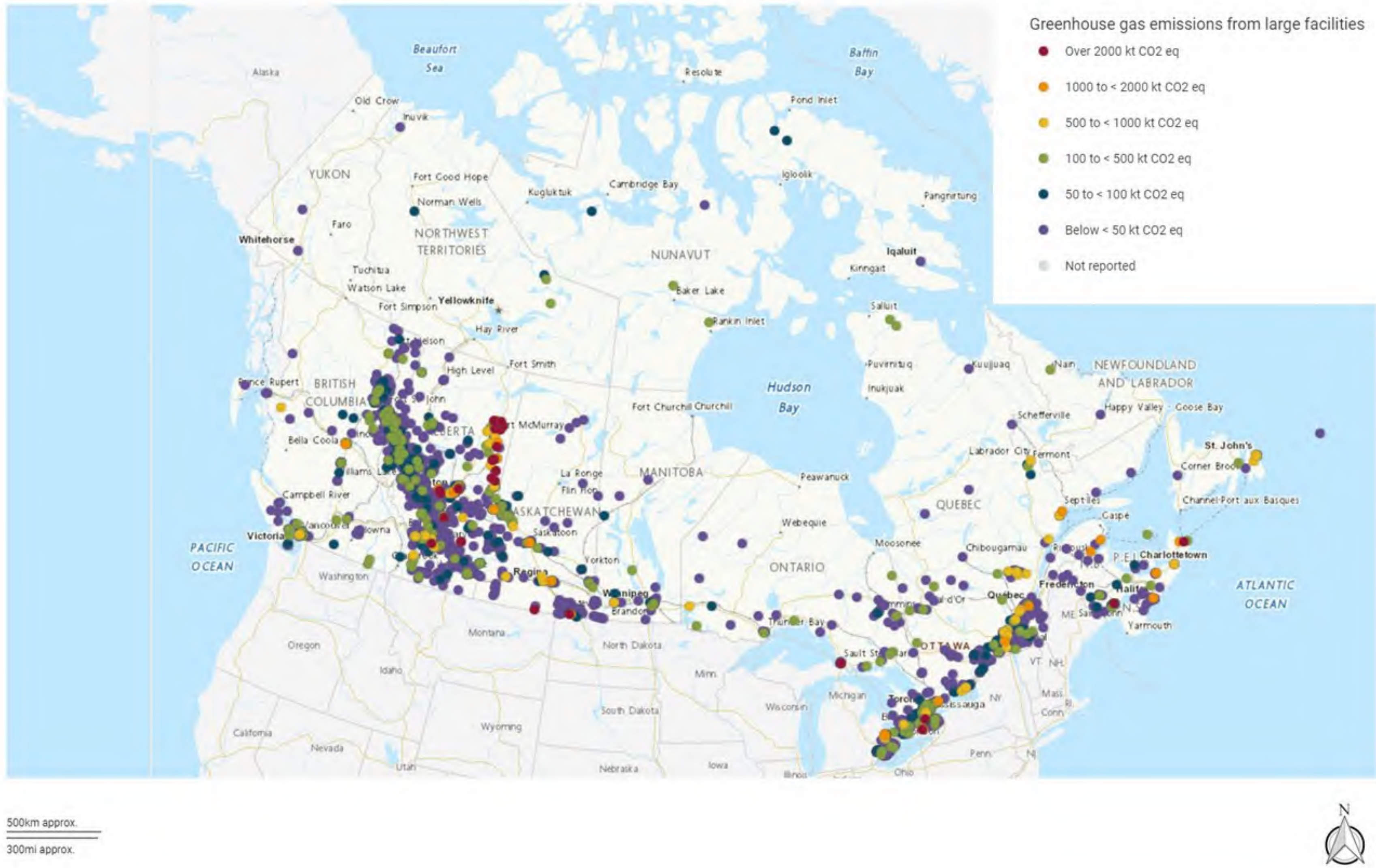
Based on the predicted emissions, the Project will likely be required to report annually through the federal Greenhouse Gas Reporting Program. Facilities are required to report if annual emissions are over 10,000 tonnes of CO_2e and the information is collected under section 46 of the *Canadian Environment Protection Act*.

To provide context for the predicted emissions, the anticipated GHGs generated from the Project were compared to the nation- and province-wide GHG emissions. The average annual nation-wide GHG emissions (2010 to 2019) were 719 Mt CO_2e (ECCC 2021c). The average annual province-wide GHG emissions (2014 to 2019) were 75.2 Mt CO_2e. By contrast, the total annual emissions predicted for the Project were 0.031 Mt CO_2e for Construction, 0.031 Mt CO_2e for Operation, and 0.025 Mt CO_2e for Decommissioning. These amounts represent less than 0.0043% of the nation-wide annual average, and less than 0.041% of the province-wide annual average. The 2020 greenhouse gas emissions from large facilities (emitting over 10,000 tonnes of CO_2e on an annual basis) are shown in Figure 2.5-1.

As additional context, the emissions associated with uranium mining and processing are part of the low GHG lifecycle emissions for nuclear power. Considering CO_2e emissions by energy source, lifecycle emissions for nuclear power are approximately 16 g CO_2e/KWh versus coal at 1,001 g CO_2e/KWh and oil at 840 g CO_2e/KWh (Figure 1.3-1 in Section 1). The lifecycle GHG emissions associated with nuclear power at 16 g CO_2e/KWh include uranium mining and milling, which have been estimated separately to contribute 1.1 g CO_2e/KWh (Parker et al. 2016) to the total.

Denison will look for opportunities to optimize energy management and improve the energy intensity of the Project where practical. Examples of potential opportunities include:

- Heat recovery loops for comfort heating.
  - Freeze plant glycol loops heat recycle for processing plant heat and comfort heating. GHG emissions estimates above incorporate propane heating for processing plant heat and comfort heating.
- Investigate or source electric powered drills. GHG emissions estimates above includes fuel-powered drills.



Source: https://indicators-map.canada.ca/App/CESI_ICDE?keys=AirEmissions_GHG&GoCTemplateCulture=en-CA

Figure 2.5-1: Greenhouse Gas Emissions from Large Facilities, 2020

2.6 Project Schedule

Following successful completion of the EA process and securing the required licences, permits, and approvals, the total duration of the Project is proposed to be 38 years including approximately 2 years of Construction, 15 years of Operation, 5 years for Decommissioning, and 15 years for Post-Decommissioning. The proposed Project schedule and milestones are summarized in Table 2.6-1.

Table 2.6-1: Project Conceptual Development Schedule

Project Activity	Duration (Years)	Year
Construction	2	1 to 3
Operation	15	3 to 18
Decommissioning (does not include progressive decommissioning during operations)	5	18 to 23
Post-Decommissioning	15	23 to 38
Release from licence and transfer back to Crown land or into Provincial Institutional Control Program	Event	Event

2.7 Project Benefits

Approximately 300 workers are expected to be required during the two-year Construction period. Each component of Construction will require workers with different types of skills and training depending on the task (e.g., road construction, wellfield drilling, erection of buildings, connection to services). During Operation, about 180 people will be employed annually to operate the wellfield and processing plant, and provide various supporting activities such as security, camp operations, operation of the water treatment and potable water plants, environmental monitoring, and maintenance of roads, equipment, and buildings.

Denison will concentrate initial and sustained efforts for employment and training initiatives for the Project with its Communities of Interest. Best efforts will be made to make sure employment is maximized within the Communities of Interest and beyond that, with Indigenous people and Residents of Saskatchewan's North. Denison will work with the leadership of the Communities of Interest to assist in determining appropriate hiring practices during all phases of the Project. In 2018, Residents of Saskatchewan's North made up approximately 47% of the total workforce in northern Saskatchewan mines (Government of Saskatchewan, Ministry of Government Relations. 2019).

Positions expected throughout Construction and Operation of the Project include supervisory and management positions, trade positions, professional and technical positions, and labour positions (with a Grade 12 requirement and in-house training programs). Training for various positions is offered through Saskatchewan Indian Institute of Technologies, Saskatchewan Polytechnic, and other institutes in northern Saskatchewan. Specific training for the Project will be developed on an identified needs basis.

The need for goods and services during Construction, Operation, and Decommissioning will generate business opportunities throughout the life of the Project. In response to the demand for northern Saskatchewan based services, northern, Indigenous-owned businesses have grown to meet a broad range of supplies and services required by the mining industry. Examples of anticipated operating goods and services include catering, housekeeping, food, freight, and bulk materials such as fuel, propane, and reagents. The total annual operating costs for the Project are expected to be approximately $39 million. Total direct and sustaining capital costs for the Project are expected to be approximately $387 million.

As outlined in Denison’s Indigenous Peoples Policy, Denison recognizes the critical necessity of advancing reconciliation with Indigenous peoples in Canada and the important role of Canadian business in the reconciliation process. Denison is committed to providing Indigenous people and businesses with sustainable economic opportunities and benefits and sharing the economic benefits of Denison's business activities (Denison Mines 2022).

Denison has established a procurement approach that requires the procurement of all goods and services for the Project to first consider businesses based within the Communities of Interest prior to looking elsewhere in northern Saskatchewan, southern Saskatchewan, and/or outside of Saskatchewan. Throughout all phases of the Project, Denison will prioritize procurement efforts within the immediate vicinity and region.

Programs and actions focused on producing socio-economic benefits for Communities of Interest have been initiated (Section 13.4 in Section 13). It is Denison’s intent to leverage its early work and existing relationships with Communities of Interest to expand current socio-economic commitments, where possible. Denison will make sure that appropriate socio-economic considerations are made in the Province’s Saskatchewan Surface Lease Agreement and any other arrangements, as appropriate.

2.8 Project Design Features

Various Project design features have been proposed that serve to eliminate, reduce, or control potential Project effects on the biophysical and human environments through all Project phases. Additional VC-specific mitigation measures are proposed in Sections 6 through 13. Examples of Project design features are provided here:

- The Project footprint and Project Area (i.e., the area of maximum physical disturbance) have been reduced to the extent practicable, to minimize habitat loss and alteration, as well as noise propagation.

- Much of the proposed Project footprint will be developed within previously disturbed areas, including roads currently used for exploration activities, thereby minimizing additional habitat disturbance.
- Restrict all construction activities to the approved Construction footprint.
- Site clearing and other works that involve disturbance of vegetation and/or soil will be completed during least-risk timing windows for wildlife and birds to avoid disturbance during sensitive time periods, whenever practicable.
- Cleared brush and soil will be stockpiled when possible, to be used in progressive reclamation.
- Implement erosion and sediment controls during Construction.
- Ponds will be designed maintain a minimum freeboard of at least 1.0 m to allow for continued functioning during a probable maximum precipitation (PMP) event.
- Processing plant exhaust from drying and packaging areas will be directed through a venturi scrubber prior to release outside of the building.
- The height of the processing plant stack will be based on results of air dispersion modelling to be an appropriate height for optimal dispersion.
- Various aspects of the processing plant design incorporate best practices for worker protection including grading floors towards sumps for spill collection, having appropriate ventilation rates, and monitoring systems in place to make sure these mitigation measures are meeting design specifications.
- Bulk storage tanks for processing and water treatment will be located inside the processing plant, in a separate room from the processing equipment. The storage tanks will sit inside appropriately designed and sized concrete secondary containment basins. The secondary containment basin for each applicable chemical system will be physically separated from the containment basins for other chemical systems.
- Ventilation in the pumphouses will be designed with the ALARA principle in mind to provide sufficient worker protection from potential radon and radon progeny exposure. Monitoring systems will be in place to make sure these mitigation measures are meeting design specifications.
- Design liners and develop appropriate performance monitoring (e.g., leak detection, groundwater monitoring) based on the characteristics of the material being stored:
  - Ponds or pads designed to temporarily or permanently store non-radioactive materials will be lined with a single geosynthetic composite liner system. This is a primary HDPE GM over a GCL. The GCL will include a low permeable layer of bentonite clay. Examples of Project components proposed to have this type of liner include: the industrial wastewater treatment plant precipitate pond, hazardous waste storage pad, and effluent monitoring and release ponds.

   - Ponds or pads designed to temporarily or permanently store potentially radioactive materials will be lined with a double geosynthetic composite liner system. This is a primary HDPE GM over a GCL and a secondary HDPE GM over an additional GCL. The GCL will include a low permeable layer of bentonite clay. In between the primary and secondary liners, a leak detection and collection system will also be installed. The selected design is the most robust currently known and offers a life of several hundred years with proper installation and maintenance. Examples of Project components proposed to have this type of liner include: wellfield runoff pond, process precipitate pond, landfill leachate collection ponds, process water pond, UBS holding area, and special waste pad.
- Fuel storage and distribution infrastructure will be constructed in accordance with applicable legislation requirements.
- Fuels will be stored in approved, above-ground, double-walled storage tank(s) equipped with secondary containment in accordance with provincial regulations and standards.
- Stationary and mobile equipment will be fueled with a fuel-dispensing truck.
- A minimum 100 m distance from any waterbody will be maintained for fuel storage, refueling activities, or equipment servicing.
- Hazardous substances will be managed in a safe and secure manner in line with Safety Data Sheets, permit conditions, and applicable regulations. Denison will maintain an up-to-date record of the various hazardous substances on site and will maintain Safety Data Sheets and appropriate procedures for spill management, handling, and clean up in an accessible location.
- Clean, non-contact runoff will be diverted around Project components where possible. Contact water, including, for example, runoff from the wellfield and around the processing plant, will be collected in various ponds and eventually routed through the IWWTP for treatment prior to release to Whitefish Lake.
- The fresh water well(s) and surface water intake will be located, designed, installed, and operated according to applicable standards and best practices to minimize effects on the groundwater and surface water environments.
- The Project will adhere to treated effluent discharge limits as stipulated in operating approvals and by regulations and for protection of aquatic life and receptors associate with the water exposure pathway.
- Battery-powered light vehicles and mobile equipment, and an AC powered dual rotary drill for ISR wellfield development instead of a traditional diesel-powered unit will be employed where practical to reduce air emissions and noise levels and improve energy efficiency.
- Project components including equipment and machinery will regularly maintained and inspected to make sure they are in good working order.
- Speed limits will be implemented on site roads for worker safety, to minimize generation of road dust, and to protect wildlife.

- Containment and control of mining solution and uranium bearing solution in the ground in general, and the mining area in particular, will use three layers of protection:
  1. well design and operation – well will have secondary containment, be made of material resistant to mining solution, pressure grouted from the ore zone to surface, and tested for mechanical integrity prior to commissioning to confirm an adequate seal from surface to the well screen at the mining area. Operational monitoring of pressure and flow will provide assurance that the wells are functioning properly.
  2. pumping – operation of the injection and recovery wells will be done in a way to maintain an inward hydraulic gradient to keep mining solutions no more than 50 m above the well screened area in the ore zone. Perimeter pumping wells will be installed vertically, horizontally, and laterally surrounding the mining area both inside and outside the freeze wall with the ability to capture fluids by pumping when required and recycle solutions should the primary containment system not perform as expected.
  3. freeze wall – a freeze wall around the mining area, extending from the surface to the basement rock isolating the mining area from regional groundwater. The freeze wall is expected to be a minimum of 10 m thick, be installed 25 m away from the uranium deposit, and extend 30 m into the basement rock.

  Data from the groundwater monitoring network installed in and around the wellfield and freeze wall will make sure these mitigation measures are meeting design specifications.
- Well casing integrity will be monitored in a rigorous fashion, thereby allowing Denison to respond to any steel casing failures in a timely manner.
  - A network of monitoring wells installed within the freeze wall area will be equipped with pressure instrumentation for the determination of the vertical strain/stresses placed on the formation. This monitoring network is designed to detect if these strains may be approaching their acceptable levels prior to failure. The injection and recovery wells will also be equipped with continuous monitoring devices for pressure and temperature that can detect a breach in the well casing if one were to occur. This data will be transmitted to the processing plant for remote monitoring through a master control system. Through the master control system, operators will be capable of controlling pumphouse production lines remotely. Wellfield monitoring will facilitate detection of any issues with the injection and recovery wells. As a further preventative measure, annual mechanical integrity testing is conducted on the wells to ensure their containment and compliancy. Active monitoring will allow for operational shutdown if a scenario is approaching a failure mode.
- Double-walled (HDPE), or equivalent, piping will be used for the wellfield surface piping system and the piping will be freeze protected and secured to minimize movement. Surface pipelines

will be designed to have secondary containment or catchment and have leak detection systems in place at key locations.

- Denison is committed to conducting stringent waste characterization throughout the life of the Project. This includes physical, radiological, and chemical characterization to maintain accurate waste inventories and determine how wastes will be dispositioned through either re-use, recycling, temporary storage, or permanent disposal (on or off site). This includes clearance of material that meets unconditional release requirements and can be safely removed from site.
- During Operation, progressive decommissioning and reclamation activities will be completed where possible, and the progress and success of these activities will be assessed annually.
- At Decommissioning, areas requiring additional control (potentially the industrial landfill and IWWTP precipitate pond) will be covered with an engineered impermeable liner system to limit infiltration of precipitation into the containment system.
- Denison's decommissioning commitment is to return the land back to the Province of Saskatchewan for unrestricted surface land use post-closure. The CDP outlines how radiological, physical, and chemical risks will be managed during Decommissioning so no unreasonable risks remain. Denison will prioritize passive versus active controls to reduce long-term risk. Additional decommissioning details will be provided in the PDP, which will submitted to regulators as part of Project licensing and permitting. Prior to executing Decommissioning activities, Denison shall prepare and submit a DDP to regulators for acceptance, which builds on the preliminary decommissioning plan.

Additional opportunities for improving the Project health, safety, and environmental performance through Project design will be completed as the Project engineering advances. The Project feasibility work is underway, with a focus on design for safety. The intent of designing for safety is to eliminate a hazard completely or to reduce its magnitude sufficiently to eliminate the need for elaborate safety systems (engineered controls) and procedures (administrative controls). Furthermore, this hazard elimination or reduction is accomplished by means that are inherent in the design and, thus, permanent and inseparable from it. The implementation of the design for safety is achieved by application of the following principles by the whole team performing engineering design or planning the construction and/or commissioning work:

- Eliminate – Remove hazardous materials, processes, and activities.
- Minimize – Use smaller quantities of hazardous substances, minimize the number of hazardous activities or process/equipment items.
- Substitute – Replace a hazardous material with one that is less hazardous; substitute a hazardous activity for one that is less hazardous.
- Moderate – Minimize the effect of a release of hazardous material or energy by changing the layout or facilities, adopting less hazardous operating conditions or a less hazardous form of a material, or by reducing the number of people exposed.

- Simplify – Design facilities to eliminate unnecessary complexity, thus minimizing causes of hazards and human errors.

2.9 Management System

Denison is undertaking sequential EA and licensing processes with the CNSC. As such, a detailed management system based on the CNSC's safety and control areas and focused on anticipated compliance verification criteria will be developed over the upcoming months to support licensing activities. It is expected that Denison's management system will be governed by corporate policies, described in programs, and detailed in plans, and will naturally mature as the Project advances.

For the EIS, the Environmental Management System (EMS) framework is provided here to support review of the assessment and provide confidence in the various biophysical and human environment assessments and overall conclusions.

2.9.1 Environmental Management System Framework

The EMS for the Project forms a critical component of the overall management system for the Project. While the overall management system forms the common basis upon which all Project activities would be implemented, the EMS provides the specific commitments to, and framework for, defining the practices and procedures to establish and confirm protection of the environment, as well as the health and safety of workers and the public. Denison will develop the EMS as the Project proceeds through licensing and permitting.

Denison will develop an EMS for the Project consistent with the principals set out by CAN/CSA ISO 14001, *Environmental Management Systems – Requirements with Guidance for Use,* with consideration to applicable provincial and federal requirements and consideration of other guidance as may be deemed appropriate.

In general terms, the EMS is a framework that provides the means to pro-actively manage environmental risks and opportunities. The EMS provides processes, procedures, policies, assigned roles and responsibilities, and considers continual monitoring and improvement of organizational structures and practices. Within the specific context of the Project, the EMS provides an overall perspective on how potentially adverse effects would be minimized and managed over the Project life. In addition, the EMS establishes expectations (and associated mechanisms) for contractors and sub-contractors to comply with environmental commitments and policies including auditing and enforcement programs.

Denison is responsible for, and committed to, providing sufficient resources to: develop and implement the EMS to meet statutory/regulatory requirements; meet its corporate expectations with respect to environment performance; meet the expectations of its interested party partners, including Indigenous communities, with respect to environment performance; and fulfill any commitments made through the EA process and beyond through all Project phases.

For additional reference, the EMS would describe Denison's environmental policies, and the measures and procedures that would be implemented to manage environmental risk. The documentation would include considerations of organizational structure (including roles and responsibilities) that would facilitate the planning and resources needed for developing, implementing, and maintaining policies and practices associated with environmental protection. Key considerations that would be addressed by the EMS include:

- identifying and managing environmental risks associated with Project components, facilities and activities;
- the identification, implementation and maintenance of pollution control activities and technologies;
- monitoring of water and air releases;
- monitoring of constituents of potential concern and for their potential effects in the environment;
- performance monitoring, non-conformance, and contingency planning; and
- communication and distribution of information.

2.9.1.1 Environment, Health, Safety and Sustainability Policy and Objectives

Denison’s corporate Environment, Health, Safety and Sustainability Policy is as follows:

Denison is committed to the operation of its facilities in a manner that puts the safety of its workers, its contractors, its community, the environment, and the principles of sustainable development above all else. Whenever issues of safety conflict with other corporate objectives, safety shall be the first consideration. Accordingly, Denison is committed to the following principles:

- building and operating facilities in compliance with all applicable laws and regulations of the jurisdictions in which it operates;
- adopting and adhering to standards that are protective of both human health and the environment at all of its facilities;
- establishing goals and objectives that would encourage the ongoing development of a sound program of sustainability in the communities that it operates in;
- approaching sustainability and engagement activities with the utmost respect for Indigenous communities, Indigenous Rights, and Indigenous Knowledge; and
- keeping radiation, health and safety hazards, and environmental risks as low as reasonably achievable.

In support of these principles, Denison shall endeavour to:

- establish and maintain clearly defined Environmental Management System to guide its operations in accordance with the foregoing principles;
- provide adequate resources and appropriate staffing to implement its health, safety, environmental, sustainability and engagement programs;
- make sure its employees and contractors are properly trained in the implementation of its Environmental Management Systems and in compliance with applicable laws and regulations;
- institute regular monitoring programs to identify risks to its workers, contractors, Indigenous Rights holders, the public, or the environment, and to confirm compliance with regulatory requirements;
- set objectives and targets in an effort to continually improve its management and performance of health, safety, environmental, sustainability and engagement programs;
- identify and reduce the potential for accidents and emergency situations, and implement emergency response plans that will protect the health and safety of its workers, contractors, the public and the environment;
- conduct regular audits to assess and confirm compliance with this policy;
- develop processes for preventing non-conformance with this policy and adopting corrective actions; and
- require regular reporting to its Board of Directors regarding compliance with this policy.

This policy has been adopted by, and its implementation is the responsibility of, the Board of Directors of Denison. The Board of Directors holds all levels of management and all employees responsible for compliance with this policy within their areas of responsibility.

2.9.1.2 Implementation of the Environmental Management System – Roles and Responsibilities

As indicated, Denison is responsible for, and committed to, providing sufficient resources to develop and implement the EMS for the Project.

The Board of Directors of Denison (the Board) has established an Environment, Health, Safety and Sustainability Committee (the Committee) to assist the Board in fulfilling its oversight responsibilities with respect to the Corporation’s commitment to environmentally sound and sustainable business practices. The mandate of the Committee is to oversee the development and implementation of policies and best practices relating to environment, health, safety, and sustainability issues in compliance with applicable laws, regulations, and policies in the jurisdictions in which Denison carries on business.

The following responsibilities of the Board are delegated to the Committee:

- periodically review and report to the Board on Denison policies related to worker health and safety; environmental and permitting matters; climate change; engagement with communities and Indigenous peoples; remediation activities and tailings facility management; and emergency response plans (collectively "Sustainability Matters");

- receive reports from management on significant Sustainability Matters;
- review with management, as they relate to Sustainability Matters: (i) the risk identification, assessment, and management systems; (ii) activities taken to monitor and mitigate risks; and (iii) the resources allocated to address such risks;
- review with management long term strategies and plans with respect to Sustainability Matters;
- review and monitor the effectiveness of policies, and systems necessary for compliance with policies, related to Sustainability Matters, with the specific direction to bring any material noncompliance with the policies to the attention of the Board in a timely fashion;
- receive regular updates from management regarding compliance with environment, health, and safety legislation, licenses, the policies and systems in place to monitor such compliance;
- report and, where appropriate, make recommendations to the Board; and
- perform such other duties as may be assigned to the Committee by the Board, from time to time.

As the EMS for the Project is developed, the responsibilities of all levels of employees (senior managers, managers, staff), as well as contractors, will defined and clearly communicated.

2.9.1.3 Environmental Management System Components – Programs and Plans

The programs and plans within the EMS are essential to implement the design and mitigation measures that have been identified in the EIS, to measure environmental performance and the effectiveness of the design and mitigation (control) measures, and to provide the information necessary for Denison to foster a culture of continuous improvement as it concerns environmental considerations.

Programs and plans that would be established within the overall umbrella of the EMS are highlighted below. Please note that the specific titles of the programs and plans provided here and their organization within the broader management system may change as the Project advances. Additionally, the details associated with these programs and plans would be developed with the EMS as the Project proceeds through licensing and permitting.

2.9.1.3.1 Environmental Protection Program

An Environmental Protection Program would be established to provide an overarching framework for key environmental monitoring and management plans and to ensure a means to demonstrate compliance with applicable environmental regulatory requirements and other performance targets that Denison may set. The program would be developed in a manner that aligns with the ISO 14001 EMS Standard, as follows:

- Planning
  - Identification and determination of significance of those environmental aspects associated with Denison's activities.
  - Establishment of environmental objectives and targets.
  - Development of appropriate plans and/or programs to achieve the objectives and targets.
- Implementation and Operation
  - Defining and documenting appropriate roles and responsibilities.
  - Establishment and maintenance of operational controls over environmental aspects.
- Checking and Corrective Action
  - Monitoring to verify environmental performance and compliance.
  - Maintaining non-conformance and corrective and preventative action procedures.
- Management Review
  - Periodic review by Denison's management to ensure the on-going suitability, adequacy and effectiveness of the EMS.

Aspects of the Environmental Protection Program are discussed further below. For context, a discussion of management of monitoring of Project emissions is provided, emissions being one of the primary means by which Project activities interact with the environment. Subsequently, select plans that would fall within the umbrella of the Environmental Protection Program are highlighted.

Management and Monitoring of Emissions

A procedure document would be developed to guide the management of emissions from the Project. The procedure would define the key requirements, responsibilities, and processes for the management of radioactive and non-radioactive emissions. The procedure would be developed in accordance with relevant guidance such as REGDOC-2.9.2, *Controlling Releases to the Environment* (CNSC 2021b) and CSA Standard N288.17, Establishing and Implementing Action Levels for Releases to the Environment from Nuclear Facilities (CSA 2017).

The procedure document would expand on regulatory requirements for the effective management of these emissions, and involves the following activities:

- identification and assessment of emission pathways;
- control and treatment of emissions;
- operational control monitoring; and
- emissions verification monitoring.

Identification and assessment of emission pathways involves identifying routes by which radioactive and non-radioactive constituents are likely to be emitted to the environment. The type and quantities of these constituents to be emitted are characterized, and subsequently assessed for the likelihood of exceeding regulatory and internal emissions limits, the magnitude and likelihood of effects to the public, the potential for adverse effects to the environment, and the potential for public concern.

Control and treatment of emissions includes identifying mitigation to prevent, reduce, or limit release of emissions to the environment. Preventive maintenance programs are implemented to reduce the likelihood of system failures, and appropriate systems are in place to provide timely warning in the event of a failure or degradation of control and treatment systems. Operational control monitoring is completed to evaluate whether emission control systems are functioning as intended.

Emissions verification monitoring is intended to verify that emissions are below regulatory limits and includes measuring or estimating substances being released into the environment by the Site. An emissions verification monitoring program is established for the monitoring of radioactive and non-radioactive emissions.

Environmental monitoring is performed to assist in determining the effect of emissions in the environment surrounding a site or facility and consists of measuring or estimating substances present in the environment.

Liquid Effluent Monitoring Plan

The liquid effluent monitoring plan would consider emissions to surface water environments from Project activities and facilities. The liquid effluent monitoring plan would describe sampling locations, frequencies and constituents. Data generated from the liquid effluent monitoring plan would serve various purposes, such as to measure quantities of materials released via this pathway to the environment, demonstrate compliance with statutory limits or internal action levels, assess performance of emissions control systems, contribute to the understanding of the potential influence of the Project's liquid emissions on the environment.

The liquid effluent monitoring plan would be informed by existing local and traditional knowledge, ongoing engagement activities with interested parties, information generated by development of EIS and its supporting documents, relevant guidance (such as REGDOC-2.9.1, Environmental Protection: Environmental Principles, Assessments and Protection Measures, Version 1.2 [CNSC 2020] and CSA Standard N288.5-11, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mine and Mills* [CSA 2011]), the Metal and Diamond Mine Effluent Regulations, licenses, approvals, and permits.

Air Emissions Monitoring Plan

The air emissions monitoring plan would consider emissions to the atmosphere from Project activities and facilities. The air emissions monitoring plan would describe sampling locations, frequencies and constituents. Data generated from the air emissions monitoring plan would serve various purposes, such as to measure quantities of materials released via this pathway to the environment, demonstrate compliance with statutory limits or internal action levels, assess performance of emissions control systems, contribute to the understanding of the potential influence of the Project's air emissions on the environment.

The liquid effluent monitoring plan would be informed by existing local and traditional knowledge, ongoing engagement activities with interested parties, information generated by development of EIS and its supporting documents, as well as relevant guidance such as that provided by the Saskatchewan Environmental Code.

Groundwater Monitoring Plan

Given the nature of the ISR mining method that will be employed by the Project groundwater monitoring is an important consideration. The groundwater monitoring plan would be developed in consideration of how Project facilities and activities could interact with the groundwater environment and groundwater users to define monitoring needs (locations, frequencies and constituents). Data generated from the groundwater monitoring plan would serve various purposes, such as to assess performance and the controls associated with the ISR process, demonstrate compliance with internal action levels, assess performance of emissions control systems, and contribute to the understanding of the potential influence of the Project on the groundwater environment. The groundwater monitoring program would demonstrate, during each Project phase, that:

- excursions are not occurring; if excursions do occur, an early warning/timely signal will be provided of when and where they are occurring such that appropriate further evaluation and actions can be undertaken;
- commitments made in the EA are being achieved; and
- protection of groundwater end use/receiving environment is being achieved.

The groundwater monitoring plan would be informed by existing local and traditional knowledge, ongoing engagement activities with interested parties, information generated by development of EIS and its supporting documents, relevant guidance, such as CSA Standard N288.7-15, *Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mine and Mills* (CSA 2015) as well as any applicable licenses, approvals, and permits.

Environmental Monitoring Plan

The environmental monitoring plan would consider the potential effects of Project emissions on the environment, focussing on downgradient or downstream areas and receptors. The environmental monitoring plan would describe sampling locations, frequencies, and measurement endpoints. Data generated from the environmental monitoring plan would serve various purposes, such as to measure the accumulation of Project-associated materials released to the environment, verify predictions made in the EIS (e.g., ERA), demonstrate compliance with statutory limits or internal action levels, contribute to the understanding of the potential influence of the Project's emissions on the environment, including risks to human health and biota.

The environmental monitoring plan would be informed by existing local and traditional knowledge, ongoing engagement activities with interested parties, information generated by development of EIS and its supporting documents, relevant guidance, such as REGDOC-2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures* (CNSC 2020) and CSA Standard N288.4-19, *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mine and Mills* (CSA 2019), the Metal and Diamond Mine Effluent Regulations and as well as any applicable licenses, approvals, and permits.

Woodland Caribou Management Plan

A woodland caribou management plan would be developed to address wildlife-specific mitigation measures based on proven and accepted mitigation following standard industry guidelines and best management practices. The plan would provide guidance to avoid or minimize interaction of the Project on woodland caribou and their habitat and include monitoring and follow-up programs, as appropriate. It would be in place during all phases of the Project and would be subject to ongoing review and revision as required. If monitoring identifies a need for additional or revised mitigation measures, a process of adaptive management (as described in the plan) would be triggered. A woodland caribou management plan for the Project would be consistent with the management goals of the SK-1 Boreal Shield Woodland Caribou Management Unit.

2.9.1.3.2 Radiation Protection Program

A Radiation Protection Program would be designed and implemented so that Denison complies with, or exceeds, the level of radiation safety that is required by the relevant regulations pursuant to the *Nuclear Safety and Control Act* and Denison's Health and Safety Policy.

Activities within the program would include:

- implementing a radiation code of practice;
- measuring and monitoring radiation on an ongoing basis; and
- reporting radiation testing results to regulators.

2.9.1.3.3 *Waste Management Program*

The Waste Management Program would include requirements and processes to ensure that Denison's activities that involve planning for, handling, transporting, processing, storage, and disposal of wastes are performed in a manner that complies with applicable regulatory and licence requirements and protects workers, the public, and the environment.

The Waste Management Program would include identification of waste inventory and the characteristics of the waste (radiological and hazardous non-radiological), waste segregation waste packaging and transfer requirements, and the plan for storage or disposal of the wastes. The Waste Management Program will detail the plans for waste rock segregation based on mineralized content and acid generating potential.

2.9.1.3.4 *Occupational Health and Safety Program*

The Occupational Health and Safety Program would be designed to provide for the protection of workers and public health and safety in relation to Denison's activities. Denison and its contactors would meet all applicable health and safety legislative requirements, provincially and federally. All activities related to the Project would be compliant with relevant legislation and would include:

- promoting employee participation in the development and implementation of safety and health programs and procedures;
- maintaining records, and reporting and investigating safety incidents;
- providing effective management and integration of contractors; and
- providing training to employees so that they can perform their tasks safely and identify potential hazards.

2.9.1.3.5 *Emergency Preparedness and Response Program*

The Emergency Preparedness and Response Program would identify how the Project will prepare for and addresses emergencies that may affect the health and safety of persons, the environment, and the protection of property. The objectives of the program would include the following:

- identification of accidents and emergencies and the actions and responsibilities in the event of an emergency;
- Project requirements for emergency response equipment and personnel;
- internal incident command structure to effectively manage complex, lengthy, and large scale emergencies;
- required communications with external emergency services, statutory bodies, and public, Indigenous groups, and regulatory agencies;
- development of appropriate emergency procedures; and
- assurance of availability of vital information during an emergency.

Emergency Preparedness and Response Program would be developed consistent with guidance provided by CNSC in REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response* (CNSC 2016).

2.9.1.3.6 Fire Protection Program

The Fire Protection Program would be developed to ensure appropriate fire protection management in consideration of fire hazard and risk analyses and demonstration of compliance to applicable fire protection codes and standards.

2.9.1.3.7 Transportation of Dangerous Goods Program

The Transportation of Dangerous Goods Program would be intended to provide for the safe transport of dangerous goods by conforming to all applicable laws, regulations, company policies and procedures. The Transportation of Dangerous Goods Program applies to all modes of transport and all locations where Denison assumes care and control of the materials.

2.9.1.3.8 Personnel Training and Performance Management Program

A Personnel Training and Performance Management Program would be developed to ensure all Project related personnel are fully equipped to effectively implement their work functions, in particular consideration of how job function may affect the environment, including worker and public health, within the context of the EMS. Measurement of performance provides the means to Denison to foster a culture of continuous improvement.

2.9.1.3.9 Contractor Performance Management Program

The Contractor Performance Management Program would be developed to manage contract development, implementation, and administration for maximizing performance and managing risk over the life cycle of a contract.

2.9.1.3.10 Site Security Program

A site Security Program would be developed. The objective of the Site Security Program would be to provide security to the site, in compliance with *Nuclear Safety and Control Act* legislation and federal government security policy, as applicable.

2.9.1.3.11 Quality Assurance Program

The Quality Assurance Program would be developed to provide an overarching risk management framework within the EMS and contribute to the goal of continuous improvement.

2.9.1.3.12 Public Information Program

Although this program would not likely be within the EMS, it would be in the Project's broader management system and has been included here for information purposes. The CNSC REGDOC-3.2.1, *Public Information and Disclosure* (CNSC 2018) sets out requirements and guidance for public information and disclosure for licensees and applicants of Class I and Class II nuclear facilities, and uranium mines and mills, for all lifecycle phases. The primary goal of the public information program, as it relates to the licensed activities, is to ensure that information related to the health, safety and security of persons and the environment, and other issues associated with the lifecycle of nuclear facilities are effectively communicated to the public. Denison would meet all requirements set out in this REGDOC, including the development of an appropriate public information program and disclosure protocol.

2.10 Project Alternatives

2.10.1 Purpose of the Project

As outlined in Section 1.3 and Section 2.1, the purpose of the Project is to construct, operate, and decommission an ISR uranium mine and processing plant to provide uranium supply for the increasing demands for nuclear power generation. The purpose of the designated project under the *Canadian Environmental Assessment Act* (Government of Canada 2019) is defined as the rationale or reasons for which the designated project would be carried out from the proponent's perspective (Canadian Environmental Assessment Agency 2015). The purpose of the Project in this context incorporates Denison's perspective as a uranium exploration and development company.

Denison has identified that there is current and future market demand for uranium, the primary raw material for nuclear fuel generation. Presently, the annual global uranium supply is less than the annual global demand, and limited inventories have been accessed to make up the supply shortfall. In the upcoming decade, new uranium mining projects will be required to meet the needs of existing global nuclear power plants, without considering additional demands from new plants (both conventional and emerging small modular reactor designs) and life extension of existing plants (World Nuclear Association 2022). Development of the Project provides an opportunity for Denison to contribute to this increased demand and lessen the gap between annual global uranium supply and annual global demand.

One way the Project contributes to broader policies is that the product contributes to zero-carbon nuclear power generation. This supply of uranium for the purpose of power generation meaningfully contributes to initiatives focussed on decarbonization at various levels of government and in the private sector. For instance, the Government of Canada is committed to reducing Canada's emissions by 40 to 45% from 2005 levels by 2030 and putting Canada on a path to reach net-zero emissions by 2050. The *Canadian Net-Zero Emissions Accountability Act* (Government of Canada 2021) establishes in law Canada's emissions reduction target of net-zero emissions by 2050. In the private sector, the voluntary Net-Zero Challenge encourages businesses to develop and implement credible and effective plans to transition their facilities and operations to net-zero emissions by 2050.

Other opportunities that the Project can provide are socio-economic in nature. Meaningful opportunity would be generated by the Project, including, but not limited to, training opportunities, direct and indirect job creation and business opportunities, increased household income, increased national gross domestic product, and increased tax revenue for governments.

The Project is located in the Athabasca Basin that is recognized globally as a leading region for uranium mining. The Project will operate within a very politically stable jurisdiction with a strong regulatory framework. This provides assurance that the Project can be developed in such a way to achieve a high level of performance from health, safety, and environment perspectives, while generating socio-economic opportunities.

In consideration of the above, the purpose of the Project from Denison's perspective is multi-faceted: the Project can address gaps in annual global uranium supply and the use of uranium in nuclear power plants can contribute to net-zero goals, and this can be achieved while making a meaningful contribution to the Canadian economy.

2.10.2 Alternatives Means Assessment

Denison first evaluated production potential from the Project in 2010. Since that time, the Project has undergone significant design and review stages and has naturally evolved into the Project described and assessed in this EIS. Appendix 2-C provides details related to the alternative means assessment framework employed and the results of the alternatives assessment for key Project components and activities; this section of the EIS provides a summary of Appendix 2-C.

Alternative means are the various ways Denison considered to implement Project components and activities. During the planning process, it is common to consider various means by which to fulfill a specific aspect of the Project.

A systematic assessment of these alternatives was used to select preferred alternatives that are carried forward as Project design elements in a manner consistent with Canadian Environmental Assessment Agency's operational policy statement (Canadian Environmental Assessment Agency 2015). These preferred alternatives ultimately become the basis upon which potential Project-related effects are evaluated in the EIS. The preferred alternatives have been presented in the preceding section of this Project Description. The documentation of this systematic alternative assessment provides transparency and traceability with respect to decision making on Project design. It also documents how input received by Indigenous groups and other Interested Parties has been considered in the design/planning process.

The alternative means assessment has been carried out in a stepwise fashion as follows (Figure 2.10-1):

1. Identification of Alternative Means: Project components for which alternate means were considered are identified;
2. Consideration of Technical Feasibility, Economic Feasibility, and Land Use Factors: the technical and economic feasibility of these alternate means is considered along with a specific screening for land use intensity and importance. Only alternate means that are

deemed technically feasible, economically feasible, and passed the land use screening are carried forward in the evaluation.

3. Potential Residual Effects Associated the Alternative Means: the potential residual effects of each alternative, in consideration of mitigation, are described; and,
4. Evaluation of Alternative Means: a comparative evaluation of alternative means that considers the potential residual effects for each alternative relative to various assessment criteria and indicators.

A description of the above four steps along with an example from Appendix 2-C (for Mining - Method) is provided in the following sections.

2.10.2.1 Identification of Alternative Means

Several Project components and activities had alternate means or options considered:

- Mining
  - Method
  - Freeze design for tertiary containment of mining solution
  - Permeability enhancement
  - Mining solution
- Processing
  - Location of processing
  - On-site processing method
- Water management
  - Freshwater supply
  - Drinking water
  - Treated effluent discharge location
  - Treated effluent discharge location to surface water
- Waste management
  - Organic waste disposal
  - Process precipitate management
  - Domestic waste disposal
- Access and transportation
  - Access road alignment
  - Stream crossing structures
  - Worker transportation

- Power
  - Primary power supply
- Support facilities
  - Camp location optimization

For each Project component or activities listed above, a variety of options were considered. For example, the options considered under Mining – Method included:

- Option 1: Open pit
- Option 2: Jet boring
- Option 3: Surface boring
- Option 4: Micro tunnel boring
- Option 5: ISR

2.10.2.2 Consideration of Technical Feasibility, Economic Feasibility, and Land Use Factors

Alternative means considered in an EIS must be technically and economically feasible (CEAA 2015).

Denison integrated an additional category at this early stage in the alternative means assessment framework: land use screening. Although technical feasibility can include land use considerations, Denison opted to include land use separately to provide greater transparency on the approach taken and also in recognition of the importance of local land use that has been communicated by interested parties. In conjunction with screening for technical and economic feasibility, an initial evaluation was conducted to review Indigenous and other land use in the area to identify alternative means that may interact with areas of high land use intensity or areas of cultural importance (e.g., known gravesites). Consideration was given to information made available to Denison in the early stages of project planning. Note that subsequent, additional consideration of engagement information, including Indigenous and other land and resource use is completed at later stages in the alternatives means assessment framework (Section 2.10.2.4). The purpose of considering land use information at this stage was to identify land use that could compromise the feasibility of the Project and screen an alternative means out from additional evaluation.

For each Project component or activity, a consideration of the technical, economic, and land use characteristics of each alternative was considered. The purpose of this step in the alternative means assessment framework is to identify feasible alternatives for further assessment and to eliminate those alternative means that are not considered to be feasible from a technical, economic, or land use lens. Only those alternatives that are deemed technically and/or economically feasible and avoided interaction with areas of high intensity or high importance land use, are carried forward for further assessment.

For example, at this step in the alternative means assessment framework Option 1 Open pit mining (under Mining – Method) was screened out due to economic factors. For Mining – Methods, the remaining four options were carried forward for further assessment.

2.10.2.3 Potential Residual Effects Associated the Alternative Means

For all alternative means carried forward from the previous step, the expected residual effects following application of mitigation measures were considered. This step in the alternative means assessment framework identifies the potential residual effects which are then brought forward to the evaluation of alternative means. Again, as an example, the information related to Mining - Method (from Appendix 2-C, Table 4) is summarized here in Table 2.10-1.

2.10.2.4 Evaluation of Alternative Means

Detailed comparative evaluations of alternative means is presented in Appendix 2-C, Table 6 to Table 22. These evaluations considered the relative residual effects of each of the technical and economically feasible alternatives for each of the evaluation criteria identified in Table 2.10-2 (same as Table 5 from Appendix 2-C), following the application of mitigation measures (described in Appendix 2-C Table 4).

By way of example (refer to Appendix 2-C for details), a detailed evaluation of Mining – Method from Appendix 2-C has been provided here as Table 2.10-3.

Based on the above alternative means assessment process, a preferred alternative means for each respective Project component or activity evaluated was selected. Rationale for the selection based on the comparative evaluation of alternatives is provided in Appendix 2-C including input received by Indigenous groups and other Interested Parties.

For reference, the alternative means assessment is conducted at a screening level, appropriate for the stage of the Project when the alternatives were considered. The assessment considered both quantitative (where possible) and qualitative information as available. The comparative evaluation identified more preferred versus less preferred alternatives. The preferred alternative(s) was selected and evaluated in much greater detail in the EA. A summary of the alternative means carried forward into the EA is provided in Table 2.10-4**.**

2.10.3 Summary of Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Alternative Means Assessment

As described above, Indigenous Knowledge, local knowledge, and engagement has influenced the alternative means assessment, specifically in step 2 (Consideration of Technical Feasibility, Economic Feasibility, and Land Use Factors) and step 4 (Evaluation of Alternative Means) of the alternative means assessment framework.

Alternative means considered in an EIS must be technically and economically feasible (CEAA 2015). Denison opted to integrate an additional category at this early stage in the alternative means assessment framework: land use screening. Denison included land use separately to provide greater transparency on the approach taken and also in recognition of the importance of local land use that has been communicated by Interested Parties. At this step in the alternative means assessment framework, an option for treated effluent discharge location was eliminated due to land use screening in conjunction with technical considerations.

Denison's specific engagement initiatives on Project alternatives are outlined in Appendix 2-C for the 1) mining method, 2) freeze design for tertiary containment of mining solution, 3) treated effluent discharge location to surface water, and 4) access road alignment. In addition to these targeted engagement sessions, information gathered more broadly during engagement was also considered in Project alternatives through the consideration of general concerns or statements. The comparative evaluation of alternative means includes specific input received from Indigenous groups and other Interested Parties that contributed to the selection of the preferred option, when applicable. Refer to the row titled *Input received from Interested Parties* in Table 2.10-3 below for an example of how engagement influenced the selection of mining method.

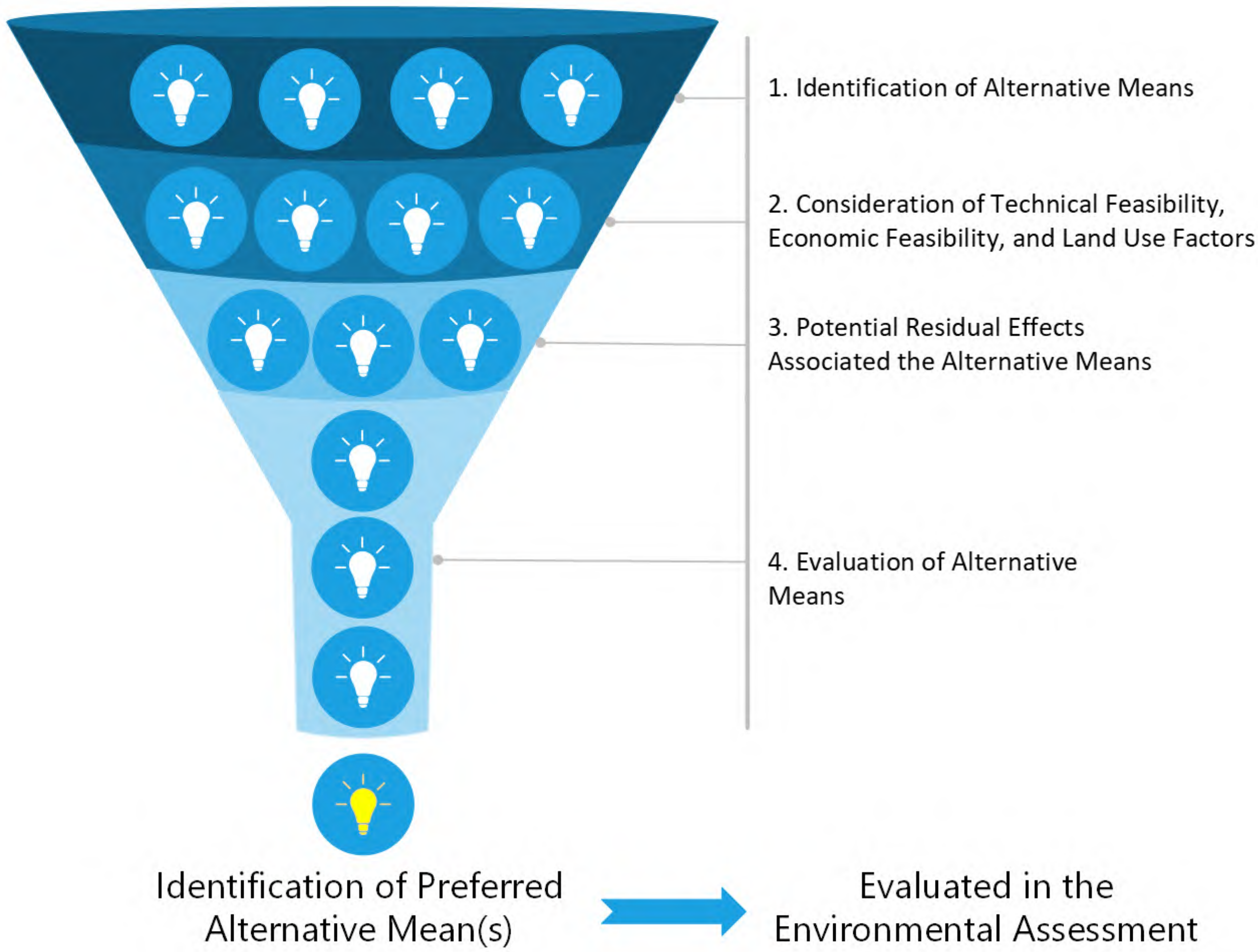


Figure 2.10-1: Alternative Means Assessment Framework for the Project

Table 2.10-1: Mitigation Measures and Residual Effects for Mining - Method (Excerpt from Appendix 2-C Table 4)

Project Component		Alternative Means Carried Through after Screening for Technical, Economic, and Land Use Factors	Mitigation Measures	Residual Effects
Mining	Method	Option 2: Jet Boring	Through design and monitoring, make sure emissions from ventilation meet applicable air quality emissions criteria Any water associated with workings and mining activities meets applicable discharge quality criteria prior to release Limit any surface development to extent practical and avoid areas of significance Follow best management practices and standards for waste characterization and management, containment of hazardous material, liner designs, fuel management	Effects to local geology by development of underground workings Effects on local vegetation, soil, bird, and wildlife habitat as a result of clearing required to develop surface infrastructure to support mining Effects on air quality via emissions from ventilation of underground workings Effects on groundwater quantity and flow paths based on need to dewatering underground mine workings Effects to surface water quality and surface water related receptors whereby mine water is released to local surface water features
		Option 3: Surface Boring	Through design and monitoring, make sure emissions from ventilation meet applicable air quality emissions criteria Any water associated with workings and mining activities meets applicable discharge quality criteria prior to release Limit any surface development to extent practical and avoid areas of significance Follow best management practices and standards for waste characterization and management, containment of hazardous material, liner designs, fuel management	Effects to local geology by development of underground workings Effects on local vegetation, soil, bird, and wildlife habitat as a result of clearing required to develop surface infrastructure to support mining Effects on air quality via emissions from ventilation of underground workings Effects on groundwater quantity and flow paths based on need to dewatering underground mine workings Effects to surface water quality and surface water related receptors whereby mine water is released to local surface water features
		Option 4: Micro Tunnel Boring	Through design and monitoring, make sure emissions from ventilation meet applicable air quality emissions criteria Any water associated with workings and mining activities meets applicable discharge quality criteria prior to release Limit any surface development to extent practical and avoid areas of significance Follow best management practices and standards for waste characterization and management, containment of hazardous material, liner designs, fuel management	Effects to local geology by development of underground workings Effects on local vegetation, soil, bird, and wildlife habitat as a result of clearing required to develop surface infrastructure to support mining Effects on air quality via emissions from ventilation of underground workings Effects on groundwater quantity and flow paths based on need to dewatering underground mine workings Effects to surface water quality and surface water-related receptors whereby mine water is released to local surface water features

Project Component		Alternative Means Carried Through after Screening for Technical, Economic, and Land Use Factors	Mitigation Measures	Residual Effects
		Option 5: ISR	Through design and monitoring, make sure emissions from ventilation meet applicable air quality emissions criteria Any water associated with workings and mining activities meets applicable discharge quality criteria prior to release Limit any surface development to extent practical and avoid areas of significance Follow best management practices and standards for waste characterization and management, containment of hazardous material, liner designs, fuel management	Effects to local geology by development of ISR mining area Effects on local vegetation, soil, bird, and wildlife habitat as a result of clearing required to develop surface infrastructure to support ISR mining Effects on groundwater quantity and flow paths based on development of ISR wellfield (injection and recovery well systems) Effects on groundwater quality by introduction of ISR mining solutions to the mining area Effects to surface water quality and surface water related receptors whereby mine water is released to local surface water features

Table 2.10-2: Detailed Alternatives Means Assessment Evaluation Criteria and Metrics (same as Table 5 in Appendix 2-C)

Criteria	Section	Valued Component	Indicator	Metric
Biophysical Environment	Atmospheric and Acoustic Environment	Air quality	Changes in air quality, including concentrations of dust, combustion products, uranium, metals and/or radionuclides	Alternatives that minimize changes in air quality and effects on ecological and human receptors are preferred.
		Noise	Changes in sound levels	Alternatives that minimize the increase in sound levels, and subsequent effects on wildlife and human receptors, are preferred.
	Geology and Groundwater	Geology	Changes in geology	Alternatives that avoid or minimize effects on geology are preferred
		Groundwater quantity	Changes in groundwater levels, groundwater flow patterns, and discharge rates to local surface water bodies	Alternatives that minimize interaction with groundwater quantity are preferred.
		Groundwater quality	Changes in concentrations of physical and chemical parameters in groundwater with consideration of discharge to local surface water bodies	Alternatives that minimize changes in groundwater quality, in the context of groundwater discharge to surface water bodies, are preferred.
	Aquatic Environment	Surface Water Quantity	Changes in surface water quantity through water taking, surface water discharge, and project overprinting of drainage areas (footprints)	Alternatives that minimize Project footprint, as well as surface water intake and release to surface water bodies, are preferred.
		Surface Water Quality	Changes in physical and chemical parameters of surface water quality can result from discharge of treated effluent to surface water bodies and land disturbance and clearing can mobilize solids into the aquatic environment	Alternatives that minimize Project footprint and changes in surface water quality and effects on fish, and other ecological receptors, are preferred.
		Fish and Fish Habitat	Changes in fish and fish habitat may develop from Project overprinting of fish habitat (habitat alteration or loss), changes in surface water quantity, surface water quality (physical and chemical parameters), sediment quality, or benthic invertebrates	Alternatives that minimize interaction with fish and fish habitat are preferred.
		Sediment Quality	Changes in sediment quality mainly from discharge of treated effluent to surface water bodies	Alternatives that minimize effects on sediment quality are preferred.
		Benthic Invertebrates	Changes in benthic invertebrate communities and quality from uptake of chemical parameters	Alternatives that minimize effects on benthic invertebrates are preferred.
		Fish Health	Changes in fish health mainly from discharge of treated effluent to surface water bodies	Alternatives that minimize effects on fish health are preferred.

Criteria	Section	Valued Component	Indicator	Metric
	Terrestrial Environment	Terrain	Changes to terrain	Alternatives that minimize interaction with terrain are preferred.
		Soil	Changes in soil quantity or quality	Alternatives that minimize loss or alteration of soil quantity, and minimize changes in soil quality, are preferred.
		Organic matter/peat	Loss of organic matter/peat	Alternatives that minimize loss or alteration of organic matter/peat are preferred.
		Vegetation and Ecosystems	Change in areal extent of vegetation habitat types and ecosystems	Alternatives that minimize loss vegetation and ecosystems are preferred.
		Listed Plant Species	Change in number of listed plant species	Alternatives that minimize direct and indirect effects on listed plant species are preferred.
		Wetlands	Change in areal extent of wetlands	Alternatives that minimize loss or alteration of wetlands are preferred.
		Ungulates	Changes in ungulate habitat (loss and/or alteration) and indirect or direct mortality of individuals	Alternatives that minimize ungulate habitat loss or alteration and minimize ungulate mortality are preferred.
		Furbearers	Changes in furbearer habitat (loss and/or alteration) and indirect or direct mortality of individuals	Alternatives that minimize furbearer habitat loss or alteration and minimize furbearer mortality are preferred.
		Woodland caribou	Changes in woodland caribou habitat (loss and/or alteration) and indirect or direct mortality of individuals	Alternatives that minimize woodland caribou habitat loss or alteration and minimize woodland caribou mortality are preferred.
		Raptors	Changes in raptor habitat (loss and/or alteration) and indirect or direct mortality of individuals	Alternatives that minimize raptor habitat loss or alteration and minimize raptor mortality are preferred.
		Migratory breeding birds	Changes in migratory breeding bird habitat (loss and/or alteration) and indirect or direct mortality of individuals	Alternatives that minimize migratory breeding bird habitat loss or alteration and minimize migratory breeding bird mortality are preferred.
		Bird species at risk	Changes in bird species at risk habitat (loss and/or alteration) and indirect or direct mortality of individuals	Alternatives that minimize bird species at risk habitat loss or alteration and minimize bird species at risk mortality are preferred.
Human Environment	Human Health	Human Health	Changes in human health from exposure to non-radiological and radiological constituents in air, water, and food	Alternatives that minimize negative changes in human health are preferred.
		Worker Health	Worker conventional health and safety and radiation exposure	Alternatives that reduce conventional health and safety risks and radiation exposure are preferred.

Criteria	Section	Valued Component	Indicator	Metric
	Land and Resource Use	Indigenous Land and Resource Use	Changes in the area of land available for Indigenous land and resource use, as well as resource availability, and perceived suitability of land and resources for safe use	Alternatives that minimize negative changes in Indigenous land and resource use are preferred.
		Other Land and Resource Use	Changes in the area of land available for non-Indigenous land and resource use, as well as resource availability, and perceived suitability of land and resources for safe use	Alternatives that minimize negative changes in other land and resource use are preferred.
		Heritage Resources	Change in the number of known archaeological resources	Alternatives that minimize direct or indirect alteration or loss of archaeological resources are preferred
	Quality of Life	Cultural Expression	Changes to knowledge transmission and traditional diet, including perceived changes in the suitability and safety of resources that support a traditional diet	Alternatives that minimize direct or indirect adverse effects on cultural expression are preferred.
		Community Well-being	Change in income of local workers and community cohesion	Alternatives that minimize direct or indirect adverse effects on community well-being are preferred.
		Infrastructure and Services	Changes in traffic, community infrastructure and services	Alternatives that minimize direct or indirect adverse effects on infrastructure and services are preferred.
	Economics	Economy	Changes in participation in the traditional economy	Alternatives that minimize direct or indirect adverse effects on economy are preferred.
Other Evaluation Factors				
Criteria			**Metric**	
Technical Factors	Complexity of design, construction, operation, and decommissioning		Simple or straightforward designs, construction techniques, and operational procedures based on tested and proven technologies are preferred. Alternatives that are more amenable to decommissioning and/or reclamation are preferred.	
Cost Factors	Capital, operating, and decommissioning costs		Lower capital costs are preferred to reduce the pre-production costs and influence the project economic viability. Lower operational costs are preferred to maintain project economics. Lower decommissioning costs are preferred to reduce long term liabilities	

Table 2.10-3: Mining – Methods - Alternative Means Assessment (same as Table 6 in Appendix 2-C)

Table Criteria	Section	Valued Component	Option 2: Jet Boring	Option 3: Surface Boring	Option 4: Micro Tunnel Boring	Option 5: ISR
Biophysical	Atmospheric and Acoustic Environment	Air quality	Less preferred option. Air quality on surface would be influenced by slurry handling, radon gas, radioactive dust in vent exhaust, dust from surface stockpiles including clean waste rock. Air quality in the mine workings would be managed with ventilation.	More preferred option. Size of mine rock stockpiles and their influence on air quality would be similar to Option 5. Changes in concentrations of radon in air from well development would be similar to option 5.	Less preferred option. Air quality in the mine workings would be managed with ventilation. Air quality on surface would be influenced by hoisted cuttings or slurry, radon gas, radioactive dust in vent exhaust, dust from surface stockpiles including clean waste rock.	More preferred option. Size of mine rock stockpiles and their influence on air quality would be similar to Option 3. Changes in concentrations of radon in air from well development would be similar to option 3.
		Noise	No appreciable difference was identified among the alternatives for changes in noise. Continual noise from surface ventilation fans and noise from mobile equipment. Similar to Option 4.	No appreciable difference was identified among the alternatives for changes in noise. No fans, noise from production drilling from surface includes compressors and mobile equipment would be continual.	No appreciable difference was identified among the alternatives for changes in noise. Continual noise from surface ventilation fans and noise from mobile equipment. Similar to Option 2.	No appreciable difference was identified among the alternatives for changes in noise. No fans, noise from surface drilling equipment includes compressors and mobile equipment would be intermittent as drilling is done only as required.
	Geology and Groundwater	Geology	Less preferred option for changes to geology, compared to options 3 and 5.	More preferred option for geology compared to options 2 and 4 since this is a surface method requiring less excavation.	Less preferred option for changes to geology, compared to options 3 and 5.	More preferred option for geology compared to options 2 and 4 since this is a surface method requiring less excavation.
		Groundwater quantity	Less preferred compared to option 3. Volume of groundwater management during mining would be similar to Option 4.	Preferred option with smallest interaction on groundwater quantity compared to options 2, 4 and 5.	Less preferred compared to option 3. Volume of groundwater management during mining would be similar to Option 4.	Less preferred compared to option 3. Use of ground freezing temporarily interacts with groundwater flow during operations.
		Groundwater quality	No appreciable difference was identified among the alternatives for changes to groundwater quality. Groundwater quality would interact with mine workings in a limited way due to groundwater management during mining.	No appreciable difference was identified among the alternatives for changes to groundwater quality.	No appreciable difference was identified among the alternatives for changes to groundwater quality. Groundwater quality would interact with mine workings in a limited way due to groundwater management during mining.	No appreciable difference was identified among the alternatives for changes to groundwater quality. Mining area remediation during decommissioning would mitigate effects on groundwater quality.
	Aquatic Environment	Surface Water Quantity Surface Water Quality Fish and Fish Habitat	Less preferred than options 3 and 5. The volume of water requiring treatment and release would be high, because of the groundwater	More preferred option compared to options 2 and 4. The volume of water needed treatment and release to a surface waterbody would be	Less preferred than options 3 and 5. The volume of water requiring treatment and release would be high, because of the groundwater	More preferred option compared to options 2 and 4. The volume of water needed treatment and release to a surface waterbody would be minimal,

Table Criteria	Section	Valued Component	Option 2: Jet Boring	Option 3: Surface Boring	Option 4: Micro Tunnel Boring	Option 5: ISR
		Sediment Quality Benthic Invertebrates Fish Health	management required for mine development. This could result in a larger effect on the aquatic environment. Quality of treated effluent expected to the similar among all four options.	minimal, and as such, this option would have a smaller effect on the aquatic environment. Quality of treated effluent expected to the similar among all four options.	management required for mine development. This could result in a larger effect on the aquatic environment. Quality of treated effluent expected to the similar among all four options.	and as such, this option would have a smaller effect on the aquatic environment. Quality of treated effluent expected to the similar among all four options.
	Terrestrial Environment	Terrain Soil Organic matter/peat Vegetation and Ecosystems Listed Plant Species Wetlands Ungulates Furbearers Woodland caribou Raptors Migratory breeding birds Bird species at risk	This option is less preferred as it may result in a greater potential effect (loss) of terrain, soil, organic matter/peat, vegetation, listed plant species, wetlands and related loss and alteration of wildlife habitat. Largest amount of disturbance due to underground waste rock creating stockpiles of acid generating, contaminated and clean waste rock. Footprint estimated to be similar to Option 4 and double the total disturbance of Option 5.	Direct surface footprint/mining disturbance expected to be the second lowest of the four options. This option is more preferred than option 2 and 4, similar to option 5 with regard to potential effects on the terrestrial environment.	This option is less preferred as it may result in a greater potential effect (loss) of terrain, soil, organic matter/peat, vegetation, listed plant species, wetlands and related loss and alteration of wildlife habitat. Largest amount of disturbance due to underground waste rock creating stockpiles of acid generating, contaminated and clean waste rock. Footprint estimated to be similar to Option 2 and double the total disturbance of Option 5.	Direct surface footprint/mining disturbance expected to be the lowest of the four options. This option is more preferred than option 2 and 4, similar to option 3 with regard to potential effects on the terrestrial environment.
Human Environment	Human Health	Human Health	Less preferred. Potential exposure to non-radiological and radiological constituents in air, water, and food may be higher with this option compared to options 3 and 5 due to 1. changes in air quality from mine rock, slurry handling, and mine ventilation and 2. larger volume of treated effluent release to the aquatic environment.	More preferred compared to option 2 and 4 due to smaller changes in air quality and smaller volume of treated effluent release	Less preferred. Potential exposure to non-radiological and radiological constituents in air, water, and food may be higher with this option compared to options 3 and 5 due to 1. changes in air quality from mine rock, slurry handling, and mine ventilation and 2. larger volume of treated effluent release to the aquatic environment.	More preferred compared to option 2 and 4 due to smaller changes in air quality and smaller volume of treated effluent release
		Worker Health	No appreciable difference was identified between alternatives	No appreciable difference was identified between alternatives	No appreciable difference was identified between alternatives	No appreciable difference was identified between alternatives

Table Criteria	Section	Valued Component	Option 2: Jet Boring	Option 3: Surface Boring	Option 4: Micro Tunnel Boring	Option 5: ISR
			because with application of mitigation measures and monitoring, all options would protect worker health and maintain radiation exposure within limits for nuclear workers. Within this context, underground work is higher risk than surface due to confined working area with heavy equipment underground and higher contaminates in underground atmosphere compared to open air conditions on surface.	because with application of mitigation measures and monitoring, all options would protect worker health and maintain radiation exposure within limits for nuclear workers. Surface operation with specialized surface equipment to drill horizontal cavities at ore depth. Physical ore cuttings will need to be rehandled on surface to either slurry for wet transport or dewater for dry transport increasing dose relative to Option 5 (which has a fraction of the drill cuttings to handle). Good conventional H&S as there is minimal mobile surface equipment.	because with application of mitigation measures and monitoring, all options would protect worker health and maintain radiation exposure within limits for nuclear workers. Within this context, this option has potentially the highest dose as workers will have greater potential exposure to radiation while servicing equipment that is working within the ore zone. Underground work is higher risk than surface due to confined working area with heavy equipment underground and higher contaminates in underground atmosphere compared to open air conditions on surface.	because with application of mitigation measures and monitoring, all options would protect worker health and maintain radiation exposure within limits for nuclear workers. Lowest dose of the four mining options evaluated in terms of dose associated with drill cuttings. The main contributor to worker dose would be radon associated with drilling the ISR wells. Surface piping of UBS, pumphouses, and well maintenance will also be a source of dose during pipeline repairs and inspection of equipment.
	Land and Resource Use	Indigenous Land and Resource Use	Less preferred compared to options 3 and 5 because of larger potential changes in resource availability linked to: 1. Larger footprint (changes to terrestrial environment) and 2. Higher volume of treated effluent (changes to aquatic environment). For all options, the area immediately around the mining activity would not be available for Indigenous land and resource use activities during operations for safety reasons. Perceived suitability of land and resources for safe use expected to be similar for all options.	More preferred compared to options 2 and 4 because of smaller potential changes in resource availability linked to: 1. smaller footprint (and changes to terrestrial environment) and 2. lower volume of treated effluent (and changes to aquatic environment). For all options, the area immediately around the mining activity would not be available for Indigenous land and resource use activities during operations for safety reasons. Perceived suitability of land and resources for safe use expected to be similar for all options.	Less preferred compared to options 3 and 5 because of larger potential changes in resource availability linked to: 1. Larger footprint (changes to terrestrial environment) and 2. Higher volume of treated effluent (changes to aquatic environment). For all options, the area immediately around the mining activity would not be available for Indigenous land and resource use activities during operations for safety reasons. Perceived suitability of land and resources for safe use expected to be similar for all options.	More preferred compared to options 2 and 4 because of smaller potential changes in resource availability linked to: 1. smaller footprint (changes to terrestrial environment) and 2. lower volume of treated effluent (changes to aquatic environment). For all options, the area immediately around the mining activity would not be available for Indigenous land and resource use activities during operations for safety reasons. Perceived suitability of land and resources for safe use expected to be similar for all options.
		Other Land and Resource Use	Less preferred compared to options 3 and 5 because of larger potential changes in resource availability linked to: 1. Larger footprint (changes to terrestrial environment) and 2. Higher volume of treated effluent (changes to aquatic environment). For all options,	More preferred compared to options 2 and 4 because of smaller potential changes in resource availability linked to: 1. smaller footprint (and changes to terrestrial environment) and 2. lower volume of treated effluent (and changes to aquatic	Less preferred compared to options 3 and 5 because of larger potential changes in resource availability linked to: 1. Larger footprint (changes to terrestrial environment) and 2. Higher volume of treated effluent (changes to aquatic environment). For all options,	More preferred compared to options 2 and 4 because of smaller potential changes in resource availability linked to: 1. smaller footprint (changes to terrestrial environment) and 2. lower

Table Criteria	Section	Valued Component	Option 2: Jet Boring	Option 3: Surface Boring	Option 4: Micro Tunnel Boring	Option 5: ISR
			the area immediately around the mining activity would not be available for Indigenous land and resource use activities during operations for safety reasons. Perceived suitability of land and resources for safe use expected to be similar for all options.	environment). For all options, the area immediately around the mining activity would not be available for Indigenous land and resource use activities during operations for safety reasons. Perceived suitability of land and resources for safe use expected to be similar for all options.	the area immediately around the mining activity would not be available for Indigenous land and resource use activities during operations for safety reasons. Perceived suitability of land and resources for safe use expected to be similar for all options.	volume of treated effluent (changes to aquatic environment). For all options, the area immediately around the mining activity would not be available for Indigenous land and resource use activities during operations for safety reasons. Perceived suitability of land and resources for safe use expected to be similar for all options.
		Heritage Resources	Less preferred compared to options 3 and 5. Larger area of surface disturbance increases potential interaction with archaeological resources.	More preferred compared to options 2 and 4. Smaller area of surface disturbance reduces potential interaction with archaeological resources.	Less preferred compared to options 3 and 5. Larger area of surface disturbance increases potential interaction with archaeological resources.	More preferred compared to options 2 and 4. Smaller area of surface disturbance reduces potential interaction with archaeological resources.
	Quality of Life	Cultural Expression	No appreciable difference was identified between alternatives for changes to knowledge transmission and traditional diet, including perceived changes in the suitability and safety of resources that support a traditional diet.			
		Community Well-being	No appreciable difference was identified between alternatives for change in income of local workers and community cohesion.			
		Infrastructure and Services	No appreciable difference was identified between alternatives for changes in traffic, community infrastructure and services.			
	Economics	Economy	No appreciable difference was identified between alternatives for changes in participation in the traditional economy.			

Technical Factors	Complexity of design, construction, operation, and decommissioning	Potential advantages: technology currently in use in Canadian uranium industry; mine layouts do not require development at or above the unconformity; remote system – safe for radiological risks. Potential technical weaknesses: Long duration development timeline; low production rate with limited ability to increase; currently used at only one mine with limited experience outside of that operation; may require extensive research and development; high technical risk including	Potential advantages: technology in widespread use in oil and gas industry; reduced safety and environmental risks with elimination of underground excavations; completely remote system – safe for radiological risks; reduced number of employees on site; short timeframe to production (weeks); good production rate with scalability; similar technique under evaluation in Canadian uranium industry (Orano's SABRE mining method).	Potential advantages: technology in widespread use in civil / municipal applications; remote system – safe for radiological risks under normal operating conditions; self-supported tunnels, thus risk of ground failure or inflow in tunnels reduced; simple concept and operation, variety of knowledgeable contractors/personnel; moderate production rate (approximately 4M lbs/yr per machine); ability to apply multiple units (scalability).	Potential advantages: technology in widespread use in international uranium operations (USA, Kazakhstan, Australia); reduced safety and environmental risks with elimination of underground excavations; completely remote system – safe for radiological risks; reduced number of employees on site; short timeframe to production (months); reduced technical risk with majority of remaining risks tested during feasibility stage; toll milling not required.

		underground operating risks, inflow risk, design and operating risk; may require bulk freezing approach versus perimeter freeze design as assumed in the PEA. This would increase freeze cost and time significantly.	Potential technical weaknesses: Drilling accuracy is paramount and needs additional testing; not currently in use in Canadian uranium industry.	Potential technical weaknesses: Recovery of ore may be limited to 90% at best due to configuration of the tunnels; congested working space in the launch stations; not currently in use in Canadian uranium industry.	Potential technical weaknesses: Not currently in use in Canadian uranium industry; mining solution permeability requires additional testing to increase confidence; low production rate – based on production rate at US operations (future testing may allow for higher production rates).
Cost Factors	Capital, operating, and decommissioning costs	Option 2 has high operating cost relative to the grade of the ore body, high capital costs and long duration development timeline, although the technology is in use at an existing uranium operation in Canada.	Option 3 has low capital and operating costs compared to jet boring.	Option 4 has the lowest ore recovery and high capital costs and long duration development timeline. Technology is commonly used in civil engineering.	Option 5 has low capital and operating costs. The technology is in widespread use at international uranium operations. ISR mining operations often have comparatively low capital and operating costs, as well as shorter timelines to first production and greater flexibility to allow production to be scaled to meet market demands.

Input received from Interested Parties:

Denison discussed potential mining methods early in the engagement process. As part of the engagement program for the Project, Denison organized a series of in-person workshops with Indigenous and non-Indigenous communities of interest (COI) and other Interested Parties in 2018. The workshops gathered community and student input in relation to potential mining methods for the Phoenix deposit. Given the history of uranium mining in the Athabasca Basin, there is a wealth of knowledge on various mining methods, and Denison sought input for which method would be best suited to efficiently and safety mining the Phoenix deposit.

The following mining methods were evaluated for effectiveness in mining the Phoenix deposit at the Project: Jet Boring, Surface Boring, Micro Tunnel Boring and In Situ Recovery. There was no specific engagement data collected related to surface boring or micro tunnel boring. Workshop participants noted that while jet boring was a relatively well-known method of mining, the high economic costs may make it undesirable for the Phoenix deposit (18-EN-VPL-2.38) (18-EN-ERFN-5.44). ISR mining is new to northern Saskatchewan and Canada. Some workshop participants were unsure how to evaluate the potential benefits and/or drawbacks of this mining method (18-EN-VILX-3.69), however other participants were confident in the method, saying they know it works in other locations, there are minimal waste streams, and method is more economically feasible than other methods (18-EN-VILX-3.68). A participant in the Village of Beauval workshop preferred the small footprint and lesser environmental impacts of ISR and viewed this method as a new opportunity for northern Saskatchewan (18-EN-VB-4.51). New opportunities are welcomed in the area, as they can support local businesses, provide training and learning opportunities, and keep money within the local economy (16-EN-MLA-109.26).

Selected alternative for mining method = Option 5: ISR

Rationale: Mining methods were evaluated through an increasingly rigorous process and considered factors such as: safety, environment, production rates, capital costs, operating costs, schedule, operational flexibility, and risk. The top four mining methods considered for the Phoenix deposit were: jet boring, surface boring, micro tunnel boring, and ISR. Independent preliminary economic assessment or class 5 level assessments were completed on each of these four options in 2017. The parameters evaluated included safety, environmental impacts, radiological safety, capital cost, operating cost, development timeframe, production rate, economic results (net present value, internal rate of return), regulatory risk, technology risk, equipment and contractor availability, and operating flexibility; this information has been summarized above in the alternatives means assessment cells. In addition, workshops were held in local Indigenous and non-Indigenous communities to capture community input into the selection of a preferred mining method once the options were narrowed down. Ultimately, based on the alternatives evaluated and feedback from Communities of Interest, Denison included the ISR method in the prefeasibility study (PFS; Denison 2018) and this mining method was selected as the basis for the EA.

Less Preferred	Neutral	More preferred

Table 2.10-4: Summary of Alternative Means Carried Forward into the Environmental Assessment

Project Component		Reference to Detailed Alternative Means Assessment Table in Appendix 2-C	Alternative Means						
			Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
Mining	Method	Table 6	~~Open pit~~	Jet Boring	Surface Boring	Micro Tunnel Boring	**ISR**		
	Freeze design for tertiary containment of mining solution	Table 7	Freeze dome	**Freeze wall**					
	Permeability enhancement	Table 8	**Hydraulics**	**Propellant**	**Mechanical**				
	Mining solution	Not applicable. Option 1 basic solution was deemed not technically feasible, economically feasible, and passed the land use screening are carried forward in the evaluation.	~~Basic solution~~	**Acidic solution**					
Processing	Location of processing	Table 9	Off-site processing at an existing mill	**On-site processing in purpose built processing plant**					
	On-site processing method	Table 10	Ion exchange	Solvent extraction	**Direct precipitation**				
Water management	Freshwater supply	Table 11	**Groundwater**	**Surface water**					
	Drinking water	Table 12	Truck drinking water to site	**Generate drinking water on site with a potable water treatment plant**					
	Treated effluent discharge location	Table 13	To groundwater	**To surface water**					

Project Component		Reference to Detailed Alternative Means Assessment Table in Appendix 2-C	Alternative Means						
			Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
	Treated effluent discharge locations for surface water	Table 14	Kratchkowsky Lake (LA-7)	Whitefish Lake north (LA-6)	**Whitefish Lake south (LA-5)**	McGowan Lake (LA-1)	Russell Lake	~~Mardoc Lake (LA-4)~~	~~Williams Lake LB-3~~
Waste management	Organic waste disposal	Table 15	On-site disposal using an incinerator	On-site disposal in domestic landfill	**On-site composting**				
	Process precipitate disposal	Table 16	On-site permanent disposal	**Off-site reprocessing and final disposal**					
	Domestic waste disposal	Table 17	Collection and disposal off site by a third-party contractor	**Collection and disposal in an on-site domestic landfill**					
Access and transportation	Access road alignment	Table 18	Direct route	Direct route to reduce cut volumes	**Follows part of the existing exploration access road**				
	Stream crossing structures	Table 19	Culverts	**Clear span bridges**					
	Worker transportation	Table 20	Ground transport	**Air transport to existing airstrip at nearby Cameco operations**	**Air transport to new airstrip constructed and operated by Denison**				
Power	Primary power supply	Table 21	Liquefied natural gas power plant	~~Solar photovoltaic power plant~~	Diesel generators	**Provincial power grid**			
Support facilities	Camp location optimization	Table 22	First location - Prefeasibility	Second location – Reduce fill volumes	**Third location - Southwest from second location**				

Selected alternative

~~Strikethrough~~ option was eliminated at an earlier step due to technical, economic, or land use factors (see Appendix 2-C)

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Appendix 2-A Engagement Database Summary – Project Description

See file "S2_App 2-A PD Engagement Table_Wheeler River.pdf"

Appendix 2-B Project-related Traffic

See file “S2_App 2-B Traffic Memo_Wheeler River.pdf”

Appendix 2-C Alternative Means Assessment

See file “S2_App 2-C Alternative Means Assessment_Wheeler River.pdf”

Denison Mines

Wheeler River Project

Final Environmental Impact Statement

November 2024

Powering
PEOPLE, PARTNERSHIPS
AND PASSION.

Wheeler River Project

Final Environmental Impact Statement

Section 3 – Indigenous and Local Knowledge

November 2024

Denison Mines Corp.

345 4th Avenue South

Saskatoon, SK, S7K 1N3

Roadmap

This roadmap of the Wheeler River Project Environmental Impact Statement (EIS) has been provided to summarize the main document sections and appendices of the EIS.

**Wheeler River Project
Environmental Impact Statement**

Executive Summary

PART I: INTRODUCTION AND CONTEXT	PART II: BIOPHYSICAL ENVIRONMENTAL ASSESSMENTS	PART III: HUMAN ENVIRONMENT ASSESSMENTS	PART IV: INTEGRATED TOPICS AND SUMMARY
Section 1: Project Introduction and Overview	Section 6: Atmospheric and Acoustic Environment	Section 10: Human Health	Section 14: Accidents and Malfunctions
Section 2: Project Description	Section 7: Geology and Groundwater	Section 11: Land and Resource Use	Section 15: Effects of the Environment on the Project
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Abbreviations, Acronyms and Units

Abbreviation / Acronym	Definition
ATK	Aboriginal Traditional Knowledge
CEA	Cumulative effects assessment
CEAA	Canadian Environmental Assessment Agency
CNSC	Canadian Nuclear Safety Commission
COI	Community of Interest
EA	Environmental assessment
EIS	Environmental Impact Statement
ERFN	English River First Nation
GIS	Geographical Information System
IAAC	Impact Assessment Agency of Canada
IK	Indigenous Knowledge
ILRU	Indigenous Land and Resource Use
ISR	In situ recovery
KML	Kineepik Métis Local #9
KPI	Key person interview
LK	Local Knowledge
LSA	Local Study Area
MN-S	Métis Nation-Saskatchewan
MVEIRB	Mackenzie Valley Environmental Impact Review Board
NR1	Northern Region 1
NR3	Northern Region 3
NVP	Northern Village of Pinehouse
OLRU	Other Land and Resource Use
RSA	Regional Study Area
SEAA	Saskatchewan Environmental Assessment Act
SVS	Shared Value Solutions
TRC	Truth and Reconciliation Commission
TEK	Traditional Ecological Knowledge
UN	United Nations
VC	Valued Component
YNLR	Ya'thi Néné Lands and Resources Office

Glossary

Term	Definition
Indigenous Community of Interest	A community whose traditional land or potential or established Aboriginal and/ or Treaty rights are in proximity to the Project or has existing transportation infrastructure that would be used by the Project. An Indigenous Community of Interest is more likely to experience impacts from the Project.
Indigenous community	An Indigenous community with a potential interest in the Project, including any Indigenous community identified by a Regulatory Agency as having a potential interest in the Project.
Indigenous Knowledge	Indigenous Knowledge is also known as Aboriginal Traditional Knowledge and Traditional Ecological Knowledge. Generally, Aboriginal Traditional Knowledge is considered as a body of knowledge built up by a group of people through generations of living in close contact with nature. Aboriginal Traditional Knowledge is cumulative and dynamic. It builds upon the historic experiences of a people and adapts to social, economic, environmental, spiritual and political change.
Indigenous people	Section 35 of the *Constitution Act, 1867* defines the term "Aboriginal peoples of Canada" as referring to the First Nation, Inuit and Métis peoples of Canada. The term "Indigenous" is used interchangeably with "Aboriginal".
Local Knowledge	Specialized knowledge developed through long-term association, interaction, and cumulative experience.

3 Indigenous and Local Knowledge

Each Indigenous community/organization defines Indigenous Knowledge (IK[1]) in their own way. Although no universally accepted definition of IK exists, an understanding of the key features and defining characteristics of IK is offered by Indigenous communities and in the literature. Canadian Environmental Assessment Agency (CEAA) (2015)[2] provides the following definition of IK:

> *"Generally, ATK [Aboriginal Traditional Knowledge] is considered as a body of knowledge built up by a group of people through generations of living in close contact with nature. ATK is cumulative and dynamic. It builds upon the historic experiences of a people and adapts to social, economic, environmental, spiritual and political change."*

Indigenous Knowledge also can be understood as the unique and collective knowledge of Indigenous peoples that may include, but is not limited to, the environmental, cultural, economic, political, and spiritual conditions of a community or region (CEAA 2015). This knowledge is passed down orally from generation to generation by Elders and is best understood in an Indigenous language to not lose any meaning through translation. Indigenous Knowledge has been developed by Indigenous groups after generations of living in close contact with the land and, fundamentally, this knowledge holds respect for each other and the earth.

Local knowledge (LK) is defined as specialized knowledge developed through long-term association, interaction, and cumulative experience (IAAC 2020). It is context-specific and unique. Local knowledge can be held by individuals, organizations, or communities. Local knowledge holders can be Indigenous or non-Indigenous (IAAC 2021). The information held does not need to be validated and vetted through processes commonly applied in the collection of IK, which is considered as community-held and shared knowledge.

This section primarily focusses on IK, but also includes LK where applicable. This section discusses the value of IK in Environmental Assessment (EA), the regulatory environment, IK and LK sources, and the approach to IK taken in the EA.

3.1 The Value of Indigenous Knowledge in Environmental Assessment Practice

Indigenous Knowledge plays an important role in the environmental assessment of major projects in Canada, with the understanding that different types of knowledge and diverse perspectives are needed to obtain a full understanding of the existing conditions in which a project is proposed, the potential effects of a project, and the significance of those effects, especially to Indigenous Peoples (BC EAO 2020).

[1] Also known as Aboriginal Traditional Knowledge or ATK and Traditional Ecological Knowledge or TEK.
[2] The Canadian Environmental Assessment Agency of Canada is now the Impact Assessment Agency of Canada.

Inclusion of Indigenous Knowledge strengthens all stages of EA in the following ways (MVEIRB 2005; BC EAO 2020):

- makes sure the perspectives and concerns of Indigenous peoples are heard;
- provides information, including historical information, that may not have been available through other sources;
- leads to better decisions, including improved project design and stronger mitigation measures;
- identifies and defines valued components; and
- identifies potential project effects to be included in the Environmental Impact Statement (EIS).

As part of 2022 engagement activities for English River First Nation, Beauval, and Pinehouse, Denison prepared a survey that asked a series of questions relating to the results of the environmental assessment. Responses indicated that Denison could learn from people regarding how to reduce the effects of the project to the environment and that the Indigenous voice should be included in monitoring plans.

3.2 Regulatory Context

The Wheeler River Project (the Project) is subject to both provincial and federal EAs, under the *Saskatchewan Environmental Assessment Act* (SEAA) and the *Canadian Environmental Assessment Act* (Government of Canada 2019a). The Canadian Nuclear Security Commission (CNSC) is Canada's nuclear regulator, responsible for regulating the use of nuclear energy and materials to protect health, safety, security, and the environment (CNSC 2018). Both the provincial and federal regulatory context is described in the following subsections.

3.2.1 Provincial Regulatory Context

The SEAA does not specifically define or require IK; however, provincial policy documents provide further guidance to the consideration of traditional knowledge, a term sometimes used interchangeably with IK.

The Government of Saskatchewan’s (2014a) technical proposal guidelines state that:

> *“Proponents should actively solicit input from the general public in the area and from other individuals or groups that may have an interest in the project and utilize their traditional and local environmental knowledge where appropriate. These groups may include community associations, municipal governments, regional planning agencies, First Nations and Métis communities, businesses, recreational users, and non-government organizations.”*

The Government of Saskatchewan's (2014b) guidance on consultation with First Nations and Métis in Saskatchewan EAs states:

> *"Proponents are encouraged to incorporate relevant ecological, traditional, or other knowledge in the presentation of information within the EIS. Common methods for working with First Nations and Métis communities to gather and present such information include conducting project-specific traditional knowledge and/or land use studies. Information-gathering exercises should be undertaken prior to submitting an EIS to ensure all relevant information is included."*

3.2.2 Federal Regulatory Context

Requirements for IK under federal legislation and regulation are described under:

- The *Canadian Environmental Assessment Act, 2012* (Government of Canada 2019a) S. 19 (3), Community knowledge and Aboriginal traditional knowledge:
  - The environmental assessment of a designated project may take into account community knowledge and Aboriginal traditional knowledge.
- Under the CNSC's Regulatory Document, 3.2.2 Aboriginal Engagement (CNSC 2016):
  - Indigenous Knowledge may help to identify potential impacts from the activity described in the licence application on traditional land use, treaty rights, Indigenous rights, and culturally important sites, including archeological sites. Gathering of IK must be approached respectfully, in collaboration with the Indigenous group, and with the understanding that the IK may be sensitive or proprietary. Indigenous Knowledge must be understood in the context of the Indigenous group's world view.

The Canadian Environmental Assessment Agency's reference guide (CEAA 2015) on considering Aboriginal traditional knowledge for EAs conducted under the *Canadian Environmental Assessment Act*, *2012* recommends implementing the following general principles:

- Work with the community.
- Seek prior informed consent.
- Access IK with the support of the community.
- Respect intellectual property rights.
- Collect IK in collaboration with the community.
- Bring IK and western knowledge together.

3.3 Indigenous Knowledge Approach

3.3.1 Guiding Principles for the Inclusion of Indigenous Knowledge

Broadly, Denison Mines Corp. (Denison) has committed to working with Indigenous communities in a spirit of mutual respect and cooperation. Denison's Indigenous Peoples Policy reflects the company's belief that reconciliation is advanced through collaboration with Indigenous peoples and communities to build long-lasting, respectful, trusting, and mutually beneficial relationships (Denison 2021). Denison's Indigenous Peoples Policy was developed based on the company's experiences with, and feedback and guidance from, Indigenous communities with whom the company is engaged. This approach makes sure that the policy captures a mutual vision for reconciliation and one that is best advanced through action (Denison 2021). The policy was developed to be consistent with the standards and principles in The United Nations Declaration on the Rights of Indigenous Peoples (UN 2007) and the Call to Action 92 (Business and Reconciliation) from Canada's Truth and Reconciliation Commission (TRC 2015).

3.3.2 Respecting Community Protocols and Procedures for Indigenous Knowledge

Access to IK is a privilege and must be respected. Prior to sharing and collecting IK, current local protocols and procedures developed by the Indigenous Community of Interest ("Indigenous COI") for the management of IK must be understood and followed. Consideration was also given to consent processes directed by the community to approve what information becomes publicly accessible and included in the EIS. For all sources of IK, guidance was sought on how specifically the knowledge should be treated and respected through a funding agreement process. To date, Denison has received permission to use and reproduce English River First Nation (ERFN) land use mapping located in the Project Terms of Reference (Denison 2019). Denison also has received permission to use two ERFN summary documents of a health and socioeconomic study (ERFN and SVS 2022a) and a Traditional Knowledge study (ERFN and SVS 2022b) as per 'Permitted Purposes' defined in an ERFN/Denison Participation and Funding Agreement. Denison fully funded both studies.

The Kineepik Métis Local #9 of Pinehouse has provided permission (Denison 2019) to use Geographic Information System (GIS) data collected as part of 2011 and 2018 use and occupancy studies (Tobias and Associates 2018a). Denison funded 75% of the 2018 land use and occupancy study. To protect the privacy of the IK, new maps have not been generated from the GIS points; instead, a generalized map has been used in Section 11.1 Indigenous Land and Resource Use.

The MN-S entered into a capacity funding agreement with Denison to produce a Métis Knowledge Study, which was provided to Denison in October 2023. Information sharing protocols were included in the agreement consistent with MN-S expectations on confidentiality. This included protocols for any disclosure of traditional land use or traditional knowledge information with other parties.

In March 2022, the Ya'thi Néné Lands and Resources Office (YNLR) transmitted their report entitled An Exploration of Recorded Athabasca Denesųłiné Traditional Knowledge, Land Use and Occupancy Information in the Vicinity of Denison Mines Wheeler River Project (YNLR 2022) and expressed support for inclusion in the report in the EIS. This report, funded by Denison, focused primarily on the Athabasca Denesųłiné First Nations including Hatchet Lake, Black Lake, and Fond du Lac. Indigenous Knowledge and LK within this report, as well as publicly available information, has been integrated into the EIS with focus on the Athabasca Denesųłiné communities. This report is an amalgamation of known information from YNLR and was not collected explicitly for the purposes of the Project and, as such, should be interpreted with caution. At the YNLR's request, the March 2022 report is included as an appendix to the EIS (See Appendix 3-A).

3.4 Indigenous and Local Knowledge Sources

3.4.1 Identifying Indigenous Knowledge Holders

An important initial step in the development of the EIS was to identify IK holders. The step is linked to how Indigenous communities were identified in the context of Project-related engagement. Section 4 Engagement describes how "Interested Parties" were identified and the process for selection. Broadly, Interested Parties are defined as any person or organization that can affect, be affected by, perceive itself to be affected by, or is interested in a decision or activity related to the Project (Section 4.3).

In identifying Indigenous communities as Interested Parties, three sub-groups were identified:

- **Indigenous Community of Interest (Indigenous COI)**: a community whose traditional land or potential or established Aboriginal and/ or Treaty rights are in proximity to the Project or has existing transportation infrastructure that would be used by the Project. An Indigenous COI is more likely to experience impacts from the Project.
- **Indigenous Community**: an Indigenous community with a potential interest in the Project, including any Indigenous community identified by a Regulatory Agency as having a potential interest in the Project.
- **Indigenous Organization**: an organization that is owned, operated, or delegated to represent Indigenous Communities in connection with the Project.

With respect to the identification of IK holders, the Indigenous COI formed the basis of where IK was explicitly sought by Denison, although Indigenous Organizations also offer relevant sources of information.

Figure 3.4-1 displays the Project location relative to the Indigenous COIs: the ERFN at Patuanak, the Métis Local #82 of Patuanak, the Kineepik Métis Local #9 of Pinehouse, and the Sipishik Métis Local #37 of Beauval. Other Indigenous communities include the Dore/Sled Lake Métis Local #67, the A La Baie Métis Local #21, Birch Narrows Dene Nation, Buffalo River Dene Nation, Lac La Ronge

Indian Band, and the Athabasca Denesųłiné First Nation communities including Fond du Lac First Nation, Black Lake First Nation, and Hatchet Lake First Nation. Indigenous organizations (not shown on map) include the Métis Nation- Saskatchewan, who has been delegated the Duty to Consult for a number of Métis locals (see Section 4), and the YNLR, who represent the Athabasca Denesųłiné First Nations.

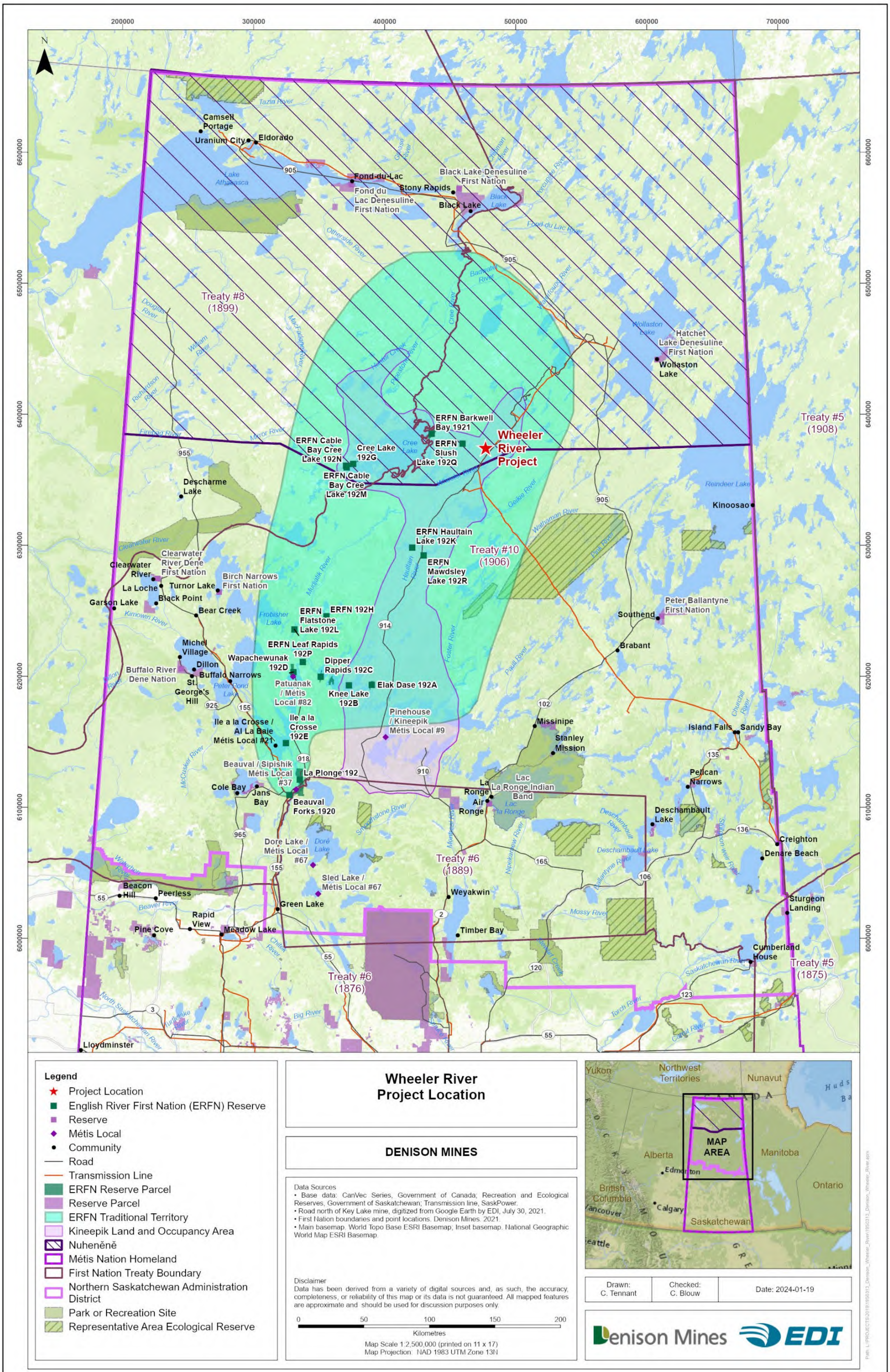

Figure 3.4-1: Overview of Project Location Relative to Communities

3.4.2 Sources of Indigenous Knowledge

Denison is supporting several processes to aid community-led collection of IK. These processes are at different stages of completion. Denison will continue to consider and integrate results from any forthcoming materials provided by communities as it advances the EIS process.

3.4.2.1 English River First Nation at Patuanak

The English River First Nation is a Denesųłiné community, comprised of both Denesųłiné and Cree people, with ancestral lands (*nuhtsiyw-kwi-Benéne*) stretching from the Churchill River to Wapata Lake in northern Saskatchewan.

> *"The ERFN name originates from the English River area, which was inhabited by the Poplar House people for periods during the year. Most of the families that now live at the Wapachewunak Reserve traditionally lived along the Churchill River system at Primeau Lake, Knee Lake, Dipper Lake and/or Cree Lake to the north (Canada North Environmental Services, 2017). Summers were spent primarily fishing along the river system. For the rest of the year, family units would spread out through the northern forests for trapping and subsistence hunting. Commonly used winter trapping areas included Haultain Lake, Costigan Lake, Foster Lake, and the area between Cree Lake and the Churchill River (Jarvenpa, 1980)"* (ERFN and SVS 2022a).

English River First Nation provided a land use map dated 2017 for Denison to gain an understanding of the extent and distribution of land use in the Project area. This map is published in the Project Terms of Reference (TOR; Denison 2019). To supplement the mapping information, funding was provided to ERFN to write their own independent contribution to the EIS, with assistance from Shared Value Solutions. English River First Nation produced a draft Traditional Knowledge Study and Health and Socio-Economic Study Results document that was split and finalized into two summary reports: 1) Wheeler River Project – Summary of Health and Socio-Economic Study Results (ERFN and SVS 2022a); and 2) Wheeler River Project - Summary of Traditional Knowledge Study Results (ERFN and SVS 2022b). The studies collectively documented baseline land use and socio-economic conditions and identified Project-related concerns and opportunities.

The first report summarizes results from sixteen interviews that were conducted for the health and socio-economic section (ERFN and SVS 2022a). The second study, i.e., the traditional knowledge study, conducted, analyzed, and presented results from 21 land use interviews, which provided both IK and LK (ERFN and SVS 2022b). The Traditional Knowledge study included maps of ERFN ecological knowledge features, personal harvesting sites, commercial harvesting sites, and occupancy sites. The Traditional Knowledge component also considered data collected with ERFN Elders in the 1980s and an analysis to look at the cumulative effects of industry on ERFN traditional territory.

3.4.2.2 Kineepik Métis at Pinehouse

The Kineepik Métis "*are considered Woodland Cree, Woodland Dene and Woodland Métis, although historical documents indicate that the member of (the Kineepik Métis Local) came from a diverse range of Métis, First Nations, and other backgrounds. The Northern Village of Pinehouse is located within the digitally mapped traditional territory of Indigenous people of Kineepik Métis Local. (They) have used these lands surrounding Missinippi (Churchill River) watershed for gathering food, shelter, and material supplies since time immemorial.*" (KML 2022).

In 2018, the Kineepik Métis Local #9 at Pinehouse (KML) approached Denison to support a land use mapping initiative in the Project area. The 2018 study builds on the land use mapping completed in 2011 by extending the spatial boundaries (Tobias and Associates 2018a). Methods used in the 2018 data collection are documented in Tobias and Associates (2018b) and results represent input from 128 respondents in 2011 and 55 respondents in 2018. The 2011 study area focussed on the community and environs north to George Lake and the 2018 study area focussed on the area north of and contiguous with the 2011 study area (from George Lake to north of Cree Lake Including the Project area). The essential methodology remained consistent for both iterations (Tobias and Associates 2018b). The Tobias and Associates (2018b) methods report indicates that collectively, the results from the 2011 and 2018 surveys represent the contemporary land base of Pinehouse residents determined "*primarily by locations where residents procure fish, birds, mammals and plant resources for direct family consumption*". A verification meeting was held in late 2018 to make sure no geographic data gaps existed and that the results speak for the whole community.

In 2022, the Kineepik Métis Local #9 (KML 2022) prepared a document to voice their perspectives on Project valued components and to provide a record for EIS development. Based on 12 community engagement sessions and review of the land use maps described above, the Kineepik Métis explained their unique social, cultural and historical context, expressed a general consensus of support for the Project, and described issues and concerns. The Kineepik Métis indicated that they regard Denison's engagement approach as a best practice process, which has surpassed any previous engagement protocols experienced before (KML 2022). As a result, the community is looking forward to continuing the engagement process with Denison and working collaboratively through any issues and concerns (KML 2022). Additional IK and LK was drawn from Kineepik Métis Local #9's *Response to the Environment Impact Assessment for the proposed Ministry of Highways 914 Extension Project* which, while expressing concerns about the proposed highway, also identified IK and LK priorities and concerns within the community (KML and NVP 2022).

3.4.2.3 Métis Nation - Saskatchewan

The Métis Nation - Saskatchewan represents the province's Métis citizens, with the Métis Nation Legislative Assembly as their governing authority. *"The Métis emerged as a distinct people/Nation in the historic Northwest during the course of the 18th & 19th centuries prior to Canada becoming a formal nation state. While the initial offspring of these unions were individuals who possessed* *mixed ancestry, the gradual establishment of distinct Métis communities, outside of First Nations and European cultures and settlements, as well as the subsequent inter-marriages between Métis women and Métis men, resulted in the genesis of a new Indigenous people – the Métis. The definition of Métis as adopted by Métis Nation–Saskatchewan is: 'a person who self identifies as Métis, is of historic Métis Nation ancestry, is distinct from other Aboriginal peoples, and is accepted by the Métis Nation'"* (Métis Nation – Saskatchewan not dated).

In recognition of the MN-S' potential interests in the Project, Denison and MN-S entered a capacity funding agreement to produce a Métis Knowledge Study.

In October 2023, the MN-S submit *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) to Denison. The Métis knowledge summarized therein included secondary literature approved for use by the MN-S and primary information collected during interviews with nine Métis citizens from Northern Region 1 (NR1) and Northern Region 3 (NR3), exclusive of information from the KML at Pinehouse who formally revoked its delegated Duty to Consult from the MN-S.

The study included an introduction; a description of the Métis in Saskatchewan; the methodology for the study; Métis knowledge; Métis ways of knowing, doing and living; and findings and recommendations relative to the Project (MN-S and Two Worlds Consulting 2023). The study occurred in three phases: planning, engagement, and reporting. After a kick-off meeting with the MN-S and NR1 and NR3 locals to introduce the Project, an in-person community-based workshop with MN-S was held to develop the overall methodology, schedule, mapping templates, and interview guides. The draft interview guide was reviewed in that process, and customized to MN-S preferences. The interview guide followed a semi-structured approach to encourage information sharing.

Nine Métis advisors were selected for interviews if they met the criteria of having lived in NR1 and/or NR3, previously worked in NR1 and/or NR3, and/or had strong kinship ties to NR1 and/or NR3 and were able to share Metis knowledge learned through oral history. The spatial boundaries were based on the Northern Saskatchewan Administrative District, which encompassed NR1 and NR3. The draft EIS was updated to include Métis knowledge where relevant to the Valued Components (VCs) assessed.

3.4.2.4 Athabasca Denesųłiné Communities

The communities of Black Lake, Fond du Lac, and Hatchet Lake Denesųłiné First Nations are collectively referred to as the Athabasca Denesųłiné. *"Fur traders originally referred to the Denesųłine as the Northern Indians and later as the Caribou Eaters or Ethen-eldeli (Smith 1981, Elias 2003, Usher 1990, Bone et al. 1973). (They) have also been called Chipewyan; a name (they) found offensive since it was given to (them) by (their) traditional enemies, the Cree. In recent times, (they) have moved away from both terminologies, preferring the term Denesųłine, meaning 'the Real or*

Genuine People'. This is the term (their) ancestors used to define themselves." (YNLR 2022). The project is located within the Nuhenéné, traditional territory of the Athabasca Denesųłiné.

The Ya'thi Néné Lands and Resources Office is the point of contact for, and representative of, the Athabasca Denesųłiné communities of Black Lake, Fond du Lac, and Hatchet Lake Denesųłiné First Nations, as well as the northern hamlets/settlements of Stony Rapids, Wollaston Lake, Uranium City, and Camsell Portage. The YNLR provided their report, named *An Exploration of Recorded Athabasca Denesųłiné Traditional Knowledge, Land Use and Occupancy Information in the Vicinity of Denison Mines Wheeler River Project*. This report summarized traditional knowledge and land use and occupancy information collected for various other projects and initiatives, documenting Athabasca Denesųłiné use in the Project area, although it was not considered a site-specific study. The Athabasca Denesųłiné have participated in many traditional knowledge studies since the 1970s and the study provided to Denison uses these existing datasets to document traditional knowledge, land use, and occupancy near the Project with the goal of supporting the regulatory process. The study documents the importance of caribou to the Athabasca Denesųłiné, their history, and maps showing land use and occupancy sites and traditional knowledge within the Nuhenéné, traditional territory of Athabasca Denesųłine. Athabasca Denesųłiné land use is further described in Section 11.

3.4.3 Local Knowledge Sources

The sources of LK used in the EIS included Indigenous resource users who provided information outside of a community-led IK process, key person interviews (KPIs), and engagement events.

One key source of LK was an ERFN trapper, whose primary residence was in the Project area. This ERFN trapper was the primary Indigenous land user in the Project area year-round and had years of experience fishing and trapping for both food and commercial purposes, hunting and travelling throughout the Project area, and this individual possessed long-term observations of the natural environment. Unfortunately, prior to the time of filing the EIS, the ERFN trapper passed away.

Additional LK was sourced through KPIs and engagement activities (see Section 4) with people that have specific knowledge and/or expertise. For example, KPIs may be conducted with outfitters to learn LK about the use of lands for harvest and recreation; school principals and day care directors to identify LK about infrastructure and services available to local communities; and local community administrators / councillors to gather information on economic characteristics such as employment and training. Engagement activities that provide LK include site visits, letters and email correspondence, phone calls, surveys, and workshops. Records of LK are recorded in the Engagement Database and are cited throughout the EIS.

3.4.4 Indigenous Knowledge Values and Worldviews

Indigenous Knowledge is generated by millennia of experience in natural resource management and environmental decision-making practice (Eckert et al. 2020). Indigenous Knowledge systems, therefore, make valuable contributions to and improve the rigor of EA (Government of Canada 2019b). It should be noted that IK systems are not homogenous or universal because they are grounded in the local history and experience of different Indigenous groups. As noted previously, communities determine the content and the degree to which IK is shared.

The ERFN, the Kineepik Métis Local #9 of Pinehouse, and the Athabasca Denesųłiné, have shared some of their key values and worldviews to inform the EA process for the Project. For example, maintaining the health of both the ecological world and the human world is a guiding principle in many of ERFN's teachings (ERFN and SVS 2022a). Through extensive experience on the land, IK of fish spawning areas, mammal habitat, important waterways, and wildlife migration corridors is held by ERFN members in the Project area and throughout the ERFN traditional territory, Nuhtsiye-Kwi Benene (ERFN and SVS 2022b). The land, in turn, takes care of the people.... "*it's like our plate; it gives us everything. The land gives us the food that we need, it gives us the clothing that we need, it gives us the heartbeat that we need."* (ERFN and SVS 2022b). On the connectivity between people and the land, an ERFN member stated: *"Water is seen as a source of life, a part of every living being, and an interconnected network that flows through everything.*" (ERFN and SVS 2022b).

English River First Nation also point out differences for conceptions of land between IK and western knowledge systems. English River First Nation explained that to understand the sociological and cultural context of ERFN, western knowledge holders are encouraged to avoid considering land as *terra nullius*, or as empty space available for extraction or development (ERFN and SVS 2022a). They state that bridging cultures requires understanding how these cultural conceptions differ (ERFN and SVS 2022a).

Transmission of knowledge is important to cultural continuity. The ERFN explain that *"Dene and Cree cultures are oral-based knowledge systems",* meaning that the language is the primary way through which their teachings (e.g., values, stories, history, relationships with land, and governance decisions) are passed on from generation to generation. As a result, several cultural and language revitalization programs are underway in the community (ERFN and SVS 2022a).

The Kineepik Métis' land and occupancy area, within which the proposed Project is situated, has been used by the people for gathering food, shelter, and material supplies since time immemorial (KML 2022). Land use is not only for securing food; Kineepik Métis hunt and gather for cultural, language, and identity purposes as well (KML 2022).

The Kineepik Métis Local #9 of Pinehouse have indicated the importance of language in the transmission on knowledge (KML and NVP 2022). The efforts to revitalize language and culture has had momentum for over a decade at Pinehouse and is moving towards an organic beginning of self-governance (KML and NVP 2022).

> *"Being the nearest community south of the uranium mining operation (the Kineepik Métis Local #9) have worked with the uranium industry for many years, formalizing partnerships with Cameco Corporation and Orano Canada in 2012 with a collaboration agreement. These relationships have allowed (Kineepik Métis Local #9) to understand the impacts stemming from projects throughout their lifecycle from (their) unique Indigenous lens"* (KML and NVP 2022).

The Kineepik Métis have completed their cultural calendar, which is comprised of the current annual traditional activities (KML 2022). This process includes the seasonal changes and adjustments of cultural activities within those changes, which include celebrations of cultural events that bring pride to community members (KML 2022).

The Kineepik Métis Local #9 also reflect on interconnectedness of language, cultural and land stewardship:

> *"While industrial development created employment and business opportunities it has also exerted extreme pressure to confirm to western cultural practices. This pressure creates an erosion of language and cultural practices… the loss of language included the loss of cultural understanding – as we lose our language, we lose our connection to the land. We lose our ability to communicate with our elders. Once the connection to the land is lost, then the spirit of conservation and concern for how the ecosystems are defined by our elders is also lost. The is the very nature of diversity as we the Indigenous peoples have know then land for time immemorial, the connection is irreplaceable, authentic, and inherent."* (KML and NVP 2022).

Similarly, the Athabasca Denesųłiné note the interconnection among people and the land, explaining that Athabasca Denesųłiné "*culture, history and way of life are interwoven with the movements and the health of the Beverly, Ahiak and Qamanijuaq barren-ground caribou herds. We are so intrinsically tied that it is often stated that the Caribou are Dene; Dene are caribou*" (YNLR 2022). As the "lifeblood" of the Athabasca Denesųłiné, the range of caribou—which fluctuates due to natural cycles, climate change, forest fires, industrial development, and other factors—defines the extent of their traditional territory (YNLR 2022).

The Wheeler River Project: Métis Knowledge Study Report explained that kinship relationships, and the relationship to the land, are paramount to their culture:

> "*These kinship relationships between our communities and families, as well as those with our extended First Nations relation, are vital to our success as a community. As such, our traditions are often a blend of Michif, Cree, and Dene spirituality, as well as*

> *the Christian traditions. This blend forms a foundational piece of our understanding of our role in the world and in our communities and families."* (MN-S and Two World Consulting 2023).

Michif is a distinct language, combining French and Cree, and evolved from communication between the Indigenous mothers and European fathers, although Métis spoke many Indigenous languages through intermarriage among regions. Storytelling and oral histories are a time-honoured concept, with stories retold year after year, with each telling allowing listened "*to understand things differently while they age(d) and gain(ed) experience*" (MN-S and Two Worlds Consulting 2023).

Similarly, Métis artistic expression is a blend of Indigenous and European styles, reflective of the regional differences and communities from which individuals came:

> *"Beadwork, embroidery, and quillwork showcase intricate patterns and motifs that tell stories of cultural intersections and shared histories. Métis artisans often incorporate natural materials like porcupine quills, moose hair, and birch bark into their creations, highlighting a deep connection to the land*" (MN-S and Two Worlds Consulting 2023).

3.4.5 Interweaving Indigenous Knowledge and Western Scientific Knowledge

In the context of contemporary decision-making, Denison recognizes that IK systems offer an alternative source of knowledge, often complementary to western science (Eckert et al. 2020). Inclusion of IK alongside western scientific knowledge should be considered through all phases of an effects assessment. This not only addresses regulatory expectations, but also recognizes the value IK adds to project planning, the completion of the EIS, and throughout the lifespan of the Project. The degree to which each community has contributed may vary because they decide what IK and LK they want to share, how it should be collected, and how it should be included in the EA process.

3.4.6 Addressing Divergence Between Indigenous Knowledge and Western Scientific Knowledge Systems

In response to instances where IK and western science diverge, Denison has established principles to address and resolve potential disagreements. These principles are outlined in more detail in Section 4 as part of the Engagement plan; however, action to resolve diverging perspectives begins when concerns are raised about the EA process, the Project, or its potential impacts. Denison seeks to:

- collaborate with IK holders in developing potential solutions to those concerns;
- where necessary, adjust the initial plans for the Project to reduce potential impacts and accommodate Rights and interests; and

- make active and good-faith efforts to resolve all material issues in the above-identified fashion.

Using this approach, Denison seeks mutually acceptable agreement where western science and IK diverge. This not only addresses regulatory expectations, but also recognizes the value IK adds to Project planning including greater knowledge about the environment, understanding of potential impacts of the development, identifying mitigation, and the significance of those impacts.

In cases where IK and western scientific disagreement cannot be resolved, EIS authors were instructed to note the divergence in the limitations at the beginning of each discipline section as well as in the concluding sections that discuss confidence in the assessment determinations and how this has been addressed in the proposed mitigation and monitoring.

Discrepancies among IK and western scientific information provide an opportunity for Denison to take a precautionary approach. Examples of concrete actions to address uncertainty in cases where IK and LK have differing conclusions on predicted Project effects include addressing uncertainty through monitoring and follow-up programs and communicating results of those monitoring and follow-up programs to demonstrate they have been responsive to the IK shared.

3.4.7 Integrating Indigenous Knowledge, Local Knowledge and Engagement into the Environmental Impact Statement

Denison has recorded and stored information regarding IK, LK and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers. These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment

Within each section of Part II and Part III are subsections titled “Influence of Indigenous Knowledge, Local Knowledge and Engagement on the Assessment”. Within these subsections are summary tables that provide additional details related to each one of the unique identification numbers referred to in that section.

3.4.8 Lands Taken Up from an Indigenous Perspective

Cumulative effects assessment is important to Indigenous communities in general because incremental effects to the environment can weaken resource economies, affect important resources such as plants, fish, and wildlife, affect rights-based and cultural activities, and affect both the health of wildlife and humans (Indigenous Centre for Cumulative Effects 2021). Indigenous people have had a long-term and close connection to lands and waters since time immemorial and have been keenly observant of changes over an extended period. For that reason, Indigenous peoples are best positioned to understand how cumulative effects from development and other activities impact their lands, resources, and communities (Indigenous Centre for Cumulative Effects 2020).

Indigenous perspectives can be complementary to the CEA for the Project, and Denison acknowledges the important relationship of the Indigenous COI to the lands and waters. "*Active land users from Indigenous communities are often quite aware of changes that have happened to the environment over time. This information can be useful to proponents in understanding the baseline conditions of their Project Study Area*" (ERFN and SVS 2022b). Throughout the EA process, Denison has gathered and brought Indigenous Knowledge together with western science to make a better Project (e.g., evaluating and considering the Ecological Knowledge Features and Concerns) (ERFN and SVS 2022b).

In addition to Project-related engagement outcomes, the Indigenous COI of ERFN and the KML have shared their Indigenous Knowledge on past, present, and predicted cumulative effects through the following sources:

- *Wheeler River Project – Summary of Health and Socio-Economic Study Results* (ERFN and SVS 2022a);
- *Wheeler River Project - Summary of Traditional Knowledge Study Results* (ERFN and SVS 2022b);
- *Kineepik Valued Ecosystem Components – KML Pre-statement for Denison EIS* (KML and NVP 2022); and
- *Response to the Environment Impact Assessment For the proposed Ministry of Highways 914 Extension Project* (KML and Limnos Environmental 2022).

Should additional information become available from ERFN, KML, or from the Métis Nation Saskatchewan, this information will be considered as it becomes available.

English River First Nation Perspectives on Cumulative Impacts

English River First Nation explained their own history and experience of colonial effects, including residential schools, language loss, their resilience, and their steps towards recovery (ERFN and SVS 2022a). They described the importance of and efforts towards reconnecting to the lands and waters after past developments in their territory and overcoming uncertainty about how these cumulative effects may have affected the health of the resources they consume (ERFN and SVS 2022a).

As part of their Traditional Knowledge study, ERFN members were asked to reflect on how their traditional territory had changed over time (ERFN and SVS 2022b). An Elder spoke about the change that the highway brought. The Elder described different time periods beginning when the road reached the community, followed by its expansion across the Churchill River, and north to facilitate access to existing uranium mines and mills. The Elder noted,

> "*Well, basically we were in an isolated community before the roads came in… we had used the rivers and the lake systems for our transportation…I would say 30 to 40 years that has changed dramatically, in terms of the road access to these areas, roads*

> *being built because of corporations and because of development…would say the early 1980s, there was an abundance of moose, an abundance of caribou, on the Haultain area, but with the road coming in, there has been more people taking the moose, taking the caribou. Also, more people starting to settle in that area, in terms of cabins, and so on and so forth, which are not the English River First Nation members"* (ERFN and SVS 2022b).

Past mining activities also have brought in local roads and trails, cutlines, and clearing for exploration that disturb wildlife habitat and movements (ERFN and SVS 2022b). The operation of heavy equipment also has disrupted wildlife. One ERFN member explained:

> "*The whole area is sensitive now, with all the things that are going on. It's disturbing the environment; the environment has been disrupted. So, the animals, the birds, and the fish are all affected, especially where there's mining activity. Because of that, animals tend to move away. So, they're not around because of all the activities that are going on*" (ERFN and SVS 2022b).

Waste from previous developments and disturbances from exploration activities are still visible and generate concerns for the health and well-being of ERFN members (ERFN and SVS 2022b).

English River First Nation used a mapping analysis known as "lands taken up" to examine cumulative changes to the land base over time. The approach subtracted disturbed lands (i.e., those affected by human influence, such as settlement, infrastructure, mining, forestry, and other industrial activities, as well as environmental changes such as forest fire and climate change) from Nuhtsiye-kwi Benene (ERFN territory) to illustrate the remaining areas of intact forests, that is, lands that remain available for ERFN land use. Results illustrated disturbances along Highway 914 between Mawdsley Lake and the Key Lake gate and further north along the Key Lake – McArthur Falls haul road between the Key Lake gate and the Project. This area "*is an important gathering place for the ERFN community, where ancestors have passed on knowledge of fishing, trapping, hunting, plant harvesting areas, historical sites, and routes for travel that continue to be used today*" (ERFN and SVS 2022b). Given the importance of this area, ERFN stress the importance of minimizing further effects that fragment the landscape going forward (ERFN and SVS 2022b).

Kineepik Métis Local Perspectives on Cumulative Impacts

The KML have cared for their lands from time immemorial and describe their connection to the land as "*irreplaceable, authentic, and inherent*". Colonization events eroded cultural practices and language in the community (KML and NVP 2022). Based on being the nearest community south of the uranium mining and having partnered with Cameo Corporation, KML noted they have a unique perspective on the cumulative effects of uranium mining (KML and Limnos Environmental 2022). Historical activities are an important consideration for the community, who noted:

> *"We have issues on cumulative impacts from historical legacy exploration and mining practices. Not specific to Denison, Cameco or Orano our land users have often found remnants of past poor exploration practices that are now affecting our continued land use. The abandoned camps and industrial waste left with no community known program for clean up are the most significant of these remnants"* (KML and NVP 2022).

Similarly,

> *"Current regulation of hunting, fishing, tourism, resources development and increase human traffic will affect and limit our ability to practice our protected rights. KML request further study on how current provincial regulations including opportunity for co-management so lessen the impacts from this project"* (KML and NVP 2022).

The KML also note the relationship of these activities to their ability to be on the land:

> *"While one project or mining operation does not materially affect our land use practices. The substantial and growing projects and mineral exploration activity severely limits our ability to practice continued and use for the region north of Haultain River. KML land users' limitation are leading to complete exclusion of the area for food sovereignty. As an example of this our hunting practices currently use high powered rifles to engage with big game including moose, bear, deer, and caribou in the area. With the significant and growing numbers of projects we do not know how we can continue to practice this method of food gathering in a safe method"* (KML and NVP 2022).

The community is concerned with the increased traffic on the road and would like better information on safety processes for community members and maintenance plans for the road (KML and Limnos Environmental 2022). With respect to the Project, the KML note that the Project alone is not expected to cause any material effect on land use, but future expansion of exploration activities and the Highway 914 extension project may cumulatively change access to resource harvesting locations and, therefore, food supply (KML and NVP 2022).

The KML noted that Denison provides "*best in class engagement practices*" and look forward to solving concerns and finding opportunities to increase community capacity in areas such as emergency response and waste management (KML and NVP 2022).

The MN-S (MN-S and Two Worlds Consulting 2023) describe some of the factors that have contributed to cumulative changes to land and resource use across their homeland including:

- imposed government programs and policies, such as the establishment of the Treaties; the game laws and fishing restrictions created by the federal and provincial governments; and the creation of the Primrose Lake Air Weapons Range;

- changes to wildlife behaviour, particularly changes to woodland caribou behaviour as a result of habitat loss, climate change, and other environmental changes;
- settler relationships and access to land and resource use over time (e.g., non-Indigenous purchase of cabins in northern Saskatchewan); and
- development activities, including various on-going uranium operations; access roads and highways; creation of campgrounds and recreation areas; presences of lodges, outfitters, and tourism; hydroelectric and transmission facilities; and abandoned mines.

The Metis Knowledge Study acknowledges that the extraction of natural resources (e.g., minerals, timber) contributes to both economic opportunities and environmental challenges, and the need to strike a balance to promote their economic interests while safeguarding the environment (MN-S and Two World Consulting 2023).

How Indigenous Perspectives Influenced the Cumulative Effects Assessment

For the purposes of this EIS, "*cumulative impacts can include environmental, socio-cultural, or economic changes that are caused by a combination of natural or human activities*" (ERFN and SVS 2022b). For the Project CEA, all residual effects, regardless of significance, are considered in each of the respective CEA for each VC. In determining potential cumulative effects, the CEA considers whether residual adverse effects of the Project on a given VC will overlap spatially and temporally with the same residual adverse effects on the VC resulting from other past, present, and reasonably foreseeable projects or activities.

Denison recognizes that Indigenous Knowledge systems offer an alternative source of knowledge, often complementary to western science (Eckert et al. 2020). The CEA for the Project follows standard methodology as per provincial (e.g., Guidelines for an Environmental Assessment under the [Saskatchewan] *Environmental Assessment Act*, 1980; Government of Saskatchewan 2022) and federal guidance (e.g., Assessing Cumulative Environmental Effects under the *Canadian Environmental Assessment Act*, 2012; Government of Canada 2019a). Among the sources of information to consider, the federal guidance notes the importance of *"Aboriginal traditional knowledge, community knowledge and scientific knowledge, or simply an expression of concern regarding potential cumulative effects to a particular VC"* (Government of Canada 2019). All sources of information were considered by discipline leads as described in this EIS section and Section 4 Engagement. The CEA for all VCs completed for the Project incorporated, as appropriate, the characterization of activities/events that have shaped the existing environment and continue to influence the VCs used for the EIS.

Much of the information shared by the Indigenous COI reflects upon their experience with past industry and other colonial factors that have shaped the existing environment, combined with their knowledge and understanding of the resources that support each communities' continued ability to express their Indigenous and Treaty Rights. Denison has considered and presented this information throughout the EIS consistent with federal guidance, which notes:

> *"Where a cumulative effects assessment gathers information useful to understanding the historical context of past impacts on Aboriginal rights, practitioners should keep in mind that, in the context of consultation and accommodation, such information will also help in understanding potential impacts to Aboriginal rights"* (Government of Canada 2019).

3.5 Summary of Indigenous Knowledge and Local Knowledge in the Environmental Assessment

3.5.1 Indigenous Knowledge in the Environmental Impact Statement

During the EIS, inclusion of IK provided greater knowledge about the environment and understanding of potential effects of the Project and the significance of those effects. Table 3.5-1 contains a record of how IK has been interwoven into the existing environment and effects assessment sections in Parts II and III of the EIS. The information is sorted according to discipline and detailed for each relevant aspect of the assessment.

Table 3.5-1: How Indigenous Knowledge was Incorporated into Existing Environment and Effects Assessment Sections

Discipline	Aspect Influenced	Section(s)	How Indigenous Knowledge was Incorporated	Source of Indigenous Knowledge (Community)
Groundwater	Project Design	7.2	Comments associated with concerns to groundwater quality, changes in water levels and quantity, and discharge to the environment were significant and these were considered within the context of community interest in the groundwater remaining supportive of surface water quality and discharge quantity and impacts to groundwater levels and quality. To this end, groundwater management, monitoring, mitigation, and evaluation of groundwater impacts are important to maintaining groundwater levels and water quality within the Local Study Area (LSA) and Regional Study Area (RSA).	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse
	Assessment	7.4	Indigenous Knowledge was valuable to understand the concern of water levels and impacts to fish and fisheries.	English River First Nation
	Mitigation	7.5	Specific concerns over the impacts from mining.	Kineepik Métis Local #9 and Northern Village of Pinehouse
	Monitoring and Follow Up	7.8	Specific concerns with respect to understanding the local hydrogeological setting. The information in the reports was valuable to understand the need for a robust monitoring program pre-mining that takes into account water levels in the local aquifers.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse
Aquatic Environment	Project Design	8.2.2	Environmental advantages of the in situ recovery (ISR) mining at Phoenix and the potential to avoid discharges into surface waters were noted.	Kineepik Métis Local #9 and Northern Village of Pinehouse
	Existing Environment	8.3.2, 8.3.3	Indigenous Knowledge was used to determine traditional land activities that regularly occur in the area, such as fishing and navigation (boating). Indigenous Knowledge identified two camps (ERFN Culture Camp and the Kineepik Métis [Pinehouse] camp) of particular importance to local Indigenous residents.	English River First Nation Athabasca Denesųłiné First Nations and Communities
			Indigenous Knowledge was also important for determining traditional food consumption in the Project area, especially in terms of frequency and diet composition. The ERFN Country Foods Study was used to determine the traditional food diet.	English River First Nation

Discipline	Aspect Influenced	Section(s)	How Indigenous Knowledge was Incorporated	Source of Indigenous Knowledge (Community)
	Assessment	8.3.2, 8.3.4	Indigenous Knowledge provided confirmation and additional information in identifying fish presence/absence and critical life history use habitats in the LSA.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse
Terrestrial Environment - Ungulates, Furbearers, and Woodland Caribou	Existing Environment	9.3.3.1, 9.3.3.2, 9.3.3.3	Indigenous Knowledge improved understanding of species' habitat and diet preferences, calving areas, population trends, and local harvest.	English River First Nation Athabasca Denesųłiné First Nations and Communities
	Assessment	9.3.6, 9.3.7	Indigenous Knowledge improved and confirmed knowledge was considered in the residual effects assessment and the cumulative effects assessment (CEA), including site access and noise disturbance.	English River First Nation Athabasca Denesųłiné First Nations and Communities
Terrestrial Environment – Raptors, Migratory Breeding Birds, and Bird Species at Risk	Existing Environment	9.4.3.1.2, 9.4.3.2.2, 9.4.3.3.2	Indigenous Knowledge improved understanding of species' distribution and regional population trends.	English River First Nation
	Assessment	9.4.6.3.2, 9.4.7	Indigenous Knowledge was considered in the residual effects assessment and the CEA. Concerns about decreasing numbers in some species and increased access to the area were incorporated into the CEA.	English River First Nation
Human Health and Ecological Risk Assessment	Existing Environment	10.1.3	Indigenous Knowledge was used to determine traditional land activities that regularly occur in the area, such as fishing, hunting, trapping, and gathering. Indigenous Knowledge identified two camps (ERFN Culture Camp and the Kineepik Métis [Pinehouse] camp) of particular importance to local Indigenous residents. Indigenous Knowledge was also important for determining traditional food consumption in the Project area, especially in terms of frequency and diet composition. The ERFN Country Foods Study was used to determine the traditional food diet. IK from ERFN indicated that they have a strong connection to the land and the importance of the natural environment.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse Athabasca Denesųłiné First Nations and Communities
Heritage Resources	Existing Environment	11.3.3	Indigenous Knowledge was used to confirm that the Project area contained cultural resources.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse

Discipline	Aspect Influenced	Section(s)	How Indigenous Knowledge was Incorporated	Source of Indigenous Knowledge (Community)
Indigenous Land and Resource Use (ILRU)	Assessment Approach	11.1.2	The social, cultural, and economic value of ILRU and future goals for the continuation of ILRU was communicated. Indigenous Knowledge provided an understanding that overall health and well-being is derived from both the consumption of resources and the practice of harvesting them, which contributed to the selection of Key Indicators. Indigenous Knowledge indicated that the communities needed to have confidence in the ISR mining approach so this was included within the assessment and follow-up engagement designed.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse Athabasca Denesųłiné First Nations and Communities Métis Nation Saskatchewan
	Existing Environment	11.1.3.2	Indigenous Knowledge described the connection to the land for Indigenous peoples including: • the gifts of shelter and medicines that the land provides; • the meaning and value of water; • how respect is taught and passed on to future generations; and/or • a growing desire to reconnect with the land and waters and continue traditional activities. The importance of specific resources for hunting, fishing, trapping and gathering was explained including their relative importance to diet.	English River First Nation Athabasca Denesųłiné First Nations and Communities Métis Nation Saskatchewan
	Assessment	11.1.4	Specific concerns were communicated. These included: • change in the abundance of animals; • air quality; • workforce fishing levels; • noise; • potential for accidental release of pollution; • the safety of drinking water downstream of the treated effluent discharge pipe; and • the ISR mining method and its safety for animals and human health. These concerns were then incorporated into the assessment to determine the nature of the potential effect.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse Métis Nation Saskatchewan

Discipline	Aspect Influenced	Section(s)	How Indigenous Knowledge was Incorporated	Source of Indigenous Knowledge (Community)
Other Land and Resource Use (OLRU)	Existing Environment	11.2.3	Historic trapping and trapping trails were described, which provided context for the boundaries of the traditional territory. Commercial fishing history was described and mapped including the species harvested, the seasons, and the timeframe that commercial fishing was undertaken.	English River First Nation Métis Nation Saskatchewan
	Assessment	11.2.4	The locations where commercial fishing and commercial trapping were considered in relation to potential Project effects.	English River First Nation Métis Nation Saskatchewan
Cultural Expression	Assessment Approach	12.1.2	Indigenous Knowledge confirmed the key indicators for community well-being and that residents in the LSA benefit from the employment and business opportunities that come with resource development projects.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse Métis Nation Saskatchewan
	Existing Environment	12.1.3	Indigenous Knowledge was used to describe the key indicators: information pertaining to knowledge transmission (inclusive of language), land-based cultural programs, land-based programming and supports, and travel routes and habitation; and traditional diet, which supports social bonds within families and communities.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse Métis Nation Saskatchewan
	Assessment	12.1.4.2	Indigenous Knowledge contributed to the characterization of changes to: • participation in cultural practices and subsequent knowledge transmission as a result of employment (e.g., time spent away from community because of the worker rotation schedule); • location of cultural practices to support knowledge transmission because of restricted access or avoidance of areas; • change in availability of country foods that support a traditional diet because of restricted access to or avoidance of hunting, fishing, trapping, and gathering areas; and • change in perceived suitability of country foods that are part of a traditional diet.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse Métis Nation Saskatchewan

Discipline	Aspect Influenced	Section(s)	How Indigenous Knowledge was Incorporated	Source of Indigenous Knowledge (Community)
	Mitigation	12.1.5	Indigenous Knowledge informed mitigation for cultural expression such as: • working with Indigenous communities to understand their important harvest times and cultural camps to support Indigenous employees in taking time off to participate in such events; and • measures protective of Indigenous land and resource use.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse
Community Well-Being	Assessment Approach	12.2.2	Indigenous Knowledge verified and confirmed the key indicators for community well-being and that residents in the LSA benefit from the employment and business opportunities that come with resource development projects.	Kineepik Métis Local #9 and Northern Village of Pinehouse
	Existing Environment	12.2.3.1, 12.2.3.2, 12.2.3.3	Indigenous Knowledge confirmed and verified information for the existing environment, including: • challenges and barriers to seeking post-secondary education, employment, and other economic opportunities; • youth access to education and employment as a priority; • the importance of traditional activities including for mental health and well-being, spiritual health, and cultural identity; and • social values and kinship rooted in relationships to the land and their importance to social cohesion.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse Métis Nation Saskatchewan
	Assessment	12.2.4.2.1, 12.2.4.2.2, 12.2.4.2.3	Indigenous Knowledge confirmed and verified information for the assessment of Community Well-being, including: • the challenges and barriers of the remote location of LSA communities such as access a lack of economic opportunities and employment; • new projects (i.e., mining industry) are seen as a benefit for LSA communities including for employment and business opportunities; and • the importance of having Elders on site at resource development projects to continue to play a role as a knowledge holders, connection to family and culture, and to provide cultural programming.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse Métis Nation Saskatchewan

Discipline	Aspect Influenced	Section(s)	How Indigenous Knowledge was Incorporated	Source of Indigenous Knowledge (Community)
	Mitigation	12.2.5	Indigenous Knowledge informed and confirmed mitigations for Community Well-being, including: • the need for pick-up point; • a no alcohol and drug policy on site; and • the need for culturally sensitive employment policies that support the Indigenous workforce, such as an Elder representative to provide cultural programming or minimizing Project activity during key cultural events.	(Informed through existing environment and assessment) English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse
Infrastructure and Services	Assessment Approach	12.3.2, 12.3.3.1	Indigenous Knowledge verified and confirmed the key indicators for Infrastructure and Services.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse
	Existing Environment	12.3.3.2.1, 12.3.3.3.1, 12.3.3.3.2	Indigenous Knowledge verified and confirmed information for the existing environment, including: • highway descriptions (Highway 914 and 165) and Key Lake gatehouse access; • education infrastructure and programming; • health facility services, providers, and programming; • social services and programming; and • recreational infrastructure and services.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse
	Assessment	12.3.4.2.1, 12.3.4.2.2	Indigenous Knowledge confirmed and verified information for the assessment of Infrastructure and Services, including: • concerns for increased truck traffic and truck traffic incidents as a result of the Project; • a need for better information on transportation safety processes; and • concerns for becoming a through road community that could further dilute community and emergency services currently in place.	Kineepik Métis Local #9 and Northern Village of Pinehouse
	Mitigation	12.3.5	Indigenous Knowledge informed and enhanced mitigations for Infrastructure and Services, including the need for an Environment and Culture Monitor and the need for an on-site Elder to provide culturally relevant programming and support.	(Informed through existing environment and assessment) English River First Nation

Discipline	Aspect Influenced	Section(s)	How Indigenous Knowledge was Incorporated	Source of Indigenous Knowledge (Community)
Economy	Assessment Approach	13.1.1, 13.1.2, 13.1.4	Indigenous Knowledge confirmed and verified the key indicators for economy and confirmed and verified the economic aspects of the Project that could be challenging or cause concern for members, including that jobs and employment should be prioritized for Indigenous communities.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse Métis Nation Saskatchewan
	Existing Environment	13.1.1, 13.1.2, 13.1.4, 13.2, 13.2.1, 13.2.3, 13.2.4	Indigenous Knowledge confirmed and verified information for the existing environment, including • challenges and barriers to seeking post-secondary education, employment, and other economic opportunities (including barriers associated to the remote location of communities and costs and time commitments for education and training); • the need to prioritize Indigenous communities for employment and contracting opportunities; • that youth access to education and employment is a priority including that previous resource development projects have encouraged younger generations to graduate and advance careers; • that limited employment opportunities currently exist (including job advancement) for Indigenous communities and its residents; and • the importance of the traditional economy to communities and its residents.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse Métis Nation Saskatchewan
	Assessment	13.3.2	Indigenous Knowledge confirmed and verified information for the assessment of Economy, including: • the importance of the traditional economy to the economic well-being of community members; • the positive impacts resource development has brought in terms of training and employment to Indigenous communities (including through Des Nedhe and PBN Construction); • that employment opportunities have encouraged younger generations to graduate and advance careers; and • that consensus exists among community members that the Project will benefit the community through employment opportunities and local community owned business and contracting opportunities.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse Métis Nation Saskatchewan

Discipline	Aspect Influenced	Section(s)	How Indigenous Knowledge was Incorporated	Source of Indigenous Knowledge (Community)
	Mitigation	13.4	Indigenous Knowledge informed mitigation and enhancement measures for Economy, including: • the need for agreements with Indigenous communities to reflect community interests and objectives relative to Project opportunities; • workforce development plans to prioritize Indigenous and non-Indigenous communities in the LSA in terms of employment and training opportunities and hiring practices during all phases of the Project; and • the establishment of a procurement approach prioritizing businesses within LSA communities throughout all phases of the Project.	(Informed through existing environment and assessment) English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse
Accidents and Malfunctions	Assessment	14.4, 14.6.7	Incorporated traffic related accident scenario along the transportation route at cultural camp locations identified in IK.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse

3.5.2 Local Knowledge in the Environmental Impact Statement

During the EIS, inclusion of LK provides greater knowledge about the environment and understanding of potential effects of the development and the significance of those effects. Table 3.5-2 contains a record of how LK has been interwoven into the existing environment and effects assessment sections. The information is sorted according to each discipline and detailed for each relevant aspect of the assessment.

Table 3.5-2: How Local Knowledge was Incorporated into Existing Environment and Effects Assessment Sections

Discipline	Aspect Influenced	Section(s)	How Local Knowledge was Incorporated	Sources of Local Knowledge
Noise	Assessment	6.2.4	As the concern was related to leased property, all leases in the study area were assumed to have a cabin and were included in the assessment.	Lease Survey
	Mitigation	6.2.5	While no exceedances of the guideline limits were predicted at any of the lease properties, mitigation measures were outlined to assist in controlling noise during construction and operations as there was a predicted increase in sound level during construction that may be noticeable.	Lease Survey
	Monitoring	6.2.8	A follow-up noise monitoring program will be completed as an outcome of the analysis to confirm that the sound levels at the nearest leased property is within the guideline limits.	Lease Survey
Groundwater	Assessment Approach	7.2	Local Knowledge was used to inform the use of groundwater in the area and the groundwater to surface water interactions. It was important to understand the use of water and protection of the aquifer system to surface water bodies.	ERFN Trapper
	Existing Environment	7.3	Study evaluation to confirm appropriate baseline groundwater monitoring.	ERFN Trapper
	Monitoring	7.8	Local Knowledge was used to inform and confirm the monitoring of groundwater quality in pre-operational and post-operational phases of the Project.	ERFN Trapper
Aquatic Environment	Existing Environment	8.3.2, 8.3.3, 8.3.4	Local Knowledge was used to determine traditional land use activities that regularly occur in the area. Specifically, LK for the fish and fish habitat assessment was generally gathered through consultation with a local fisher/trapper. Consultations with the ERFN Trapper provided confirmation and additional information in identifying fish presence/absence and critical life history use habitats in the LSA. Confirmation of fish and fish habitat information through follow-up consultation. Consultations with the ERFN Trapper provided confirmation and additional information in identifying fish presence/absence and critical life history use habitats in the LSA.	ERFN Trapper
Terrestrial Environment – Vegetation and Ecosystems	Existing Environment	9.2.3.1.1	Included cultural plant use references.	ERFN Trapper Lease Survey
	Assessment	9.2.4.2.1, 9.2.4.2.2, 9.2.4.2.1	Included reference to desire for progressive reclamation.	ERFN Trapper Lease Survey

Discipline	Aspect Influenced	Section(s)	How Local Knowledge was Incorporated	Sources of Local Knowledge
Terrestrial Environment - Ungulates, Furbearers, and Woodland Caribou	Existing Environment	9.3.3.1, 9.3.3.2, 9.3.3.3	Improved understanding of species' habitat and diet preferences. Confirmed species population trends. Improved information on local harvest.	ERFN Trapper
	Assessment	9.3.6, 9.3.7	Improved and confirmed local knowledge was considered in the residual effects assessment and the CEA. Concerns about increased access were incorporated into the CEA.	ERFN Trapper
Terrestrial Environment - Raptors, Migratory Breeding Birds, and Bird Species at Risk	Existing Environment	9.4.3.2.2, 9.4.3.3.2	Improved understanding of species' distribution and regional population trends.	ERFN Trapper
	Assessment	9.4.6. 9.4.7	Improved knowledge that was considered in the residual effects assessment and the CEA. Concerns about decreasing numbers in some species and increased access to the area were incorporated into the CEA.	ERFN Trapper
Human Health and Ecological Risk Assessment	Existing Environment	10.1.3	Local Knowledge was used to determine traditional land use activities that regularly occur in the area such as fishing, hunting, trapping, and gathering. Specifically, LK for the human health and safety assessment was generally gathered through consultation with a local fisher/trapper.	ERFN Trapper KPI Program 2018
	Assessment	10.1.4	Information gathered during consultation with local community members was used to determine residency characteristics for the recreational fisher/hunter/firewood gatherer and the fisher/trapper receptors; specifically, the location of cabins and hunting/fishing areas near Denison mine and the length of time spent in the Project area versus the reference area. Consultation with the ERFN Trapper was also helpful in determining local traditional food diet composition and the proportion of traditional foods in the diet.	KPI Program 2019 ERFN Trapper
			The Lease Holder survey was used to determine the locations of a few operational cabins near the Project area and their uses. It also confirmed that traditional activities such as fishing and hunting are regularly occurring activities in the Project area.	Lease Survey

Discipline	Aspect Influenced	Section(s)	How Local Knowledge was Incorporated	Sources of Local Knowledge
Heritage Resources	Existing Environment	11.3.1.1, 11.3.3	Local Knowledge confirmed that the Project area could have cultural/heritage resources as the area is the traditional territory of three separate Indigenous groups.	English River First Nation Ya'thi Néné Land and Resources Office Kineepik Métis Local #9 and Village of Pinehouse Lake Lease Survey
Indigenous Land and Resource Use (ILRU)	Existing Environment	11.1.3.1 11.1.3.2	The traditional territories boundaries and seasonal travel routes were shared and mapped for use in the assessment and to provide an understanding of historic and contemporary land use places and areas. Travel on local waterbodies, overland trails, and cabins were described and mapped, which helped understand any potential effects on navigation, travel, cabins or campsites. Resources harvested through hunting, fishing, trapping and gathering were mapped and described to provide an understanding of the extent, frequency, and importance of this land use. Important cultural and sacred gathering spots were described and the importance of cultural camps for the continuation of culture was explained so that any changes to these features could be assessed.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse Athabasca Denesųłiné
	Assessment	11.1.4, 11.1.4.5	The ERFN Trapper provided perspectives on how the Project may affect ERFN Trapper's land use. Provided concerns about potential changes to water quality at treated effluent discharge location, and the ability to drink surface water untreated in proximity to the Project. Asked about accidents and malfunctions including failure of freeze wall and follow up explanation was provided to explain that the freeze wall takes an extended period of time to thaw. Provided perspectives and details about concerns with respect to increases in traffic associated with Project activities.	ERFN Trapper English River First Nation Kineepik Métis Local Northern Village of Pinehouse
	Mitigation	11.1.5.3	Provided concerns about ISR mining (new to Canada) and perceived benefits (no mill, tailings, and better overall environmentally). Planned follow-up was developed to conduct further engagement about the ISR technology.	English River First Nation, Lodge owner, Northern Village of Pinehouse

Discipline	Aspect Influenced	Section(s)	How Local Knowledge was Incorporated	Sources of Local Knowledge
	Cumulative Effects	11.1.7	Expressed concerns about future interactions that ILRU could have with the Highway 914 extension project and traditional use.	English River First Nation Kineepik Métis Local #9 and Northern Village of Pinehouse
Other Land and Resource Use (OLRU)	Assessment Approach	11.2.1.1 11.2.1.2	The selection of OLRU as a Valued Component and its Key Indicators was supported by engagement with communities.	English River First Nation, Northern Village of Pinehouse, Northern Village of Beauval
	Existing Environment	11.2.3.2 11.2.3.4	The ERFN provided a multi-generational history of trapping that informed the Commercial Trapping section. The value of species for income was explained. The ERFN provided information about their participation in the lodge and outfitting industry which provided perspectives on the resource economy. Travel on local waterbodies, overland trails, and cabins were described and mapped, which helped understand any potential effects on navigation, travel, cabins or campsites. Specific concerns related to commercial activities were incorporated into the assessment to determine the nature of the potential effect.	English River First Nation
		11.2.3.3.1	Locations where commercial fishing was conducted by residents provided understanding of the potential for effects on commercial fishing.	English River First Nation Ya'thi Néné Land and Resources Office
	Assessment	11.2.4.4	The ERFN provided information on how management of trapping on Fur blocks N-18 and N-16 is conducted, which enabled appropriate consideration of mitigation options.	English River First Nation
		11.2.4.5.1	Provided an understanding of concerns with respect to air quality.	English River First Nation
		11.2.4.5	Provided perspectives and details about concerns with respect to increases in traffic associated with Project activities Provided concerns about the potential for workforce fishing and how this fishing may interact with the local environment around the cabin.	Kineepik Métis Local #9 Cabin Owner
		11.2.4.5	Provide concerns about ISR mining (new to Canada) and perceived benefits (no mill, tailings, and better overall environmentally). Planned follow-up was developed to conduct further engagement about the ISR technology.	English River First Nation, Lodge owner, Northern Village of Pinehouse

Discipline	Aspect Influenced	Section(s)	How Local Knowledge was Incorporated	Sources of Local Knowledge
		11.2.4.5	Provided concerns about potential changes to water quality at treated effluent discharge location (LA-5).	Cabin Owner
		11.2.4.5	Asked about accidents and malfunctions including failure of freeze wall and follow up explanation was provided to explain that the freeze wall takes an extended period of time to thaw.	English River First Nation Northern Village of Pinehouse
	Cumulative Effects	11.2.7	Concerns were raised about increased access into the OLRU LSA by interactions with the Highway 914 extension project and the bypass of the Key Lake gate.	Lodge Owner, Cabin Owners, ERFN Trapper Kineepik Métis Local #9 and Northern Village of Pinehouse
Community Well-Being	Existing Environment	12.2.3.1, 12.2.3.3	Local Knowledge confirmed and verified information for the existing environment, including: • the importance of family, kinship, and community for LSA community cohesion; • concerns of family members and community members working for a resource development project being taken out of community for periods at a time (such as commuter rotation); • the benefits of resource development projects on the local economy including increased income and employment opportunities; and • that the main policing issues in Beauval and Pinehouse Lake include offences related to drugs and alcohol.	KPI Program 2021-2022
	Assessment	12.2.4.2.3, 12.2.4.2.1, 12.2.4.2.3	Local Knowledge confirmed and verified information for the assessment of Community Well-being, including: • factors that influence migration decisions include access to employment, income, and education; • concerns of family members and community members working for a resource development project being taken out of community for periods at a time (such as commuter rotation); • the benefits of resource development projects on the local economy including increased income and employment opportunities; and • concern for the potential adverse effects from increased income on workers, their families, and communities such as those related to drug and alcohol use and addictions.	KPI Program 2021-2022

Discipline	Aspect Influenced	Section(s)	How Local Knowledge was Incorporated	Sources of Local Knowledge
	Mitigation	12.2.5	Local Knowledge informed and enhanced mitigations for Community Well-being, including the need for pick-up points to reduce hardship on employees and a no alcohol and drug policy on site.	(Informed through existing environment and assessment) KPI Program 2021-2022
Infrastructure and Services	Existing Environment	12.3.3.2.1, 12.3.3.3.1	Local Knowledge verified and confirmed information for the existing environment, including: highway descriptions (Highway 914 and 165) and Key Lake gatehouse access.	KPI Program 2021-2022
	Assessment	12.3.4.2.1, 12.3.4.2.2	Local Knowledge verified and confirmed the understanding of individuals and communities' key interests and concerns related to Project truck traffic and community infrastructure and services, including an understanding of social services and health services gaps for Beauval and Pinehouse Lake.	KPI Program 2021-2022 Lease Survey
Economy	Existing Environment	13.2.3	Local Knowledge, through an ERFN Trapper, confirmed and verified information for the existing environment, including information on the traditional economy in and near the LSA, such as wildlife and fish species population and distribution and hunting, fishing, and trapping.	ERFN Trapper
	Assessment	13.3.2	Local Knowledge, through an ERFN Trapper, verified and enhanced information on the traditional economy in and near the LSA.	ERFN Trapper

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Appendix 3-A Ya'thi Néné Report: *An Exploration of Recorded Athabasca Denesųłiné Traditional Knowledge, Land Use, and Occupancy Information in the Vicinity of Denison Mines Wheeler River Project*

See file "S3_App 3-A Ya'thi Néné Report_Wheeler River.pdf"

Denison Mines

Wheeler River Project

Final Environmental Impact Statement

November 2024

Powering
PEOPLE, PARTNERSHIPS AND PASSION.

Wheeler River Project

Final Environmental Impact Statement

Section 4 – Engagement

November 2024

Denison Mines

Denison Mines Corp.

345 4th Avenue South

Saskatoon, SK, S7K 1N3

Roadmap

This roadmap of the Wheeler River Project Environmental Impact Statement (EIS) has been provided to summarize the main document sections and appendices of the EIS.

Wheeler River Project
Environmental Impact Statement

Executive Summary (English, French, Cree, Dene)

PART I: INTRODUCTION AND CONTEXT	PART II: BIOPHYSICAL ENVIRONMENTAL ASSESSMENTS	PART III: HUMAN ENVIRONMENT ASSESSMENTS	PART IV: INTEGRATED TOPICS AND SUMMARY
Section 1: Project Introduction and Overview	Section 6: Atmospheric and Acoustic Environment	Section 10: Human Health	Section 14: Accidents and Malfunctions
Section 2: Project Description	Section 7: Geology and Groundwater	Section 11: Land and Resource Use	Section 15: Effects of the Environment on the Project
Section 3: Indigenous and Local Knowledge	Section 8: Aquatic Environment	Section 12: Quality of Life	Section 16: Assessment Summary and Conclusions
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Abbreviations, Acronyms, and Units

Abbreviation / Acronym	Definition
ALBML	A La Baie Métis Local #21
BNDN	Birch Narrows Dene Nation
BRDN	Buffalo River Dene Nation
CEAA 2012	*Canadian Environmental Assessment Act, 2012*
CNSC	Canadian Nuclear Safety Commission
COI	Communities of Interest
Denison	Denison Mines Corp.
EA	Environmental Assessment
EIS	Environmental Impact Statement
ERFN	English River First Nation
IER	Indigenous Engagement Report
IK	Indigenous Knowledge
IPP	Indigenous Peoples Policy
ISR	In situ recovery
KML	Kineepik Métis Local #9
LK	Local Knowledge
LLRIB	Lac La Ronge Indian Band
MLTC	Meadow Lake Tribal Council
MN-S	Métis Nation – Saskatchewan
MOU	Memorandum of Understanding
NAD	Northern Administration District
NVB	Northern Village of Beauval
NVILX	Northern Village of Île-à-la Crosse
NVP	Northern Village of Pinehouse
PAGC	Prince Albert Grand Council
PML	Patuanak Métis Local #82
PBCN	Peter Ballantyne Cree Nation
Project	Wheeler River Project
RAP	Reconciliation Action Plan
SK MOE	Saskatchewan Ministry of Environment
SML	Sipishik Métis Local #37
SVS	Shared Value Solutions
TK	Traditional Knowledge
UMMD	Uranium Mines and Mills Division
VC	Valued Component
YNLR	Ya'thi Néné Lands and Resource Office

Units	Definition
ha	hectare
km	kilometre
m	metre

Glossary

Term	Definition
Duty to Consult	First Nations, Inuit and Métis peoples in Canada have unique rights that are guaranteed under section 35 of the Constitution Act, 1982. Section 35 recognizes and affirms the existing Aboriginal and treaty rights of Indigenous peoples. As a way to protect these rights, the doctrine of the duty to consult and, where appropriate, accommodate Indigenous groups, was developed by Canadian courts.
Indigenous Community of Interest	A community whose traditional land or potential or established Aboriginal and/ or Treaty rights are in proximity to the Project or has existing transportation infrastructure that would be used by the Project. An Indigenous Community of Interest is more likely to experience impacts from the Project.
Indigenous Community	An Indigenous community with a potential interest in the Project, including any Indigenous community identified by a Regulatory Agency as having a potential interest in the Project.
Indigenous Knowledge	Indigenous Knowledge is also known as Aboriginal Traditional Knowledge and Traditional Ecological Knowledge. Generally, Aboriginal Traditional Knowledge is considered as a body of knowledge built up by a group of people through generations of living in close contact with nature. Aboriginal Traditional Knowledge is cumulative and dynamic. It builds upon the historic experiences of a people and adapts to social, economic, environmental, spiritual and political change.
Indigenous Organization	An operation or organization that is owned and/or operated by an Indigenous Community or group of Indigenous Communities or has been delegated the right to represent an Indigenous Community or group of Indigenous Communities in connection with the Project.
Indigenous People	Section 35 of the *Constitution Act, 1867* defines the term “Aboriginal peoples of Canada” as referring to the First Nation, Inuit and Métis peoples of Canada. The term “Indigenous” is used interchangeably with “Aboriginal”.
Interested Party	Any person or organization that can affect, be affected by, perceive itself to be affected by, or is interested in a decision or activity related to the Project.
Local Knowledge	Specialized knowledge developed through long-term association, interaction, and cumulative experience.
Non-Indigenous Community of Interest	A municipality or other non-Indigenous community located near the existing transportation infrastructure utilized by the Project. A Non-Indigenous COI may experience efforts by Denison to offer employment, training, and business opportunities in connection with the Project and therefore may experience positive socioeconomic impacts as a result of the Project.
Northern Saskatchewan Administration District	The Northern Saskatchewan Administration District is defined in the province of Saskatchewan’s *Northern Municipalities Act, 2010.* The Northern Saskatchewan Administration District includes approximately 250,000 square kilometres (about 44% of Saskatchewan’s land area) but is home to only 38,000 people or less than 4% of the province’s population. Residents of the Northern Saskatchewan Administration District live in over 40 communities, which include incorporated municipalities (towns, villages, hamlets and settlements – most of which self-identify as Métis communities), First Nation reserves, and unincorporated areas. More than 80% of people who live in the Northern Saskatchewan Administration District self-identify as Indigenous.
Valued Components	Valued Components are aspects of the biophysical and human environments that may be affected (adversely or positively) by the Project. The value of a component not only relates to its role in the environment, but also the value people place on it.

4 Engagement

4.1 Introduction

Denison Mines Corp. (Denison) understands the importance of engaging with Indigenous communities and organizations, the general public, and regulatory agencies, collectively referred to as Interested Parties. Since 2016, Denison has engaged with Interested Parties to develop meaningful relationships so a collaborative approach to the Wheeler River Project (the Project) can take place. Denison has developed and implemented a Project engagement plan to guide and structure engagement activities. This section will describe the engagement requirements and activities undertaken by Denison regarding the Project up to January 2024. The activities have been designed to comply with regulatory requirements detailed in Section 4.1.1.

4.1.1 Regulatory Context

The Project is subject to both federal and provincial Environmental Assessment (EA) processes under the *Canadian Environmental Assessment Act, 2012* (CEAA 2012; Government of Canada 2019) and *The Environmental Assessment Act* (Government of Saskatchewan 2018). Requirements for engagement under each regulatory process include the following guidance documentation:

- Canadian Nuclear Safety Commission (CNSC) requirements (under CEAA 2012 assessment):
  - P*ublic and Indigenous Engagement – Public Information and Disclosure* (CNSC 2018). Licensees and licence applicants of uranium mines and mills, Class I and applicable Class II nuclear facilities shall develop and implement a public information program that includes a disclosure protocol. The public information program and its disclosure protocol shall be commensurate with the public's perception of risk and the level of public interest in the licensed activities, which may be influenced by the complexity of the nuclear facility's lifecycle and activities, and the risks to public health and safety and the environment perceived to be associated with the facility and activities.
  - *Public and Indigenous Engagement – Indigenous Engagement* (CNSC 2022). The CNSC identifies requirements for CNSC licensees, with respect to Indigenous engagement. It also provides guidance and information on conducting Indigenous engagement activities. The CNSC has the responsibility for fulfilling its legal duty to consult, and where appropriate, accommodate Indigenous peoples when its decisions may have an effect on potential or established Indigenous and/or treaty rights. This includes the requirement to complete an Indigenous Engagement Report (IER). This report must include a list of Indigenous groups identified for engagement, summary of engagement activities conducted to date, a description of planned Indigenous engagement activities, and a proposed schedule for reporting to the CNSC.

  - *Guidance on Indigenous Engagement for Proposed Projects undergoing Environmental Assessments under CEAA 2012* (CNSC 2021). The guidance document is intended to assist the proponent in preparing Indigenous documentation that will satisfy CNSC's requirements for undergoing an EA under CEAA 2012. The document includes a description of what is expected in the Environmental Impact Statement (EIS) and the IER, CNSC's requirements for the key steps in the EA process (draft and final EIS submissions), and details on how the proponent must demonstrate they have conducted adequate or complete Indigenous engagement (including instructions related to engagement methods, topics, and recording of Indigenous engagement (i.e., a record of engagement and a summary of issues and concerns by Indigenous groups).
  - *Generic Guidelines for the Preparation of an Environmental Impact Statement, pursuant to the CEAA 2012* (CNSC 2016). These guidelines summarize the requirements of CEAA 2012 for public participation and Indigenous engagement. The purpose of these guidelines is to ensure opportunities for meaningful public and Indigenous peoples participation during an EA and to provide the public and Indigenous peoples with opportunities to participate in the EA. Meaningful public and Indigenous participation is best achieved when all parties have a clear understanding of the proposed project as early as possible in the review process. The proponent is required to provide current information about the project to the public and Indigenous peoples and especially to the communities likely to be most affected by the project (CNSC 2016).
- Saskatchewan requirements:
  - *First Nation and Métis Consultation Policy Framework* (Government of Saskatchewan 2010). The Government of Saskatchewan's Duty to Consult Policy states that consultation with First Nations and rights-bearing Métis communities is required prior to any decisions that may affect Treaty Rights, Aboriginal Rights, and traditional uses of land and resources. The Duty to Consult Policy is in place to advance reconciliation and promote certainty for Saskatchewan residents, including First Nations and Métis.
  - Proponent's Guide: Consultation with First Nations and Métis in Saskatchewan Environmental Impact Assessment – Guidelines for Engaging and Consulting with First Nations and Métis Communities in Relation to Environmental Assessment in Saskatchewan (Government of Saskatchewan 2014). This document provides direction for project proponents on the Ministry of Environment's requirements for consultation with First Nations and Métis is outlined in this Government of Saskatchewan's Proponents Guide. Engagement must be carried out by the proponent during all stages of the EA. The Duty to Consult process aims to make sure all pertinent information received during engagement activities will be incorporated in the EA, the engagement process is well-documented for the Ministry to assess if the proponent fulfilled engagement requirements, and any potential

effects to Indigenous rights and traditional uses and resources have been documented and mitigated as to the best of the proponent's abilities.

- *Proponent Handbook – Voluntary Engagement with First Nations and Métis Communities to Inform Government's Duty to Consult Process* (Government of Saskatchewan 2013). The Government of Saskatchewan has a Duty to Consult with First Nations and Métis communities when there is a possibility of effects to Treaty and Aboriginal rights, or Traditional uses of lands and resources, resulting from a decision or action.
- *Guidelines for the Terms of Reference and Environmental Impacts Statement* (Government of Saskatchewan 2021). This guideline provides information to assist proponents in developing a term of reference and EIS for a proposed project determined to be a development pursuant to Section 2(d) of *The Environmental Assessment Act* (Government of Saskatchewan 2018). The guidelines outline the staged process a proponent must follow, general EIS requirements, advice on confidentiality, and how the province and federal governments cooperate in the EA process. Template guides are provided for the terms of reference and the EIS, including information related to engagement.

4.1.2 Denison's Indigenous Peoples Policy and Investment and Sustainability Philosophy

In 2021, Denison announced the adoption of an Indigenous Peoples Policy (IPP). The IPP reflects Denison's recognition of the important role of Canadian business in the process of reconciliation with Indigenous peoples in Canada and outlines Denison's commitment to take action towards advancing reconciliation. The IPP was developed based on Denison's experiences with, as well as feedback and guidance received from, Indigenous communities with whom Denison is actively engaged. This approach was designed to make sure the IPP appropriately captures a mutual vision for reconciliation. The IPP identifies five key areas of action that will support the ongoing development of a continuously evolving Reconciliation Action Plan (RAP): Engagement; Empowerment; Environment; Employment; and Education. Through the RAP, Denison is striving to interweave the principles of reconciliation throughout all areas of the company's operations (Denison 2021a).

Development of the Project will require significant capital expenditures and will represent a considerable investment. Similar to other mine sites, the development of the Project will carry significant risks (including technical and non-technical risks). During the evaluation and assessment phase, Denison will evaluate these risks, amongst others, and determine the extent to which the Project justifies the required capital investment. Denison will always weigh the investment risks related to its ability to generate a competitive economic return for its shareholders.

Denison is committed to operating the Project in a fully sustainable manner, considering not only the maintenance of high standards of safety and environmental compliance, but also financial discipline. Denison envisions a project that provides maximal benefits to employees, potentially affected communities, business partners, and Denison shareholders. This commitment will require the partnership and support of all parties with interests in, or related to, the Project.

4.2 Engagement Approach

Denison understands the importance of engaging with local and Indigenous communities, residents, businesses, organizations, land users and the various regulatory authorities. Since 2016, Denison has been engaging with Interested Parties to support the development of positive relationships and a mutual commitment to collaboration. Interested Parties are further categorized into three broad groups, each with several sub-categories (more fully described in Sections 4.3 and 4.4):

- Indigenous Groups
  - Indigenous Communities of Interest (COI)
  - Other Indigenous Communities
  - Indigenous Organizations
- General Public
  - Non-Indigenous COI
  - Other Non-Indigenous Communities
  - Nearby Land Users
  - Organizations
- Regulatory Agencies

A list of the Interested Parties for the Project can be found in Figure 4.2-1.

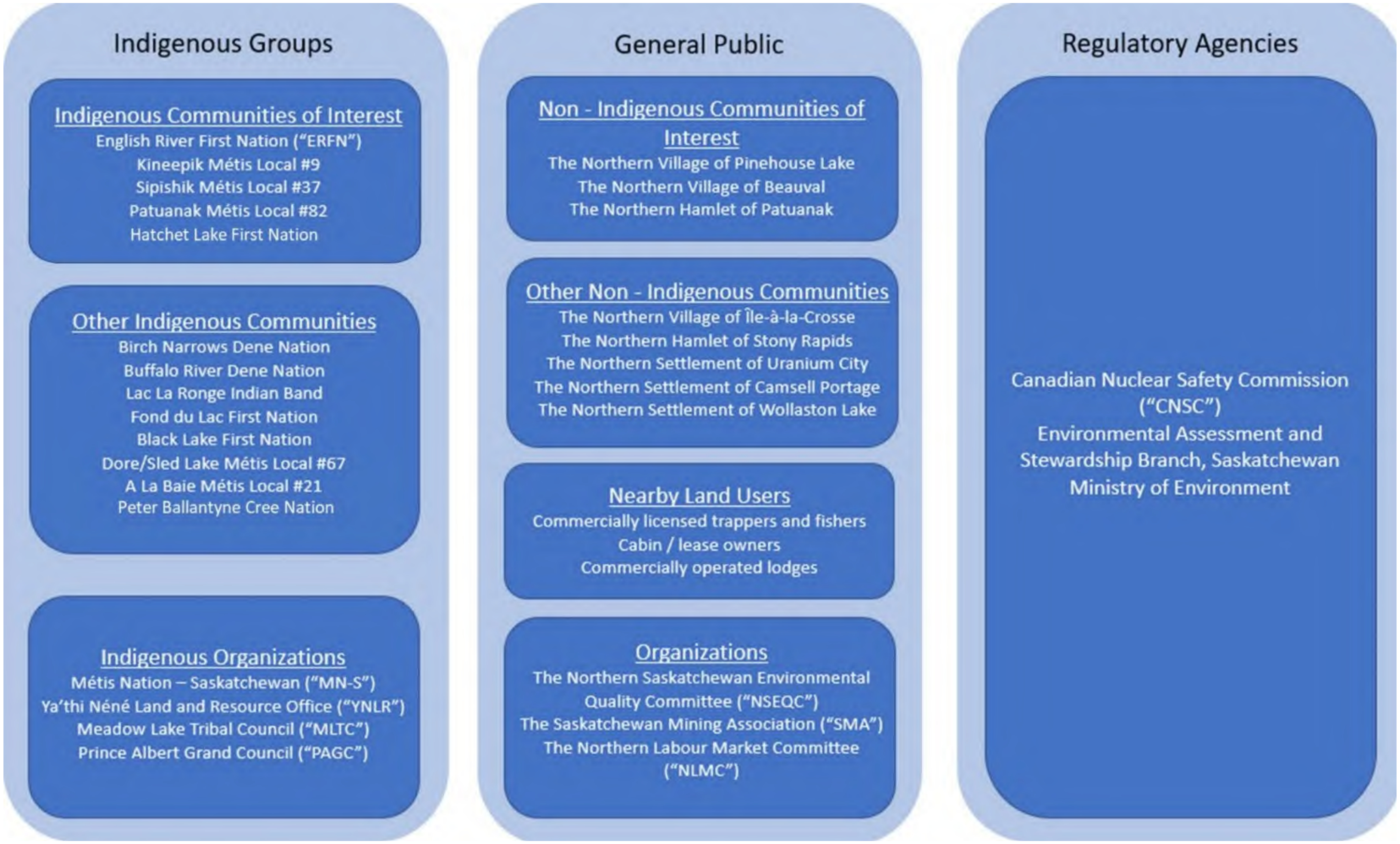

Figure 4.2-1: Interested Parties for the Project[1,2]

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[1] The MN-S holds the delegated Duty to Consult for Dore/Sled Lake Métis Local #67 and A La Baie Métis Local # 21, SML, and PML.

[2] Engagement activities with the Athabasca Basin First Nations and Communities (Fond du Lac, Black Lake, Hatchet Lake, Stony Rapids, Camsell Portage, Uranium City and Wollaston Lake) occur through YNLR.

Denison's engagement activities with Interested Parties have been designed to meet their expectations while complying with both federal and provincial regulatory legislation. Engagement is defined as the sharing and gathering of project-related information from Interested Parties, and the collaboration with Interested Parties in a good faith effort with the goal of developing mutually acceptable resolutions to issues identified. The development of relationships with Interested Parties is a fundamental determinant of the Project's success. Denison has outlined the following key principles to develop positive relationships through engaging with Interested Parties:

1. Conduct engagement in a variety of ways, venues, and make every effort to identify and include all Interested Parties using an iterative process.
2. Undertake the development of a relationship between Denison and the Interested Party.
3. Provide meaningful and relevant information about the Project in a culturally appropriate format and language that is easily understood by each specific group – which respects local traditions, timeframes, and the decision-making processes of each entity.
4. Based on information shared between Denison and the Interested Party, seek information about their interests; listen to the information shared; and aim to understand their perspectives and priorities.
5. Consider how the interests of Interested Parties interact with Denison's and the Project.
6. Integrate the perspectives and interests of Interested Parties in decision-making about the Project, where appropriate, including the process for assessing the Project.
7. Where concerns are raised about the process, the Project, or its potential effects, collaborate with Interested Parties in developing potential solutions to those concerns.
8. Where necessary, adjust the initial plans for the Project to reduce potential effects and accommodate Rights and interests.
9. Make active and good-faith efforts to resolve all material issues in the above-identified fashion.
10. Commence development of the Project (if appropriate and permitted) in a manner that respects interests.

Denison has further identified key objectives respecting Indigenous engagement associated with the Project:

- Build and maintain authentic relationships based on a foundation of trust, good faith, and transparency.
- Create a respectful dialogue process that promotes communication and collaboration among Denison and Indigenous communities, in a timely and accurate fashion.
- Understand how the proposed development of the Project may affect the interests of Indigenous peoples (including Indigenous and/or Treaty Rights), and work with Indigenous

peoples to avoid, mitigate, or otherwise address effects, while also collaborating to maximize potential positive effects.

Engagement activities for the Project can and will evolve over time, as information is gathered that is pertinent to Denison's understanding of the Interested Parties and their relationship to, and interest in, the Project.

4.2.1 Engagement Methods

Denison has applied a variety of methods to support engagement activities throughout the engagement process and used different methods with various groups depending on requirements and preferences of the process. Engagement methods have included in-person, remote (audio only, virtual, and digital), and print. These methods were aligned with key Project phases:

- pre-Project description (April 2016 to May 2019);
- post-Project description (July 2019 to October 2022);
- environmental assessment outcomes and relationship to licensing/approvals (October 2022 to January 2024) and
- future activities (following final EIS submission).

Engagement methods were reviewed in March 2020 in response to the initial wave of the COVID-19 pandemic. Activities that included direct in-person interaction, such as site visits, were not possible in 2020 and 2021 and necessitated a shift to remote-style engagement methods.

Workshops/Information Sessions: Denison hosted these types of engagement on the overall Project and the EA. Topics included general Project information, potential effects associated with Project activities, alternatives/options assessment, identification of Valued Components (VCs), preliminary effects assessment, and mitigation.

Site Visits: Denison coordinated and hosted site visits at the Project location (generally in the summer months).

Meetings: Various types of meetings, with Indigenous and non-Indigenous members, were held to learn about the Project, meet Denison and its team, and provide an opportunity to ask questions. Meetings with leadership of Indigenous and non-Indigenous communities also occurred. The purpose of the various meetings was to provide opportunities for sharing of information and to solicit feedback.

Virtual Meetings/Presentations: Denison adapted to the COVID-19 pandemic by hosting virtual community meetings and/or presentations.

Presentations: Denison made presentations to various groups and organizations to share information and seek feedback.

Letters: These were distributed at key junctures in the process to inform recipients of pertinent Project information and the EA process (including identifying what stage the Project was at).

Project Website: Denison created a Project website to provide ongoing and updated online information about the Project and the EA process, including key milestone events and engagement activities. The Project website provided another avenue for receiving feedback about the Project, including the ability to submit email comments, questions, and information requests directly through the Project website.

Online or Mailed Survey Questionnaire: Due to the COVID-19 pandemic, Denison used an online survey with select key Interested Party groups to receive input on VCs and baseline land and resource user information. Online surveys were advertised to the Indigenous COI and the non-Indigenous COI; a mailed survey was sent to Nearby Land Users.

Supporting Media and Tools: Denison has used local community radio stations, digital and social media, and print media to help reach a variety of audiences.

4.2.2 Engagement Recording

For each of the engagement methods described in Section 4.2.1, any perspectives that were shared by an Interested Party were recorded and consolidated into a single Engagement Database for the Project. Individual comments/questions and responses were recorded and coded into the database by one Denison staff person to provide quality control and continuity.

After this process was completed, the Engagement Database was used to generate unique reports for subject matter specialists to support EA activities. Each comment, question, or statement and response was assigned a unique identification number (e.g., 21-EN-SUR-446.52) so that individual statements could be properly referenced in the assessment documentation. As evidenced throughout the EIS, specific engagement data have been highlighted where the information shared with Denison has been informative to the EA process. This can be seen through the reference to the unique identification number, coupled with supporting materials found in Appendix 4-A.

4.3 Engagement with Indigenous Groups

Denison is committed to conducting meaningful engagement with Indigenous communities and organizations potentially affected by the Project, and to maintain relationships with these communities and organizations throughout all phases of the Project.

The approach to engagement has considered relevant guidance, specifically *Public and Indigenous Engagement – Indigenous Engagement* (CNSC 2022), *Proponent's Guide: Consultation with First Nations and Métis in Saskatchewan Environmental Impact Assessment – Guidelines for Engaging and Consulting with First Nations and Métis Communities in Relation to Environmental Assessment in Saskatchewan* (Government of Saskatchewan 2014), *Considering Aboriginal Traditional*

Knowledge in Environmental Assessments Conducted Under the Canadian Environmental Assessment Act, 2012 (Government of Canada 2015).

The submission of the proposed Project to the Federal and Provincial regulatory agencies to obtain environmental impact assessment approvals has triggered the Crown's Duty to Consult (both Federal and Provincial) with potentially affected Indigenous communities. Denison is committed to supporting the Crown in carrying out its Duty to Consult obligations. Specifically, as directed by the Province of Saskatchewan, Denison has been assigned various procedural aspects of Saskatchewan Ministry of Environment's (SK MOE) consultation process in the development of the EIS. For this Project, the CNSC has not delegated any procedural aspects of the Duty to Consult to Denison (Denison 2022). Denison remains committed to providing CNSC, along with the Province of Saskatchewan, information that may inform the CNSC analysis of its Duty to Consult in connection with the EA process.

Indigenous people's have a unique relationship with the environment, and importantly, Indigenous and Treaty Rights, which must be fully respected during the process of Project development, Construction, Operation, and Decommissioning. To this end, Denison's objectives with respect to Indigenous engagement associated with the Project are as follows:

- build and maintain authentic relationships built on trust and transparency;
- create a respectful dialogue process that promotes communication between Denison and Indigenous communities and organizations, in a timely and accurate fashion; and
- understand how the proposed development of the Project may affect the ability of Indigenous peoples to exercise collective Indigenous/Treaty Rights.

4.3.1 Engagement with Identified Indigenous Communities and Organizations, and Supporting Criteria

The Northern Administration District (NAD) of Saskatchewan (northern Saskatchewan) includes approximately half of Saskatchewan's land area, but less than four per cent of the province's population (Government of Saskatchewan n.d.). Northern Saskatchewan is approximately 250,000 square kilometres, or about 44% of Saskatchewan's area and is home to about 38,000 people (Statistics Canada 2017) living in approximately 45 communities, which include incorporated municipalities (such as towns, villages, hamlets, and settlements), First Nation reserves, and unincorporated areas. More than 80% of people who live in northern Saskatchewan self-identify as Indigenous. Within the NAD, the communities are roughly divided between the three regions: the Athabasca Basin region, the North Central region, and the West Side region. Figure 4.3-1 illustrates where these NAD communities are in relation to the Project. Figure 4.3-2 illustrates where identified Indigenous communities and organizations are located in relation to the Project.

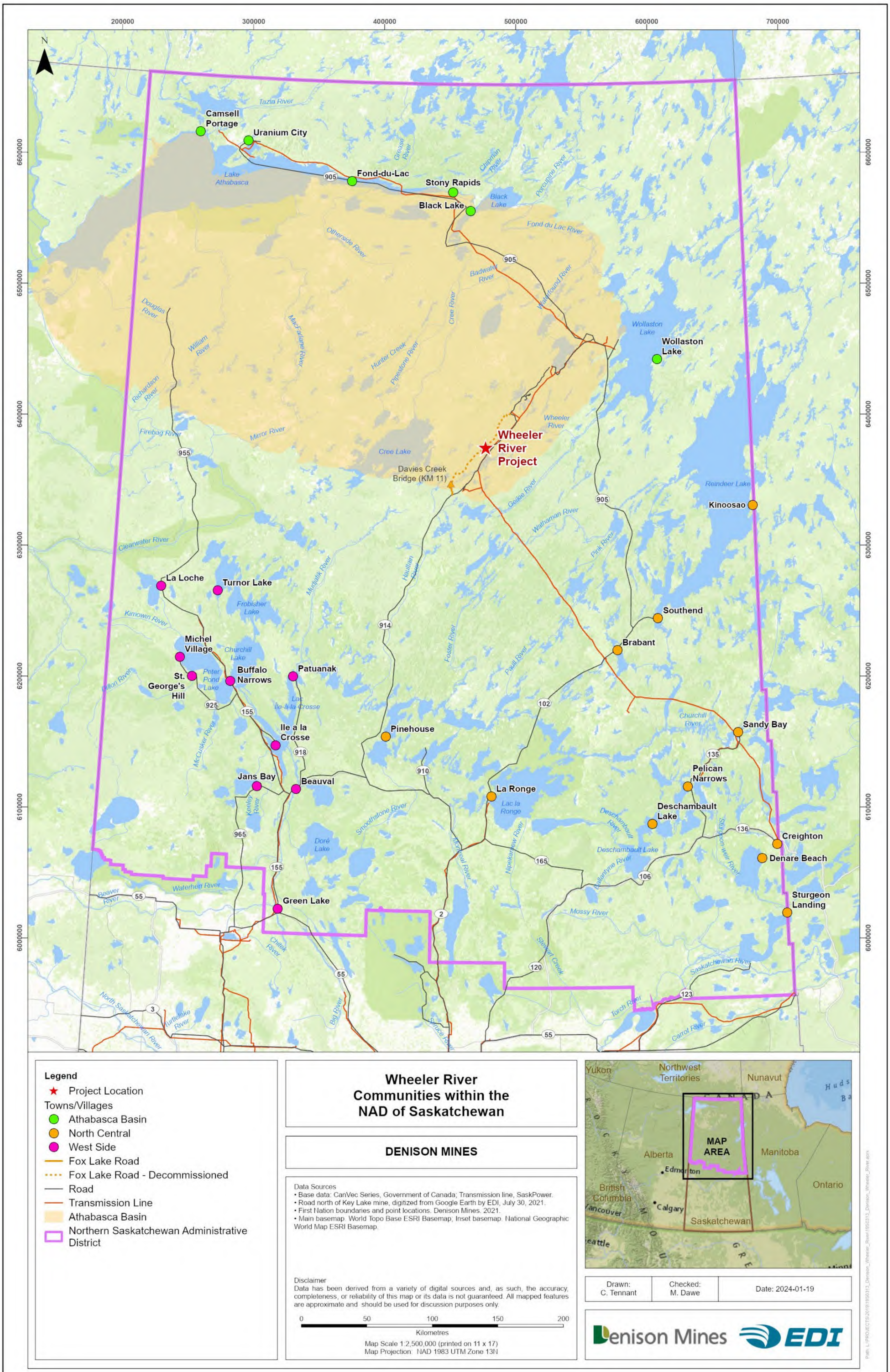

Figure 4.3-1: Communities within the Northern Administration District of Saskatchewan

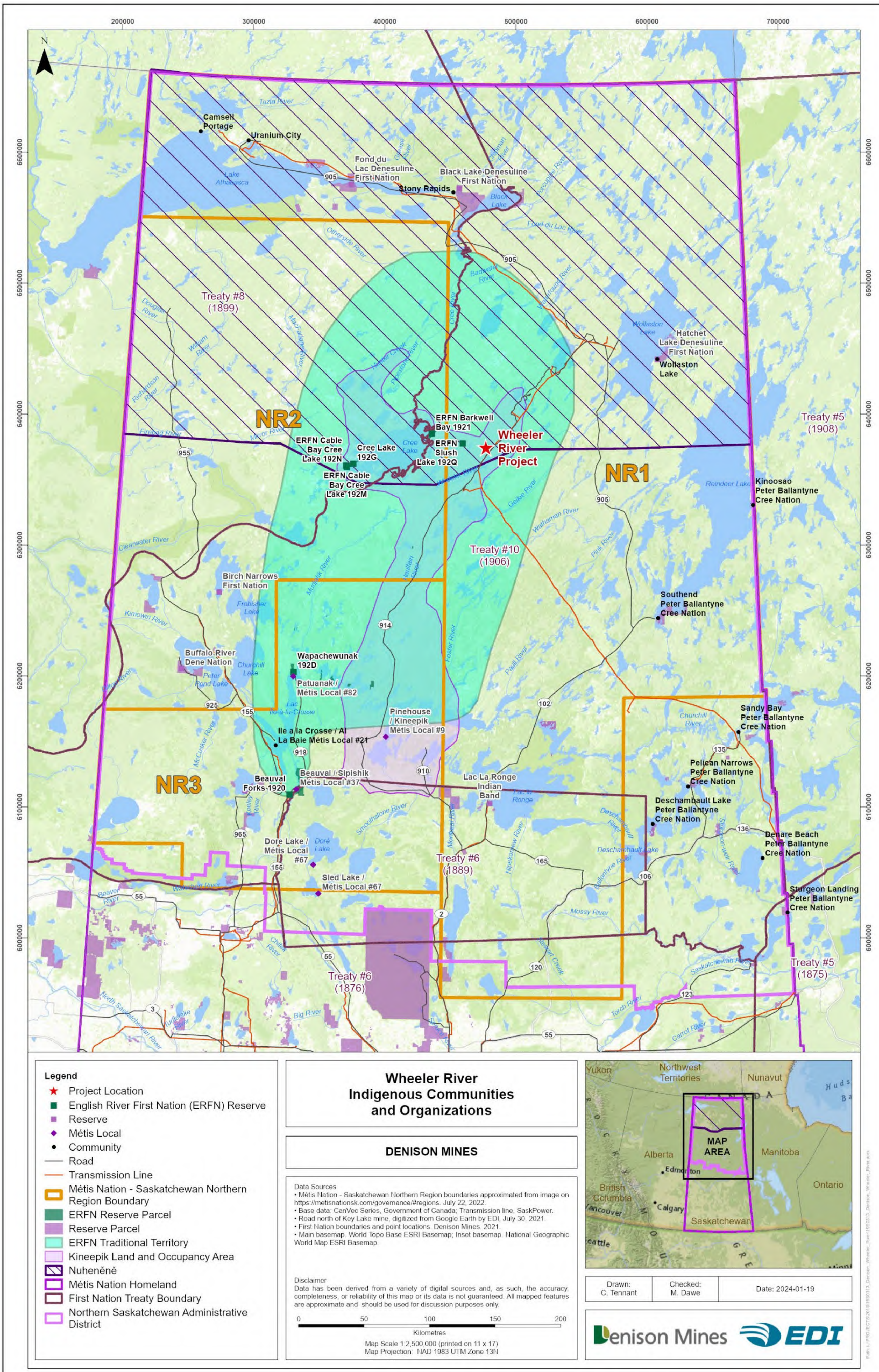

Figure 4.3-2: Identified Indigenous Communities and Organizations in Relation to the Project

Consistent with the history associated with other uranium mining projects located within the NAD, Denison recognizes that many Indigenous communities within the NAD typically have an interest in uranium activities, but that an approach based on appropriate criteria to determine those included in the engagement program is required.

No populated Indigenous communities occur in close proximity to the Project site. Calculated using a straight line, the closest Indigenous communities are approximately 150 km from the site. Travelling by existing roads, the closest Indigenous community to the Project is approximately 260 km away.

The following criteria have been used to appropriately evaluate Indigenous communities located in the NAD that would be engaged by Denison:

- Treaty 10 signatory (Treaty in which the Project is located);
- potential or established Indigenous and/or Treaty Rights within the Project Area;
- geographic proximity of community and/or reserve land to the Project site;
- known traditional territory in and around the Project site;
- history of relationship with operating companies, the CNSC, and the Province in relation to other projects located near the Project (McArthur River, Key Lake, Millennium); and
- the potential for collective exercising of Indigenous and/or Treaty Rights in proximity to the Project.

The results of the initial assessment using these criteria determined that English River First Nation (ERFN), Kineepik Métis Local #9 (KML), the Sipishik Métis Local #37 (SML), and the A La Baie Métis Local #21 (ALBML) would form part of Denison's initial focus for Indigenous engagement activities (see Table 4.3-1). These initial Indigenous groups were discussed with representatives of the SK MOE and the CNSC. The Patuanak Métis Local #82 (PML) was added after those discussions based on further evaluation. As more information has been gained since the onset of engagement activities in 2016 regarding the various traditional land use and areas of occupancy by Indigenous groups around the Project, the list has been modified accordingly, including with respect to the reclassification of ALBML, and the addition of Hatchet Lake First Nation (HLFN). Engagement details with the current four Indigenous COI, as set out below, are included in Section 4.3.2.

Table 4.3-1: Indigenous Communities of Interest and Focus of Engagement Activities

Indigenous Communities of Interest	Brief Description of Rationale Criteria
English River First Nation	• Treaty 10 signatory. • Potential or established Indigenous/Treaty Rights within the Project Area. • Geographic proximity of community and/or reserve land to the Project site (Slush Lake reserve approximately 16 km away; Barkwell Bay reserve 39 km away; community of Patuanak 229 km away in straight line). • Known traditional territory in and around the Project site, including travel routes. • History of relationship with operating companies, the CNSC and the Province in relation to other projects located near the Project (McArthur River, Key Lake, Millennium). • Potential for collective exercising of Indigenous/Treaty Rights in proximity to the Project.
Kineepik Métis Local #9	• Potential or established Indigenous/Treaty Rights within the Project Area. • Geographic proximity of community and/or reserve land to the Project site (233 km away). • Known traditional territory in and around the Project site, including travel routes. • History of relationship with operating companies, the CNSC and the Province in relation to other projects located near the Project (McArthur River, Key Lake, Millennium). • Potential for collective exercising of Indigenous/Treaty Rights in proximity to the Project.
Sipishik Métis Local #37	• Potential or established Indigenous/Treaty Rights within the Project Area. • Known traditional territory in and around the Project site, including travel routes. • Familial ties through the ERFN Membership and La Plonge reserve (immediately adjacent to Beauval). • Potential for collective exercising of Indigenous/Treaty Rights in proximity to the Project.
Patuanak Métis Local #82	• Potential or established Indigenous/Treaty Rights within the Project Area. • Known traditional territory in and around the Project site, including travel routes. • Familial ties through the ERFN Membership and Wapachewunak 192D reserve (immediately adjacent to Patuanak). • Potential for collective exercising of Indigenous/Treaty Rights in proximity to the Project.
Hatchet Lake First Nation	• Treaty 10 signatory. • Potential or established Indigenous/Treaty Rights within the Project Area. • Geographic proximity of community and/or reserve land to the Project site (150 km) • Known traditional territory in and around the Project site. • Potential for collective exercising of Indigenous/Treaty Rights in proximity to the Project.

Denison has recognized other nearby Indigenous communities exist with a potential interest in the Project, including Indigenous communities that have been identified by a Regulatory Agency as having a potential interest in the Project. These Other Indigenous Communities have been identified to include Birch Narrows Dene Nation (BNDN), Buffalo River Dene Nation (BRDN), Lac La Ronge Indian Band (LLRIB), Fond du Lac First Nation, Black Lake First Nation, Dore/Sled Lake Métis Local #67, ALBML, and Peter Ballantyne Cree Nation (PBCN). Engagement details with these nine Other Indigenous Communities are included in Section 4.3.3.

Indigenous Organizations

Indigenous organizations can provide a single point of contact for Denison to share information more broadly to a wide variety of Indigenous communities and their leadership regarding project information, and company information. In many cases, these Indigenous organizations have been delegated the right to represent an Indigenous community or group of Indigenous communities in connection with the Project. These organizations can also provide specific information regarding their members, interests their members may have, and opportunities for Denison to work collaboratively together on various initiatives.

Denison has identified four Indigenous Organizations: the Métis Nation – Saskatchewan (MN-S); Ya'thi Néné Lands and Resource Office (YNLR); Meadow Lake Tribal Council (MLTC); and Prince Albert Grand Council (PAGC).

Métis Nation-Saskatchewan

As the elected government of the Métis people of Saskatchewan, the MN-S plays an important role related to engagement activities. The MN-S is currently structured with a President, an Executive, a Provincial Métis Council, Regional Directors, and Local Presidents.

The Project is located within Métis Northern Region 1 in Saskatchewan. However, several key Métis communities with whom Denison is engaging are located in Métis Northern Region 3.

The MN-S website states that "*consultations must be with the Métis government structures that are elected and supported by the Métis people*." (MN-S n.d.c.)

Engagement with MN-S is captured under Section 4.3.4.1.

Ya'thi Néné Lands and Resource Office

The YNLR was created as a not-for-profit organization to be the single point of contact between industry, government and the local Athabasca communities of Hatchet Lake First Nation, Black Lake First Nation, Fond du Lac First Nation, Camsell Portage, Stony Rapids, Uranium City, and Wollaston Post. Hatchet Lake First Nation is a Treaty 10 signatory.

The Project is located within the Nuhenéné (the Athabasca Denesųłiné territory). Engagement with YNLR is captured under Section 4.3.4.2.

Meadow Lake Tribal Council

According to the MLTC website "*the [MLTC] began in 1981 when the First Nations of Northwest Saskatchewan united to form the Meadow Lake District Chiefs Joint Venture. The Meadow Lake District Chiefs became officially known as the Meadow Lake Tribal Council in 1996*" (MLTC n.d.a). Meadow Lake Tribal Council represents nine Cree and Dene nations: BNDN, BRDN, Canoe Lake Cree Nation, Clearwater River Dene Nation, ERFN, Flying Dust First Nation, Makwa Sahgaiehcan First Nation, Ministikwan Lake Cree Nation, and Waterhen Lake First Nation. Meadow Lake Tribal

Council is an advocate for program delivery and services in the nine participating Nations. The Indigenous communities that overlap with the Project and are members of MLTC are BNDN, BRDN, and ERFN. Engagement with MLTC is captured under Section 4.3.4.3.

Prince Albert Grand Council

According to the Prince Albert Grand Council (PAGC) website, the Grand Council's history dates back to the 1960s when "*the twelve Chiefs of the Prince Albert District formed a political alliance, to collectively work together on common issues, which was formalized under the Charter of the Federation of Saskatchewan Indians*" (PAGC n.d.) In 1993, the name was changed to PAGC. The 12 Nations that make up PAGC are: Black Lake Denesuline Nation, Cumberland House, Fond du Lac First Nation, Hatchet Lake First Nation, James Smith Cree Nation, LLRIB, Montreal Lake Cree Nation, Peter Ballantyne Cree Nation, Red Earth Cree Nation, Shoal Lake Cree Nation, Sturgeon Lake First Nation, and Wahpetan Dakota Nation. The Indigenous communities that overlap with the Project and are members of PAGC include Black Lake Denesuline Nation, Fond du Lac First Nation, Hatchet Lake First Nation, and LLRIB. Engagement with PAGC is captured under Section 4.3.4.3.

4.3.2 Engagement with Indigenous Communities of Interest

As described in Section 4.3.1, the Indigenous COI were determined to be:

- English River First Nation;
- Kineepik Métis Local #9;
- Sipishik Métis Local #37;
- Patuanak Métis Local #82; and
- Hatchet Lake First Nation.

4.3.2.1 Engagement with English River First Nation

English River First Nation is a Denesųłiné community with ancestral lands (*nuhtsiyw-kwi-Benéne*) stretching from the Churchill River to Wapata Lake in northern Saskatchewan.

> "*The ERFN name originates from the English River area, which was inhabited by the Poplar House people for periods during the year. Most of the families that now live at the Wapachewunak Reserve traditionally lived along the Churchill River system at Primeau Lake, Knee Lake, Dipper Lake and/or Cree Lake to the north (Canada North Environmental Services, 2017). Summers were spent primarily fishing along the river system. For the rest of the year, family units would spread out through the northern forests for trapping and subsistence hunting. Commonly used winter trapping areas included Haultain Lake, Costigan Lake, Foster Lake, and the area between Cree Lake and the Churchill River (Jarvenpa, 1980).*" (ERFN and SVS 2022a)

English River First Nation is a signatory to Treaty 10. English River First Nation's reserves are approximately 16 km from the Project (Slush Lake reserve); 39 km from the Project (Barkwell Bay reserve); and 229 km away (Wapachuanak Reserve, the main residential reserve for ERFN). The ERFN also has a reserve at La Plonge.

Figure 4.3-2 illustrates where communities are in relation to the Project, both in terms of direct linear distance and travel distance.

4.3.2.1.1 History of Interactions

Since 2016, Denison has engaged with members of the ERFN in various ways. A comprehensive listing of engagement activities between Denison and ERFN, including a brief description of the purpose or activity and outcome where appropriate, is included in the IER.

4.3.2.1.2 Agreements Relative to the Environmental Assessment Process

To formalize Denison's commitment to ERFN, a Memorandum of Understanding (MOU) was signed between Denison and ERFN in 2018. This non-binding MOU formalized the intent to work together in a spirit of mutual respect to cooperate to collectively identify practical means by which to avoid, mitigate, or otherwise address potential effects of the Project upon the exercise of Indigenous Rights, Treaty Rights, and interests.

In 2021, Denison and ERFN built upon the 2018 MOU and signed a Participation and Funding Agreement and Letter of Intent, which outlined a mutually agreeable framework and applicable funding arrangements to facilitate ERFN's participation and engagement in the EA process for the Project—including ERFN's contribution to Denison's understanding of the Project in a holistic way that respected ERFN's rights and interests (Denison 2021b). As a result, several additional activities have been undertaken between ERFN and Denison, which are further described in Section 4.3.2.1.3.

In 2023, ERFN and Denison concluded an Agreement in respect of the Project that provides, among other matters, various procedural and substantive commitments by Denison to ERFN and the support and consent of ERFN for the development and operation of the Project in a sustainable manner which respects ERFN's inherent, Aboriginal and Treaty rights, advances reconciliation with Indigenous peoples, and provides economic opportunities and other benefits to ERFN.

4.3.2.1.3 Key Engagement Activities

During the engagement activities undertaken with ERFN, several key engagement activities have played a significant role in relation to the EA process. The main forms of engagement included meetings with Chief and Council, community meetings, a workshop on early infrastructure options (2018), a site visit (2019), virtual presentations and meetings on VCs (2021), two online surveys (2021 and 2022), and a meeting and information session on preliminary effects and mitigation (2022). Also in 2021, Denison met with the newly formed ERFN's Nuhtsiye-kwi Benéne (Ancestral Lands Committee) for specific input into the Project. As noted in Section 4.2.1, due to the COVID-19 pandemic, engagement switched to virtual meetings in 2021. In mid-2022, appropriate engagement activities moved back to in-person.

The following text describes several the key engagement activities in more detail. These key engagement activities were supported by ongoing engagement methods including, but not limited to, those outlined in Section 4.2.1.

Engagement Focus: Pre-Project Description - April 2016 to May 2019

Introductory Meeting – July 7, 2016: This was the inaugural meeting between members of the senior management team of Denison and the Chief of ERFN. General discussion occurred pertaining to direct employment, business opportunities, and overall planning for a meeting to occur in the community of Patuanak, for later in the month. For more specifics about this activity, please see Appendix 4-A, ROC #99.

Introductory Meeting – July 27, 2016: This was the inaugural meeting between the senior management team of Denison and ERFN Members of Wapachewunak. About 30 Members were in attendance, along with the Chief and several ERFN Councillors. Much of the meeting focussed on clarifying the nature of Denison's activities, including the Project, the interest in an agreement for the Nation in relation to any project, the interest in employment and business opportunities, the interest in protection of the environment from exploration and Project activities, questions in relation to the nuclear industry in general, and the general sharing of information pertaining to knowledge of land and wildlife in and around the Project. For more specifics about this activity, please see Appendix 4-A, ROC #100.

Workshop – May 3, 2018: In collaboration with the Chief of ERFN, Denison hosted a workshop with several individuals representing a variety of entities within ERFN Patuanak. The focus of this engagement activity was to obtain feedback on three alternatives/options for the proposed Project: the road alignment from Highway 914 into the Project Area; the potential treated effluent discharge location; and the mining method options. The meeting had been rescheduled several times and the attendance was minimal. The Chief attended this meeting. General questions were asked regarding the various alternatives and options, and points of clarification pertaining to aspects of the Project. Please See Section 2 Project Description for more details. For more specifics about this activity, please see Appendix 4-A, ROC #5.

Engagement Focus: Post-Project Description – July 2019 to October 2022

The focus of this engagement activity was to provide an in-field opportunity to understand the proposed Project and the various elements associated with the Project.

In August 2019, Denison hosted a site tour at the Project location over two separate days. Day one was a tour comprising a wide variety of Interested Parties, and included an ERFN Member. Day two was a tour with the ERFN Chief, Elders and a local ERFN Trapper. The tour involved an initial presentation regarding the Project, followed by travel around the Project site to the various locations for the proposed elements of the Project. During these site visits, ERFN commented on or queried about:

- the importance of Denison respecting their traditional territory and making sure benefits flow to ERFN;
- the proposed in situ recovery (ISR) mining method (pressures, makeup of mining solution);
- the proposed freezing method (potential concern to groundwater, understanding of the drilling process);
- the important of working with ERFN harvesters and land users;
- the nature of the 2019 in-field test;
- effects of the proposed Project on air emissions; and
- reclamation activities.

For additional details about this activity, please see Appendix 4-A, ROC#1 and ROC #140.

Engagement efforts were temporarily suspended in March 2020 as a result of the COVID-19 pandemic. As noted in Section 4.2.1, due to the COVID-19 pandemic, engagement switched to virtual meetings in 2021. In mid-2022, appropriate engagement activities moved back to in-person.

Meetings - March 31, 2021: Denison hosted three virtual meetings with ERFN including with Chief and Council, with the St. Louis School (high school students), as well as a virtual meeting for ERFN Members living on the Patuanak reserve, La Plonge reserve and urban members.

The focus of these engagement activities was to provide information about the Project to the ERFN members, present a preliminary list of VCs that Denison had identified as part of the EA process, and provide an opportunity for members to provide feedback on the proposed list of VCs, and ask questions about Project components of interest or concern to them. For more specifics about these activities, please see Appendix 4-A, ROC #447, 448 & 456.

The virtual meeting was advertised on the radio and social media, and posters were placed in community buildings. The Zoom platform was used for the meeting, which was also broadcasted live through the La Plonge radio station (93.1FM). At least 24 Zoom accounts were used to attend the presentation, although it is possible that more than one person viewed the presentation from each account.

The ERFN Members meeting was held live on March 31, 2021, by Zoom. Topics covered during the presentation include the following:

- Denison company introduction and key staff members;
- introduction to regulators;
- location of the Project;

- ISR mining at the Project, including the recent change in the Project design from freeze dome technology to a freeze wall containment method;
- employment opportunities;
- EA; and
- VCs.

Meeting participants were encouraged to complete Denison's online survey in relation to the VCs considered important to ERFN Members. Following the presentation, Denison answered questions submitted through the online chat function.

Key themes that emerged from the questions posed at the ERFN meetings, which indicated either interests or concerns, are summarized below:

- Participants wanted to understand more about the ISR mining method, how it is different from other mines in the area, if this method creates tailings or other wastes, how the freeze wall works, what happens to the mining solution, and the potential effects of this method on the environment.
- Questions were also asked about the reclamation process at the Project, such as what would happen to the mining cavity and the wells once mining was completed.
- Participants wanted to know more about potential effects to the environment including effects to wildlife; effects specifically to moose and caribou populations during Construction of the mine; reclamation of the mine; issues surrounding potential contamination and clean-up; and effects to groundwater and surface water near the Project.
- Participants wanted to know if they would be able to view the EIS before the public hearings start.
- Participants asked questions about hiring practices, specifically if local companies and community members be given priority for contracts and employment.
- Questions were also asked about training; would Denison pay for training for specific jobs and would this training be transferrable to other jobs?
- Several participants raised concerns about the use of online engagement. They explained that engaging with Elders was very important and that engaging through technology is hard for some members, especially without a translator.
- Participants wanted to know what kind of benefits the community would receive from the Project, specifically collaboration agreements.
- Questions were asked about access to the land around the Project and statements were made regarding the importance that those who use land for traditional purposes continue to be able to pursue this.

Denison provided a report back to ERFN regarding what was heard by Denison during the engagement activities. This report was shared in hard copy form (sent to the ERFN Patuanak and La Plonge offices), shared with ERFN for posting to an ERFN website, posted on the Denison website (www.wheelerriverproject.ca), and a video was made by Denison for those who prefer oral communications, also on the Denison website. For additional details about this activity, please see Appendix 4-A, #447.

Online Survey**:** During and following the ERFN meeting(s), members were invited to provide feedback on VCs through an online survey. The purpose of the survey was to seek feedback on the importance of the VCs to members, and identify interests or concerns related to the Project, providing an additional mean by which feedback could be provided to Denison. Members who were unable to attend the presentation were also encouraged to provide feedback through the survey. The survey was marketed to members using Facebook and radio advertisements.

The survey was open for feedback from March 31 to April 9, 2021, for 10 days. A total of 23 responses were received, and 20 of these were considered complete, for an 87% rate of survey completion.

The survey included reach and marketing questions about how respondents heard about the survey and if they attended a presentation. This information helped Denison to determine which event marketing efforts were most effective.

The survey also asked respondents to disclose voluntary demographic information, such as age, primary residence, and identity, to help Denison determine if there were large demographic groups whose perspectives were not represented in the results.

Following the reach and marketing and demographic questions, the survey included questions specific to the preliminary list of VCs. These questions were followed by the opportunity for respondents to share their thoughts on opportunities and challenges related to the Project.

Demographics

A total of 21 respondents disclosed their age range. Most survey respondents (76%) were between the ages of 35 and 64, compared to 19% who were between the ages of 16 and 34.

A total of 20 respondents disclosed information about Indigenous identity. The majority (95%) of respondents identified as First Nations. The remaining respondents identified as non-Indigenous (5%). No respondents identified as Métis, or non-status.

A total of 21 participants disclosed where they live for most of the year. Most respondents live in English River (43%), followed by Patuanak (29%), and members who lived in urban areas (14%). The remaining members lived in La Plonge (5%; n=1) and “other” communities (9%; n=2).

Valued Components

A total of 26 interconnected VCs were proposed to respondents. Respondents were asked to select from the list which VCs they felt were important for Denison to research further as part of the EA. A total of 19 respondents identified VCs that were important to them. One respondent indicated that all the VCs were both important and not important to them. Another respondent had contradictory responses. Such responses were not included in the analysis.

While all 26 VCs were identified as important by at least one respondent, the following were identified as important by more than half of the respondents:

- traditional land and resource use;
- surface water;
- fish;
- groundwater quality;
- air quality;
- employment;
- community well-being;
- vegetation; and
- fish habitat and aquatic plants.

The VCs identified as important by the greatest number of respondents included traditional land and resource use (selected by 72% of respondents) and surface water, which was selected by 67% of respondents.

In response to why they felt the VCs they selected were important, the following themes emerged from the responses received.

- Respondents selected VCs they felt were vital to the well-being of the environment.
- Respondents selected VCs they felt would protect their traditional territory for future generations and would allow their traditional livelihood to continue.
- Others selected VCs related to employment opportunities and explained that there are not many opportunities in northern Saskatchewan.

The theme of protecting the land to allow future generations to continue traditional lifeways stood out as particularly important to respondents.

Six respondents identified VCs they felt were missing from the preliminary list and should be added including:

- knowledge of resource management;

- traditional food;
- consultation;
- the longevity of the land;
- working relationships (particularly between ERFN and Denison); and
- joint ventures.

Traditional food, the longevity of the land (sustainability) and joint ventures were well captured by VCs already considered by Denison. Knowledge of resource management, consultation, and working relationships have been considered by Denison as items to focus on in terms of the relationship between Denison and ERFN and regular information sharing.

The complete list of VCs included in this EIS is available in Section 5.3.1 in Section 5 Approach and Methodology of the Assessment.

Opportunities and Challenges

Respondents were asked, based on what they knew so far about the Project, to share the aspects of the Project that they felt could benefit or work well for the community. A total of 17 people responded to this question.

Some of the unique or specific opportunities mentioned included the following items:

- training opportunities;
- employment opportunities;
- opportunities for local companies (TRON and Des Nedhe);
- the possibility of royalties for the community;
- increased communications (quarterly) would be beneficial to the community, possibly through a community liaison; and
- the potential for community development and a collaborative agreement.

One respondent believed that "*no aspect of the project is beneficial to the community as it will harm the earth.*"

Respondents were then asked what aspects of the Project they felt would be challenging or cause concern for their community. Themes that emerged from the 26 responses received included the following:

- potential effects from ISR mining including the use of acid, and the possibility of residual uranium leaking into the groundwater after the freeze wall has been removed;
- storage and shipping of yellowcake and other harmful substances is a concern;

- the potential effect of the Project on the environment, including on wildlife in the area around the Project;
- potential negative effects to community health;
- concern that Elders are not being consulted as most of the engagement has been through online means and without a translator;
- concerns around long-term effects on the land and the potential for this to negatively affect traditional lifeways; and
- the need for consistent communication and updates to make sure Denison is accountable and is conducting the Project with integrity and respect.

None of these themes stood out as more prevalent than others.

Questions and Comments

Respondents were asked if they had any questions for Denison and if there was anything else they wanted Denison to know related to the Project. Several questions were posed relating to local training and employment opportunities. A comment was made that people from northern Saskatchewan should be given priority in hiring and business opportunities.

Other questions related to Project design details, such as how Denison will make sure residual uranium will not leak into the environment.

Finally, some respondents noted the importance of engaging in non- electronic/technological ways to make sure the voices of Elders are heard. They also noted that it will be essential to have a translator. Additionally, one respondent noted that it would be helpful to have a community office for the Project. For additional details about this activity, please see Appendix 4-A, ROC #456.

Meetings (Chief and Council and Patuanak & La Plonge Open Houses) - May 30 and May 31, 2022: On May 30 and May 31, 2022, engagement activities were undertaken at the ERFN Patuanak reserve at the Band Hall (May 30) and ERFN La Plonge reserve at the Silver Building (May 31). The ERFN La Plonge meeting was originally intended to occur at the Beauval Community Centre, but owing to a set of community circumstances, was moved to the La Plonge Reserve Silver Building. The change in venue was communicated via radio the day of the event. The focus of these engagement activities was to share the preliminary findings of the EA, proposed mitigation measures, and preliminary conclusions of the EIS, and to facilitate dialogue related to this information.

Engagement activities were conducted as a focused meetings with Chief and Council and as general open houses. Date and location of open house meetings were advertised on local radio stations, Facebook pages, TV channels, and posters. During the open houses members were able to complete a survey, in hard copy or digital format, to express their opinions. Comments and questions were also captured by Denison in a record-keeping notebook, and transcribed following the event.

To communicate EA findings and Projects details, Denison created and displayed three models and 15 informational poster boards. The three models depicted: 1) the uranium ore body and projected, below ground, extraction infrastructure; 2) the Project site surface with associated infrastructure; and 3) A 1:294 scale map of the area surrounding the Project site. The 15 informational poster boards presented EA findings in relation to VCs identified as important during previous rounds of engagement activities, as well as detail on technologies, regulatory processes, and procedures.

Chief and Council Leadership Meeting – May 30, 2022**:** The leadership meeting was held in ERFN Patuanak on May 30, 2022, with the Chief and Council. Denison provided an overview of the Project that included information on Project specifics, current status, predicted timeline, and preliminary EA findings.

The dialogue between Denison and ERFN Chief and Council highlighted several themes that primarily centered around the biophysical environment, socio-economic elements, and general technical inquires. A general concern for environmental integrity was expressed, including mention of climate change, potential seismic activity, and monitoring as it relates to uranium decay. Inquiries relating to employment, training, and community benefits were made. Representatives from the CNSC and SK MOE were present. For additional details about this activity, please see Appendix 4-A, ROC #621.

Open House in Patuanak (ERFN Reserve) - May 30, 2022**:** The open house was held at the ERFN Patuanak Band Hall, with members of the Hamlet of Patuanak welcomed to attend. A total of 31 attendees signed the sign-in sheet. Several individuals chose not to sign in, making the attendance at the ERFN Patuanak open house higher than implied by the sign-in sheet. Dialogue during the open house was largely in the form of attendees seeking clarity. The inquiries of attendees highlighted a general concern for the biophysical environment. Comments relating to ground subsistence, water quality, and environmental integrity were recurrently expressed. Questions surrounding Project specifics were often expressed in relation to concern for the biophysical environment. Multiple questions additionally related to socio-economic matters. Attendees expressed comments and inquiries relating to employment, training, accessibility, and benefit agreements. The basis of all socio-economic related dialogue appeared to highlight general focus on community and community member well-being. For additional details about this activity, please see Appendix 4-A, ROC #618.

Open House in La Plonge (ERFN Reserve) - May 31, 2022**:** The open house in La Plonge was held at the Silver Building. The ERFN La Plonge members and residents of Beauval and surrounding area were welcomed to attend. A total of 14 attendees signed the sign-in sheet. Several individuals chose not to sign in, making the attendance at the La Plonge open house higher than implied by the sign-in sheet. Spatial restraints led Denison to display only 7 poster boards. Brochures containing all poster board imagery and information were distributed, accommodating for the absent poster board information.

Dialogue during the open house expressed regard for groundwater and geology. Community members asked questions relating to methodology, inquiring as to effects of Project specifics on characteristics of groundwater and geology. Additional questions predominantly pertained to Project specific information. For additional details about this activity, please see Appendix 4-A, ROC #619.

Online Survey**:** During and following the ERFN meeting(s), attendees were invited to provide feedback on preliminary effects, mitigation, and monitoring through an online survey. Denison created a survey, available in hardcopy and digital formats during each open house and in digital format for two weeks following open house meetings.

Ten survey respondents indicated that they were from ERFN, with six stating that their primary residence was ERFN Patuanak and four stating their primary residence was ERFN La Plonge, and all self-identifying as First Nation. Seven survey respondents indicated that they were within the age range of 35 to 64 years old, two indicated that they were 65 years or more, and one indicated that they were within the 16 to 34 age cohort. Five survey respondents selected the "Other" category to indicate how they heard of the survey, three selected "Word of Mouth," one selected "Facebook," and one selected "Radio".

The survey was comprised of four core questions:

1. Are there any topics of particular concern that Denison needs to pay special attention to?
2. Are there any things missing that Denison should consider to reduce the effects of the Project to the environment?
3. Are there any topics that you would like to see included in monitoring plans?
4. What additional information would be helpful for you to understand the Project and its potential impacts to people and the environment?

When asked the question **"Are there any topics of particular concern that Denison needs to pay special attention to?"** responses predominantly centered around the biophysical environment. This was expressed in several ways, with three responses having some mention of the general environment, one response more specifically referencing cumulative effects through mention of climate change and the vulnerability of northern environments, and one response expressing concern over groundwater quality. Remaining topics expressed by survey respondents in relation to question one were varied, though still relate to a consideration for community context. Employment was mentioned in two instances, traditional land and resource use in two instances, community politics in one instance, and community concerns in one instance. The remaining two responses expressed that there was no topics of concern they felt afforded special attention.

When asked the question **“Are there any things missing that Denison should consider to reduce the effects of the Project to the environment?”** five survey respondents indicated that they felt there was nothing missing. Two survey respondents referenced the environment: one by simply referencing the environment, and the other by referencing the potential effect of exploration on various characteristics of the biophysical environment. While these responses did not relate to the survey question, they emphasized that maintenance of environmental integrity is important. One respondent stated, “Environmental jobs,” in response to this survey question. One survey respondent left the answer incomplete.

When asked the question **“Are there any topics that you would like to see included in the monitoring plan?”** many respondents provided unrelated responses. Of the responses that related to the survey question, one stressed the inclusion of long-term monitoring and surface water. These responses reference environmental jobs and general environmental plans. One response asked how the uranium was discovered, and another requested that ERFN communities be declared as Denison’s priority Indigenous community in relation to the Project. Two responses stressed Indigenous considerations, one stating that they would like to see Indigenous voices be part of the monitoring plan and the other stating that they would like community Elders to be liaison workers. One survey response emphasized mental health.

When asked the question **“What additional information would be helpful for you to understand the Project and its potential impacts to people and the environment?”** three respondents indicated that they did not require any additional information. Three survey responses specifically and directly related to the survey question. One respondent referenced the accessibility of information, stating that it would be helpful to provide explanations in Dene. One survey respondent suggested a community liaison worker to communicate the most current information. One survey respondent suggested to increase the number of infographics. The respondents provided unrelated answers on training and employment, family history and non-specific environmental effects, and questions regarding community benefits. One survey respondent indicated it would be helpful to have a better understanding of the environment.

The survey results were shared with the EIS discipline leads for consideration, where appropriate, in their assessments. In a few instances, the recommendations provided by survey respondents are considered as part of ongoing discussions Denison and ERFN are having, such as the need for Indigenous representation in environmental monitoring and the consideration of Elders/community members as liaisons between Denison and the Nation. For additional details about this activity, please see Appendix 4-A, ROC #652.

Engagement Focus: Environmental Assessment and Relationship to Licensing / Approvals – October 2022 to Present

Site Tour – June 22, 2023: On June 22, 2023, Denison hosted ERFN at the Project to provide an overview of the work done to date on the Project, including the 2022 and 2023 Feasibility Field

Tests in support of the Project. During the site tour, an overview of the overall Project was provided, including the environmental assessment outcomes and next steps for licensing / approvals. Twenty-five ERFN Members were in attendance, including several youth and elders. The site visit opened with the Wheeler River Project site being blessed by two Elders from the ERFN.

The focus of the following engagement activities was to share the findings of the EA, mitigation measures, monitoring, significance, cumulative effects, the conclusions of the EIS, and the relationship between the environmental assessment and the ultimate licensing / approvals process for the Project.

During October 2023, ERFN held an election for Chief and Council, and as such, it was requested by ERFN that Denison not undertake in-community engagement activities.

Meeting – December 13, 2023: On December 13, 2023, Denison and the newly-elected ERFN Chief and Council held a meeting in which the details of the Project were shared, including the status of the regulatory process and next steps.

Workshop – March 15, 2024: On March 15, 2024, Denison hosted a workshop in Saskatoon with 22 members of English River First Nation, as well as ERFN's environmental advisor, and 6 Denison staff members in attendance. The workshop focus was to provide details associated with the environmental assessment outcomes and the relationship to licensing/approvals and to facilitate discussion and receive feedback pertinent to these topics. Information was shared through presentation slides and information handouts. For additional details about this activity, please see Appendix 4-A, ROC #1087.

Future Engagement Activities

Denison and ERFN have an agreed-upon process to regularly engage about ongoing matters related to the Project and the associated regulatory approval process. Denison expects to continue working with ERFN, throughout the remainder of the environment assessment and approval process and into the licensing process, to coordinate engagement activities in relation to topics of interest in relation to the Project.

4.3.2.1.4 Engagement Activities Associated with ERFN-Specific Processes

As noted in Section 4.3.2.1.2, Denison entered into a Participation and Funding Agreement and Letter of Intent with ERFN in relation to the EA process in 2021. As a result, ERFN and Denison have developed some engagement activities specific to ERFN, funded by Denison:

1. Early information-sharing occurred between Denison and ERFN pertaining to the scope development of various activities in relation to various components of the EA:
    a. Denison was invited to review proposed interview questions for the studies to be undertaken by ERFN in relation to socioeconomics/health and wellness.

b. The ERFN was invited to review scoping materials for socioeconomic/health and wellness in relation to the assessment methodology proposed by Denison. In response to specific feedback from ERFN, Denison undertook a full assessment on a new Key Indicator called Traditional Economy. See Section 13 Economics.

c. The ERFN was invited to review the proposed Table of Contents and structure for the EIS in relation how they expected ERFN-authored information to be included into the EIS; the ERFN provided comments relative to this pertaining to various sections of the EIS. Denison shared the information with the discipline leads for consideration, where appropriate, in the respective sections of the EIS.

d. The ERFN was invited to review the proposed scope for Cumulative Effects in relation how ERFN's view of cumulative effects in ERFN's traditional territory. The ERFN provided direction to Denison that the ERFN perspective in relation to cumulative effects would include a 'lands taken up' map incorporated into the forthcoming ERFN-prepared Traditional Knowledge (TK) study (see next point for additional details).

2. Preparation of ERFN-authored reports on topics determined as important by ERFN in relation to the Project:

   a. The ERFN prepared their own independent contribution to the EIS, with assistance from Shared Value Solutions. The information from the following two reports has been shared with Denison to contribute and inform the EA:

      i. The Wheeler River Project – Summary of Health and Socio-Economic Study Results report summarizes results from 16 interviews that were conducted for the health and socio-economic topics (ERFN and SVS 2022a).

      ii. The Wheeler River Project – Summary of Traditional Knowledge Study Results (ERFN and SVS 2022b) presented results from 21 land use interviews, which provided both TK and Local Knowledge (LK) (ERFN and SVS 2022b). The TK study included maps of ERFN ecological knowledge features, personal harvesting sites, commercial harvesting sites, and occupancy sites. The TK component also considered data collected with ERFN Elders in the 1980s and consideration of the cumulative nature of industry in ERFN traditional territory.

The information in the EIS with respect to the knowledge and information by and about ERFN is substantially based on the information contained in these two reports. Please see Table 3.5-1 in Section 3 Indigenous and Local Knowledge for more information.

3. Review by ERFN of EIS information prior to filing draft EIS with Regulators:

   a. Denison shared EIS information (in the forms of specific sections of the EIS) with ERFN prior to filing the draft EIS with the Regulators, to provide ERFN an opportunity to review information made in reference to ERFN, including that information provided to Denison in the reports authored by ERFN, as identified above. The sections shared with ERFN were:

i. Section 3 Indigenous and Local Knowledge;
ii. Section 11 Land and Resource Use;
iii. Section 12 Quality of Life;
iv. Section 13 Economics; and
v. Section 16 Assessment Summary and Conclusions.

During this pre-review, ERFN expressed a variety of concerns to Denison regarding:

- the geographic boundaries of the Local Study Area and Regional Study Area;
- the level of information included in the EIS relating to ERFN's Indigenous Knowledge (IK) and traditional land use activities;
- the potential effects of uranium mining and the Project and how this concern may influence certain members to be averse to using lands or resources near the Project site; and
- employment and business opportunities for ERFN and its members.

Denison addressed these concerns in a response letter to ERFN in early October 2022, which included a disposition table responding to each specific concern identified by ERFN. As necessary, Denison has also addressed ERFN's concerns in the relevant sections of the EIS.

Nuhtsiye-kwi Benéne Committee (Ancestral Lands Committee)

In 2021, in response to ERFN's interest in the establishment of a specific committee in relation to Denison activities and the Project, ERFN and Denison established the Nuhtsiye-kwi Benéne Committee (Ancestral Lands Committee), supported by Denison. As declared by one of the participants, during the inaugural meeting, the purpose of the Nuhtsiye-kwi Benéne Committee is "*to let Denison know how we feel, giving a voice to the people in a community in a respectful way, share information – two-way sharing.*"

Over 2021, the Nuhtsiye-kwi Benéne Committee held three meetings.

Inaugural Meeting – April 22, 2021: During this inaugural meeting of the Nuhtsiye-kwi Benéne Committee, the focus was developing the purpose, vision and expectations of the Nuhtsiye-kwi Benéne Committee. General discussion occurred about the history and use of the land, and the perspectives of ERFN regarding activity that has occurred in their traditional territory. Brief discussion occurred regarding Project design considerations that would enable safe access to and around the Project site for ERFN and non-ERFN members; Denison committed to providing more details about this at the following meeting. For additional details about this activity, please see Appendix 4-A, ROC #458.

Project Site Access, Subsidence, Linear Feature Reclamation Pilot Program – June 15, 2021: During this meeting, Denison and ERFN shared information between each other regarding a number of topics related to the Project.

Denison provided a detailed discussion on the need for restrictions through the Project site for safety reasons, and where those proposed restrictions would be (i.e., gate houses). Generally, ERFN agreed with the concepts of check points in key areas of safety concern, provided that Members could access areas that were not subject to the need for restrictions (see Section 2 for more information). Denison confirmed the importance of providing access to the greatest degree possible for ERFN and other Indigenous people, while respecting the need for safety for all in the area.

At the request of ERFN, Denison also provided a detailed discussion on the potential for subsidence (i.e., surface disturbance involving the gradual sinking of land due to underground activities, such as mining). Denison had commissioned a report on the potential for this and provided the results from the third-party expert. The ERFN expressed satisfaction at the information that was provided in relation to their concerns (see Section 7 Geology and Groundwater and Section 9 Terrestrial Environment for additional information about the potential for subsidence).

Denison also provided an overview of a pilot program being undertaken with respect to mitigation of *existing* cut lines in relation to reduction of predation of ungulates (i.e., moose, caribou) by wolves. General information was shared between the groups regarding knowledge pertaining to use of the area by ungulates in relation to the cut lines, and forest fire areas. While the pilot project was not related to the EA for the Project, some of the information shared by ERFN in relation to these elements have been incorporated into an understanding of the existing environment (see Section 9 for more information). For additional details about this activity, please see Appendix 4-A, ROC #473.

Exploration Activities, Update on the Project, Heritage Management Protocols – October 14, 2021: During this meeting, Denison provided ERFN with an overview of general exploration activities, and an update on the Project and the plans for 2021 and 2022 activities. In response to a request from ERFN, Denison presented information on the heritage assessment done for the Project and the proposed plans for responding to the identification of a heritage artifact. In this context, heritage refers to archaeological and palaeontological (precontact) items. As part of the discussion regarding the finding of artifacts, Denison committed to including a consultation element with ERFN in the Heritage Management Plan, should an artifact be found during the development of the Project (see Section 11.3 in Section 11 for more information). For additional details about this activity, please see Appendix 4-A, ROC #591.

4.3.2.1.5 English River First Nation Public Comments on Draft Environmental Impact Statement and Related Processes

An important part of the engagement of Interested Parties for the Project is facilitated by federal regulators and occurs vis-à-vis a public review of the draft EIS. During this public review of the draft EIS, Interested Parties can submit their views in writing on the adequacy of the information presented in the EIS, as measured against appropriate guidance materials, and on the technical merit of the information presented in the EIS.

The CNSC offered participant funding to assist Indigenous peoples, members of the public, and stakeholders in the review of the draft EIS. This participant funding offering was available from January 10, 2022, to March 14, 2022. On November 21, 2022, the public was invited to comment on the draft EIS by the CNSC.

On Feb 22, 2023, ERFN submitted public comments on the draft EIS to the CNSC (Government of Canada 2024).

The initial ERFN public comments on the draft EIS totaled 271 technical comments. In working with ERFN and its support team, this initial list was discussed, prioritized, and summarized into 15 key areas of concern to be addressed prior to finalizing the EIS, and those areas that can be addressed in later stages of the various approvals processes. On August 18, 2023, ERFN provided Denison with specific questions in relation to these 15 key areas of concern, with a request for Denison to respond to the summary of the issues (see Appendix 4-A, ROC #968). On November 1, 2023, Denison provided ERFN with a technical memo providing responses to the summary of main issues as requested by ERFN (see Appendix 4-A, ROC #987). On November 28, 2023, Denison was notified by ERFN that ERFN had reviewed Denison's responses to their main issues and areas of concern, and were satisfied with the level of response provided by Denison at this stage of project planning (see Appendix 4-A, ROC #1007).

4.3.2.1.6 English River First Nation Consent for the Project

On September 27, 2023, ERFN provided a letter to the CNSC and the Province of Saskatchewan a letter that outlined ERFN's consent for the Project, subject to Denison materially fulfilling its commitments to ERFN. The letter further noted ERFN's intent to participate in the ongoing regulatory approval processes for the Project in a manner consistent with agreement between the two parties.

4.3.2.1.7 English River First Nation Key Interests, Issues and Concerns

A summary of key interests, issues and concerns gathered throughout the course of engagement for the Project, including any formal submissions made through the regulatory process, are identified in Appendix 4-B. It is important to note that areas of identified interest, issues or concerns are not always related to environmental effects as defined by CEAA 2012; they can be reflective of *general* areas of interest in relation to the Project more broadly. Where appropriate, the table aims to provide clarity with respect to this distinction.

4.3.2.2 Engagement with Kineepik Métis Local #9

Pinehouse is the community in which KML generally resides. The Kineepik Métis "*are considered Woodland Cree, Woodland Dene and Woodland Métis, although historical documents indicate that the member of (the Kineepik Métis Local) came from a diverse range of Métis, First Nations, and other backgrounds. The Northern Village of Pinehouse is located within the digitally mapped traditional territory of Indigenous people of Kineepik Métis Local. (They) have used these lands surrounding Missinippi (Churchill River) watershed for gathering food, shelter, and material supplies since time immemorial.*" (KML 2022).

Figure 4.3-2 illustrates where KML is in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, KML is located 230 km away from the Project. In terms of travel distance by existing transportation routes, KML is located 270 km away from the Project.

4.3.2.2.1 History of Interactions

Since 2016, Denison has been engaging with KML in a variety of ways. "*As of 2011, KML has a population of 1,600 people, of which 1,400 live on the [Northern Village of Pinehouse] municipality and 200 living either in other jurisdictions or on the land surrounding the community*" (KML 2022). In some instances, the elected officials of Métis Locals are also elected members of the municipality and, therefore, represent both their Indigenous community as well as their municipality. As a result, during the onset of engagement activities in 2016, the entities of KML and the Village of Pinehouse Lake had some overlap between each other.

In 2019, the KML delegated their Duty to Consult for the Project to the MN-S. Clear distinction between the Métis leadership and Citizens, and the Village leadership and residents was, therefore, necessary to make sure the MN-S was able to appropriately provide the representation of the Métis of KML, per the delegated Duty to Consult. As a result, Denison distinguished its engagement efforts between MN-S, on behalf of KML, and the general public of the Village of Pinehouse, with no intended overlap in relation to Métis interests.

In 2021, the KML revoked their delegated Duty to Consult to the MN-S. Denison re-engaged the KML directly in respect of the Project.

A comprehensive listing of engagement activities between Denison and KML, including a brief description of the purpose or activity and outcome where appropriate, is included in the IER.

4.3.2.2.2 Agreements Relative to the Environmental Assessment Process

To formalize Denison's commitment to KML, a MOU was signed by Denison, KML, and the Village of Pinehouse Lake in 2017. The signing of this MOU with both KML and the Village of Pinehouse Lake reflected the perspective of KML and the Village of Pinehouse Lake to represent both municipal residents and the Métis Citizens co-operatively. This non-binding MOU formalized the intent to work together in a spirit of mutual respect to cooperate to collectively identify practical means by which to avoid, mitigate, or otherwise address potential effects of the Project upon the exercise of the Indigenous Rights, Treaty Rights, and interests.

In 2018, Denison, the KML, and the Village of Pinehouse Lake signed an addendum to the original MOU whereby Denison committed to financially supporting an initiative to undertake a second phase of land use and occupancy mapping representing the KML and the Village of Pinehouse Lake. This work was subsequently undertaken in 2018 and shared with Denison for use in documents in relation to regulatory proceedings associated with its activities, including the Project.

In 2019, the KML delegated their Duty to Consult for the Project to the MN-S. Thereafter, as directed, Denison engaged with MN-S on behalf of KML (and other Métis Locals who likewise delegated their Duty to Consult to MN-S).

In 2021, the KML revoked their delegated Duty to Consult to the MN-S. Denison re-engaged the KML directly in respect of the Project while continuing to engage separately with the general public of the Village of Pinehouse Lake.

In 2022, Denison and the KML built upon the 2017 MOU and signed a Participation Agreement and associated Letter Agreement, which outlined a mutually agreeable framework and applicable funding arrangements to facilitate KML's participation and engagement in the EA process for the Project—including KML's contribution to Denison's environmental understanding of the Project in a holistic way that respected KML's rights and interests. As a result, several additional activities have been undertaken between KML and Denison, which are further described in Section 4.3.2.2.3.

In July 2024, KML and Denison concluded an Agreement in respect of the Project that provides, among other matters, various procedural and substantive commitments by Denison to KML and the support and consent of KML for the development and operation of the Project in a sustainable manner, which respects KML's inherent Aboriginal rights, advances reconciliation with Indigenous peoples, and provides economic opportunities and other benefits to KML.

4.3.2.2.3 Key Engagement Activities

During the engagement activities undertaken with KML, several key engagement activities took place that have played a meaningful role in relation to the EA process. The main forms of engagement included meetings with leadership, community meetings, a workshop on early infrastructure options (2018), a site visit (2019), a meeting coordinated by the MN-S (2019), one online survey (2022), and a meeting and information session on preliminary effects and mitigation (2022). As noted in Section 4.2.1, due to the COVID-19 pandemic, engagement switched to virtual meetings in 2021. In mid-2022, appropriate engagement activities moved back to in-person. The following text describes several the key engagement activities. These key engagement activities were supported by ongoing engagement methods including, but not limited to, those outlined in Section 4.2.1.

Engagement Focus: Pre-Project Description - April 2016 to May 2019

Meeting – September 7, 2016: Introductory meeting in Village of Pinehouse Lake: This was the inaugural meeting between the senior management team of Denison and members of KML. About 20 individuals were in attendance, along with the President of KML. Much of the meeting focussed on clarifying the nature of Denison's activities, including the Project and related exploration activities, the interest in employment and business opportunities, the interest in protection of the environment from exploration and Project activities, including consideration of cumulative effects, and questions in relation to the nuclear industry in general and the market related to uranium. For additional details about this activity, please see Appendix 4-A, ROC #105.

Workshop – January 16, 2018: Denison hosted a workshop with grade 11 and 12 students, plus a number of community members. The focus of the workshop was to obtain feedback on three alternatives/options for the proposed Project: the road alignment from Highway 914 into the Project Area; the potential treated effluent discharge location; and the mining method options.

The focus of this engagement activity was to obtain feedback on three alternatives/options for the proposed Project: the road alignment from Highway 914 into the Project Area; the potential treated effluent discharge location; and the mining method options. For additional information about this activity, please see Appendix 4-A, ROC #2. General questions were asked regarding the various alternatives and options, and points of clarification pertaining to aspects of the Project. Feedback was collected on the various options and has been incorporated into the final design for road alignment, and the treated effluent discharge location. Please see Section 2 for more details. For additional details about this activity, please see Appendix 4-A, ROC #2.

Engagement Focus: Post-Project Description – July 2019 to October 2022

Site Tour - August 23, 2019: In August 2019, Denison hosted a site tour at the Project location. Attending the site tour was the President of KML and the Executive Director of the KML. The focus of this engagement activity was to provide an in-field opportunity to understand the proposed Project and the various elements associated with the Project.

The tour involved an initial presentation regarding the Project, followed by travel around the Project site to the various locations for the proposed elements of the Project. Representatives from the CNSC and SK MOE were present. For more information about this activity, please see Appendix 4-A, ROC #1.

Meeting – November 5, 2019: Denison hosted a meeting with the MN-S President, the Northern Region 3 President, legal counsel, some administrators, and several Local Presidents and representatives, including KML in attendance. This engagement activity was coordinated with the MN-S, in response to the delegated Duty to Consult from several Métis Locals as of November

2019. The focus was to provide an overview of the Project and discuss Métis interests in the Project. See Section 4.3.4.1.3 for a detailed discussion on this meeting. For additional details about this activity, please see Appendix 4-A, ROC #62.

Engagement efforts were temporarily suspended in March 2020 as a result of the COVID-19 pandemic. As noted in Section 4.2.1, due to the COVID-19 pandemic, engagement switched to virtual meetings in 2021. In mid-2022, appropriate engagement activities moved back to in-person.

During this period, Denison engaged with MN-S on behalf of KML (and other Métis Locals who likewise delegated their Duty to Consult to MN-S). See Section 4.3.4.1.3 for a detailed discussion of this engagement.

Meetings (Leadership and Open House in the Village of Pinehouse Lake) – June 1, 2022:

On June 1, 2022, engagement activities were undertaken in collaboration with KML to occur in the Village of Pinehouse Lake, in the Village Hall. The focus of these engagement activities was to share the preliminary findings of the EA, proposed mitigation measures and preliminary conclusions of the EIS, and to facilitate dialogue related to this information. The structure and layout of the meeting was jointly established between Denison and KML. Engagement activities were conducted as a focused leadership meeting with KML representatives and the Village of Pinehouse representatives (at their joint request), and as a general open house. Date and location of open house meetings were advertised on local radio stations, Facebook pages, TV channels, and posters. During the open house, members were able to complete a survey, in hard copy or digital format, to express their opinions. Comments and questions were also captured by Denison in a record-keeping notebook, and transcribed following the event.

To communicate EA findings and Projects details, Denison created and displayed three models and 15 informational poster boards. The three models depicted: 1) the uranium ore body and projected, below ground, extraction infrastructure; 2) the Project site surface with associated infrastructure; and 3) a 1:294 scale map of the area surrounding the Project site. The 15 informational poster boards presented EA findings in relation to VCs identified as important during previous rounds of engagement activities, as well as detail on technologies, regulatory processes, and procedures.

KML and Village of Pinehouse Leadership Meeting – June 1, 2022: The leadership meeting was held in at the Pinehouse Lake gas bar on June 1, 2022, with invited representatives of KML and the Village of Pinehouse Lake. Denison provided an overview of the Project that included information on Project specifics, current status, predicted timeline, and preliminary EA findings.

The dialogue between Denison and the leadership related to Project specifics, including inquiries about the dimensions of the ore body and freeze wall. Questions surrounding employment and training were also expressed. A need for a culturally sensitive training model was communicated. This bridged to discussion of the reduced footprint of the Project translating to fewer employment opportunities. Leadership expressed a desire for appropriate training for community residents to adequately compete as Project related jobs become available. Representatives from the CNSC and SK MOE were present. For more information about this activity, please see Appendix 4-A, ROC #623.

Open House in Village of Pinehouse Lake – June 1, 2022: As mentioned previously, the open house was co-planned between Denison and KML. The open house was held at the Pinehouse Community Centre, welcoming members of the surrounding area. A total of 52 attendees signed the sign-in sheet. Some individuals chose not to sign in, making the attendance at the Pinehouse open house slightly higher than recorded by the sign-in sheet. Through open house dialogue, community members expressed a general interest in the Project and Project-specific information. Questions such as "How does ISR mining work?" and "How does calcium chloride (CaCl) cool and freeze the ground?" illustrate this interest. Other questions, while primarily geared toward gaining clarity on Project specifics, suggest consideration for mitigation measures, human health, and the biophysical environment. Examples of this include questions such as "Where will the drinking water [for the camp] come from?" and inquiries over potential effects of work schedules on worker health. Representatives from the CNSC and SK MOE were present. For additional details about this activity, please see Appendix 4-A, ROC #620.

Online Survey: During and following the meeting(s), attendees were invited to provide feedback on preliminary effects, mitigation, and monitoring through an online survey. Denison created a survey, available in hardcopy and digital formats during each open house and available in digital format for two weeks following the open house. The survey was comprised of four core questions:

1. Are there any topics of particular concern that Denison needs to pay special attention to?
2. Are there any things missing that Denison should consider to reduce the effects of the Project to the environment?
3. Are there any topics that you would like to see included in monitoring plans?
4. What additional information would be helpful for you to understand the Project and its potential impacts to people and the environment?

The 25 survey respondents indicated that they were from Pinehouse, with 15 self-identifying as Métis, nine as First Nation, and one as Indigenous without further specification. Survey respondents primarily heard of the survey through word of mouth, indicated by 10 survey respondents. Five survey respondents indicated that they heard of the survey through Facebook, and five indicated they heard of the survey through "other" means. Three respondents heard of the survey through posters, and two through radio. Most survey respondents were in the 35 to 64 age cohort, indicated in 16 instances. Five respondents indicated that they were in the 16 to34 cohort and four indicated that they were in the 65+ age cohort.

When asked the question **“Are there any topics of particular concern that Denison needs to pay special attention to?”** five respondents provided incomplete answers. Six survey respondents expressed that they had no concerns, with statements ranging from variations of the word “no” to positive statements such as “*I think Denison covered all the main topics very well*.” Five respondents emphasized employment and training, one of which framed this emphasis in a northern context. Five survey respondents highlighted a concern for the environment; responses included: one focused on water quality; two environmental restoration; one on the general environment; and one on mining source water treatment and runoff, presumably as it relates to the environment. One response expressed a concern over recycling. The remaining responses touched on a variety of topics. One survey respondent supplied a community benefits inquiry. Accessibility of the Project site and Project buildings was a concern for another respondent. Concern over the potential for future Covid-19 restrictions and possible vaccination requirements was expressed, though this response may be extended to include pandemic planning in general.

When asked the question **“Are there any things missing that Denison should consider to reduce the effects of the Project to the environment?”** 10 survey respondents indicated that they felt that was nothing missing. These responses, again, ranged from “no” to positive commentary such as “*No- work at Denison Mine couple shifts, like the safe orientated culture and respect of land and native people that live near the mine sites*.” One additional survey response stated “*May in the future*.” This may express no concern and/or a desire for forward planning. One survey respondent directly referenced forward planning in addition to stressing the importance of wildlife, and caribou habitat management. Waste management was referenced by one respondent, emphasizing recycling and providing the suggestion of recycling paper. One survey respondent emphasized air quality, while another inquired “*Are these surface pipes [spill] ready at all times*?” One survey response suggested the inclusion of LK and TK, suggesting Denison “*learn from the people around this project*.” One survey respondent expressed concern for land users and wanted it to be affirmed that mining methods were safe. Seven survey respondents provided incomplete responses.

When asked the question **“Are there any topics that you would like to see included in the monitoring plans?”** five respondents supplied incomplete answers and nine indicated that there was nothing additional that they felt needed to be considered. Several responses did not relate to the survey question; two suggested a focus on local employment opportunities, one inquired about water quality as per human consumption and treatment, one requested more local meetings, one inquired about double plated pipes and spill readiness, one stated that someone was required to teach safety, and one requested more project context. Responses related to the survey question related to water quality, with one response simply stating water sampling and the other emphasizing monitoring of aquatic environments as well as budgeting appropriately for long-term monitoring. Similarly, another survey respondent stated “future-wise”, potentially referring to long-term monitoring or incorporating topics into the monitoring plan in a future context. One survey response indicated they would like to see ongoing reporting on Project Operation.

When asked the question **“What additional information would be helpful for you to understand the Project and its potential impacts to people and the environment?”** six indicated that no additional information was needed and five provided incomplete responses. Several survey respondents provided unrelated suggestions to this survey question. Forming mutually beneficial agreements was suggested through the response “*Always explain the motto ‘help us help you.”*. Two respondents focused on opportunities for youth, one in terms of employment and the other in terms of scholarships, and one survey respondent emphasized general opportunity for future employment. One survey respondent suggested employment considerations for people with disabilities. Waste management was focused on, with one survey respondent suggesting an increase in practice of recycling as well as questioning water quality and sampling. One respondent suggested Elder representation in decision making. Responses that related to the survey question generally suggested a need for high level information including Project timeline, more information on environmental effects, water quality changes from Project Operation, and general Project site information including potential jobs and tasks. The importance of ongoing dialogue was emphasized in responses that suggested continued transparency and regular community meetings.

Most of the information shared with Denison regarding the above questions on the survey are suitably captured and addressed by Denison as part of the current work on the EA and the Project in general. In a few instances, the recommendations in relation to sharing of information in the future, such as with respect to environmental monitoring and employment opportunities, will be carried through into ongoing discussions between Denison and KML. For additional details about this activity, please see Appendix 4-A, ROC #652.

Engagement Focus: Environmental Assessment and Relationship to Licensing / Approvals – October 2022 to Present

Site Tour – June 14, 2023*:* On June 14, 2023, Denison hosted KML at the Project site to provide an overview of the work done to date on the Project, including the 2022 and 2023 Feasibility Field Test in support of the Project. During the site tour, an overview of the overall Project was provided, including the environmental assessment outcomes and next steps for licensing / approvals. Twenty-one KML representatives were in attendance, including several youth and elders.

Meetings (Land User and Open House) – October 24, 2023: On October 24, 2023, engagement activities were undertaken in collaboration with KML in the Village of Pinehouse Lake at the Village Hall.

The focus of these engagement activities was to share the findings of the EA, mitigation measures, monitoring, significance, cumulative effects, the conclusions of the EIS, and the relationship between the environmental assessment and the ultimate licensing / approvals process for the Project.

The structure and layout of the meeting was jointly established between Denison and KML. Engagement activities were conducted as a focused leadership meeting with KML land users, and as a general open house with a specified time period for an overview presentation. The date and location of open house meetings were advertised on local radio stations, Facebook pages, TV channels, and posters. Comments and questions were also captured by Denison in a record-keeping notebook, and transcribed following the event.

To communicate EA findings, Project details and the relationship to the licensing / approvals process, Denison displayed three models and 6 informational poster boards. The three models depicted: 1) the uranium ore body and projected below ground and extraction infrastructure; 2) the Project site surface with associated infrastructure; and 3) a 1:294 scale map of the area surrounding the Project site. The 6 informational poster boards presented EA findings and related licensing / approvals actions in relation to VCs identified as important during previous rounds of engagement activities.

KML Land User Meeting – October 24, 2023: The KML land user meeting was held in at the Village Hall on October 24, 2023, from 1pm to 3pm. The purpose of this meeting was to share information about the Project, with a particular focus on the flow of information from the environmental assessment into licensing, permits, and commitments. The event was planned and invitations extended as part of the process in place led by KML. Information boards and area models were displayed and information booklets were provided. Denison prepared a formal presentation, and a translator was present to translate as needed. The Canadian Nuclear Safety Commission and the Saskatchewan Ministry of Environment were invited by Denison and were in attendance.

For more information about this activity, please see Appendix 4-A, ROC #979

Open House in Village of Pinehouse Lake – October 24, 2023: In coordination with KML, Denison hosted an open house event in the Northern Village of Pinehouse to share information about the Project, with a particular focus on the flow of information from the environmental assessment into licensing, permits, and commitments. Denison advertised the event with social media posts and posters around the community. In addition to members of KML, 48 residents were recorded as in attendance. Information boards and area models were displayed and information booklets were provided. Denison prepared a formal presentation, and a translator was present to translate as needed. The Canadian Nuclear Safety Commission and the Saskatchewan Ministry of Environment were invited by Denison and were in attendance. For additional details about this activity, please see Appendix 4-A, ROC #978.

Site Tour (Student) – May 7, 2024: In coordination with Kineepik Métis Local, Denison hosted a site tour at the Wheeler River Project for Pinehouse high school students.

Meeting (Land User) – May 8, 2024: In coordination with Kineepik Métis Local, Denison hosted a land user meeting at the Pinehouse Village Hall. The focus of the meeting was to share updates on the Wheeler River Project, answer land user questions, facilitate discussion, and provide information on Project stage and licensing progression. The event was planned and invitations extended as part of the process in place led by KML. Denison prepared a presentation and distributed informational handouts to attendees. The meeting was attended by 38 land users and 4 KML staff. For additional details about this activity, please see Appendix 4-A, ROC #1088.

Future Engagement Activities

Denison and KML have an agreed-upon process to regularly engage about ongoing matters related to the Project and the associated regulatory approval process. Denison expects to continue working with KML throughout the remainder of the environmental assessment and approval process and into the licensing process, to coordinate engagement activities in relation to topics of interest to them in relation to the Project.

4.3.2.2.4 Engagement Activities Associated with KML-Specific Processes

As noted in Section 4.3.2.2.2, Denison entered into an MOU with KML and Addendum in 2017 and 2018, along with a Participation Agreement in 2022. As a result, KML and Denison have developed engagement activities specific to KML, funded by Denison:

1. Land Use and Occupancy Mapping

In 2018, the KML at Pinehouse approached Denison to support a land use mapping initiative in the Project Area. The 2018 study builds on the land use mapping completed in 2011 by extending the spatial boundaries (Tobias and Associates 2018a). Methods used in the 2018 data collection are documented in Tobias and Associates (2018b) and results represent input from 128 respondents in 2011 and 55 respondents in 2018. The Tobias and Associates (2018b) methods report indicates that, collectively, the results from the 2011 and 2018 surveys represent the contemporary land base of Pinehouse residents determined "*primarily by locations where residents procure fish, birds, mammals and plant resources for direct family consumption*". A verification meeting was held in late 2018 to make sure no geographic data gaps existed and that the results speak for the whole community.

This occupancy and land use data have been incorporated into the EIS. Please see Table 3.5-2 in Section 3.

2. KML Valued Ecosystem Components:

In 2022, the KML prepared a report (KML 2022) to voice their perspectives on Project valued ecosystem components. An initial draft was provided to Denison in April 2022 and a final report was provided in June 2022. Based on 12 community engagement sessions and review of the land use maps described above, the Kineepik Métis explained their unique social, cultural and historical context, expressed general support for the Project, and described issues and concerns. (KML 2022).

This report was used throughout the EIS, where appropriate. Please see Table 3.5-1 in Section 3.

Kineepik Métis Local #9 Public Comments on the Draft Environmental Impact Statement and Related Processes: An important part of the engagement of Interested Parties for the Project is facilitated by federal regulators and occurs vis-à-vis a public review of the draft EIS. During this public review of the draft EIS, Interested Parties can submit their views in writing on the adequacy of the information presented in the EIS, as measured against appropriate guidance materials, and on the technical merit of the information presented in the EIS.

The CNSC offered participant funding to assist Indigenous peoples, members of the public, and stakeholders in the review of the draft EIS. This participant funding offering was available from January 10, 2022, to March 14, 2022. On November 21, 2022, public comments were invited on the draft EIS by the CNSC.

On Feb 17, 2023, KML submitted public comments on the draft EIS to the CNSC (Government of Canada 2024), consisting of 11 technical comments.

On June 11, 2023, following work undertaken together since receipt of the February 17, 2023, public comments, Denison provided KML with an updated table of issues, concerns and interests capturing engagement efforts over the years for both KML and the NVP – including Denison's responses to those issues, concerns, and interests, as associated with the Project draft EIS. KML provided feedback and stated that they were satisfied with the updated table, including Denison's responses to the issues, concerns, and interests (see ROC #917).

On November 22, 2023, Denison provided KML with specific responses to KML's February 17, 2023, public comments (see Appendix 4-A, ROC #970). On December 5, 2023, KML confirmed to Denison that Denison's responses to the February 17, 2023, public comments had resolved KML's comments / concerns on the draft EIS and the Project (see Appendix 4-A, ROC #1027).

4.3.2.2.5 Kineepik Métis Local #9 Consent for the Project

On August 1, 2024, KML provided a letter to the CNSC and the Province of Saskatchewan that outlined KML's consent for the Project, subject to Denison materially fulfilling its commitments to KML. The letter further noted KML's intent to participate in the ongoing regulatory approval processes for the Project in a manner consistent with the agreement between the two parties.

4.3.2.2.6 Kineepik Métis Local #9 Key Interests, Issues and Concerns

A summary of key interests, issues, and concerns gathered throughout the course of engagement for the Project, including any formal submissions made through the regulatory process, are identified in Appendix 4-B. It is important to note that areas of identified interest, issues or concerns are not always related to environmental effects as defined by CEAA - they can be reflective of *general* areas of interest in relation to the Project more broadly. Where appropriate, the table aims to provide clarity with respect to this distinction. Additional information on key issues and concerns raised from the Northern Village of Pinehouse (NVP) can be found in Appendix 4-B.

4.3.2.3 Engagement with Sipishik Métis Local #37

Beauval is the community in which SML residents generally reside. Beauval—"Beautiful Valley"—is located in northern Saskatchewan overlooking the picturesque Beaver River Valley, providing a striking view of the river and surrounding nature. The community has a proud history of culture, language, and heritage. In history, Beauval was a trading post location along the Churchill River trade route for the Hudson's Bay Company; this route is still traveled via canoe by history buffs and avid outdoorsman for the pristine scenes and memorable nature experience with historic influence. The trail to Fort Black was an early access route from Beauval to neighboring Île-à-la-Crosse for early settlers, trappers and fishers. The historical significance of this trail to the livelihood of the community in the past adds to the rich history of the Métis heritage and culture of Beauval, Saskatchewan (MN-S n.d.a).

Figure 4.3-2 illustrates where SML is in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, SML is located 295 km away from the Project. In terms of travel distance by existing transportation routes, SML is located 375 km away from the Project.

4.3.2.3.1 History of Interactions

Since 2016, Denison has been engaging with SML in a variety of ways. The Northern Village of Beauval (NVB), and many of the community members residing in Beauval, self-identify as Métis. In some instances, the elected officials of Métis Locals are also elected members of the municipality and, therefore, represent both their Indigenous community as well as their municipality. As a result, during the onset of engagement activities in 2016, the entities of SML and the Village of Beauval had some overlap.

In 2019, the SML delegated their Duty to Consult for the Project to the MN-S. From 2019, the MN-S has been representing SML in respect of engagement with Denison for the Project. Clear distinction between the Métis leadership and Citizens, and the Village leadership and residents was, therefore, necessary to make sure the MN-S was able to appropriately provide the representation of the Métis of SML, per the delegated Duty to Consult. As a result, Denison focussed engagement efforts exclusively toward the general public of the Village of Beauval onwards from this point, with no intended overlap in relation to Métis interests.

A comprehensive listing of engagement activities between Denison and SML, including a brief description of the purpose or activity and outcome where appropriate, is included in the IER.

4.3.2.3.2 Agreements Relative to the Environmental Assessment Process

To formalize Denison's commitment to SML, a MOU was signed by Denison, SML and the Village of Beauval in 2018. The signing of this MOU with both SML and the Village of Beauval reflected the perspective of SML and the Village of Beauval to represent both municipal residents and the Métis Citizens co-operatively. This non-binding MOU formalized the intent to work together in a spirit of mutual respect to cooperate to collectively identify practical means by which to avoid, mitigate, or otherwise address potential effects of the Project upon the exercise of the Indigenous Rights, Treaty Rights, and interests, to the extent they are identified in relation to the Project.

In 2019, SML delegated their Duty to Consult for the Project to the MN-S. From 2019, the MN-S has been representing SML in respect of engagement with Denison for the Project.

4.3.2.3.3 Key Engagement Activities

During the engagement activities undertaken with SML, the main forms of engagement included meetings with leadership, a community meeting, a workshop on early infrastructure options (2018), and a site visit (2019) and a meeting coordinated by the MN-S (2019). These key engagement activities were supported by ongoing engagement methods including, but not limited to, those outlined in Section 4.2.1.

Engagement Focus: Pre-Project Description - April 2016 to May 2019

Introductory Meeting in the Village of Beauval - December 6, 2016: This was the inaugural meeting between the senior management team of Denison and various entities associated with SML and the Village of Beauval. Much of the meeting focussed on clarifying the nature of Denison's activities, including the Project and related exploration activities, the interest in employment and business opportunities, opportunities and considerations for the long-term, and questions in relation to the nuclear industry in general and the market related to uranium. For more information about this activity, please see Appendix 4-A, ROC #107.

Workshop – January 18, 2018: Denison hosted a workshop with several community members. The focus of the workshop was to obtain feedback on three alternatives/options for the proposed Project: the road alignment from Highway 914 into the Project Area; the potential treated effluent discharge location; and the mining method options. General questions were asked regarding the various alternatives and options, and points of clarification pertaining to aspects of the Project. Feedback was collected on the various options and has been incorporated into the final design for road alignment, and the treated effluent discharge location. Please see Section 2 for more details. For additional details about this activity, please see Appendix 4-A, ROC #4.

Engagement Focus: Post-Project Description – July 2019 to October 2022

Site Tour – August 23, 2019: In August 2019, Denison hosted a site tour at the Project location. The focus of this engagement activity was to provide an in-field opportunity to understand the proposed Project and the various elements associated with the Project. Attending the site tour was the Vice President of SML. The tour involved an initial presentation regarding the Project, followed by travel around the Project site to the various locations for the proposed elements of the Project. Representatives from the CNSC and SK MOE were present. For more information about this activity, please see Appendix 4-A, ROC #1.

Meeting – November 15, 2019: Denison hosted a meeting with the MN-S President, the Northern Region 3 President, legal counsel, some administrators, and several Local Presidents and representatives, including SML in attendance. This engagement activity was coordinated with the MN-S, in response to the delegated Duty to Consult from several Métis Locals as of October 2019. The focus was to provide an overview of the Project and discuss Métis interests in the Project.

See Section 4.3.4.1.3 for a detailed discussion on this meeting. For more specifics about this activity, please see Appendix 4-A, ROC #62.

In 2019, SML delegated their Duty to Consult for the Project to the MN-S. From 2019, the MN-S has been representing SML in respect of engagement with Denison for the Project. For details on Denison's engagement with MN-S, see Section 4.3.4.1.

Future Engagement Activities

Denison expects to continue working with the SML, through the MN-S 2024, throughout the remainder of the environmental assessment and approval process and into the licensing process, to coordinate engagement activities in relation to topics of interest in relation to the Project, in accordance with an agreed-upon process.

4.3.2.3.4 Sipishik Métis Local #37 Public Comments on Draft Environmental Impact Statement and Related Processes

An important part of the engagement of Interested Parties for the Project is facilitated by federal regulators and occurs vis-à-vis a public review of the draft EIS. During this public review of the draft EIS, Interested Parties can submit their views in writing on the adequacy of the information presented in the EIS, as measured against appropriate guidance materials, and on the technical merit of the information presented in the EIS.

The CNSC offered participant funding to assist Indigenous peoples, members of the public, and stakeholders in the review of the draft EIS. This participant funding offering was available from January 10, 2022, to March 14, 2022. On November 21, 2022, public comments were invited on the draft EIS by the CNSC.

On March 3, 2023, the MN-S submitted public comments on the draft EIS to the CNSC (Government of Canada 2024). As SML delegated their duty to consult to the MN-S, engagement on issues related to the environmental assessment are now represented by the MN-S.

On December 1, 2023, following work undertaken with the MN-S since receipt of the March 3, 2023, public comments, Denison provided responses to the MN-S' public comments made on the draft EIS (please see Appendix 4-A, ROC #973).

During this same time period, Denison and the MN-S met regularly to discuss the advancement of the Métis Knowledge Study and to discuss items in relation to the development of a MN-S defined process for engagement on the Project, including in relation to the resolution of the MN-S public comments and general issues and concerns. One of the key areas of concern raised by the MN-S was the inclusion of information obtained as a result of the completion of the Métis Knowledge Study into the EIS. The Métis Knowledge Study was received by Denison on October 24, 2023, and Denison has integrated relevant information from the Study into the EIS accordingly.

In July 2023, Denison and the MN-S began discussions pertaining to the development of a Joint Working Group process in relation to engagement with the MN-S about the Project. As of June 30, 2024, Denison and the MN-S had tentatively agreed to amendments to the existing Capacity Funding Agreement in support of this mutually agreeable engagement process, with the amendments awaiting final approval as part of a process defined by MN-S.

Following further discussions between Denison and the MN-S during August 2024, MN-S outlined an additional process that MN-S desired take place between Denison and the MN-S, to occur in parallel to the earlier discussed mutually agreeable engagement process. It is Denison's understanding that the commencement of these parallel processes is expected to occur in the coming months.

For more information about the work undertaken with the MN-S, please see Section 4.3.4.1.

4.3.2.3.5 Sipishik Métis Local #37 Key Interests, Issues and Concerns

A summary of key interests, issues, and concerns gathered throughout the course of engagement for the Project, including any formal submissions made through the regulatory process, are identified in Appendix 4-B. It is important to note that areas of identified interest, issues or concerns are not always related to environmental effects as defined by CEAA 2012 (the regime under which the Project is undergoing regulatory assessment) - they can be reflective of general areas of interest in relation to the Project more broadly. Where appropriate, the table aims to provide clarity with respect to this distinction. As SML delegated their duty to consult to the MN-S in late 2019, the table is representative to the timeframe prior to the delegation of the duty to consult by the SML to the MN-S.

Additional information on key issues and concerns raised from the NVB can be found in Appendix 4-B.

4.3.2.4 Engagement with Patuanak Métis Local #82

Patuanak is the community in which PML generally resides. As of the June 2022, there were 14 registered Citizens associated with PML. Patuanak is a community in northern Saskatchewan, Canada. It is the administrative headquarters of the ERFN reserve near Churchill River and the north end of Lac Île-à-la-Crosse. In Dene, it sounds similar to Boni Cheri (Bëghą́ɲch'ërë). The community consists of the Northern Hamlet of Patuanak with 64 residents governed by a Mayor and three Councillors and the adjoining Wapachewunak 192D reserve of the English River Dene Nation with 482 residents (Canada Census 2011). Patuanak is about 92 km (57 miles) north of Beauval at the end of Highway 918.

Figure 4.3-2 illustrates where Patuanak is in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, PML is located 230 km away from the Project. In terms of travel distance by existing transportation routes, PML is located 460 km away from the Project.

4.3.2.4.1 History of Interactions

Before 2019, Denison undertook engagement activities in the Patuanak area (including with PML) more broadly through work done in relation to the ERFN Wapachewunak reserve, consistent with the strong interconnections in the area. In mid-2019, Denison was advised by the Province of Saskatchewan of the interest of PML in relation to the Project. As a result, beginning June 2019, Denison began engaging directly with PML. This included sending correspondence to PML about the Project description, having informal discussions pertaining to their interests in the Project, and hosting a site visit (2019) and a meeting jointly coordinated by the MN-S (2019).

In 2019, the PML delegated their Duty to Consult for the Project to the MN-S. From 2019, the MN-S has been representing PML in respect of engagement with Denison for the Project. Since then, Denison has been engaging with MN-S on behalf of PML and other Métis Locals. For details of this engagement, see Section 4.3.4.1. The following section summarizes engagement activities that occurred with Denison and PML in 2019. Appendix 4-A includes further details pertaining to all these interactions. These key engagement activities were supported by ongoing engagement methods including, but not limited to, those outlined in Section 4.2.1.

4.3.2.4.2 Key Engagement Activities

<u>**Engagement Focus: Pre-Project Description - April 2016 to May 2019**</u>

Site Tour – August 23, 2019: In August 2019, Denison hosted a site tour at the Project location. The focus of this engagement activity was to provide an in-field opportunity to understand the proposed Project and the various elements associated with the Project.

Attending the site tour was the President of PML. The tour involved an initial presentation regarding the Project, followed by travel around the Project site to the various locations for the proposed elements of the Project. Representatives from the CNSC and SK MOE were present.

For more information about this activity, please see Appendix 4-A, ROC #1.

Meeting – November 5, 2019: Denison hosted a meeting with the MN-S President, the Northern Region 3 President, legal counsel, some administrators, and several Local Presidents and representatives, including PML in attendance. This engagement activity was coordinated with the MN-S in response to the delegated Duty to Consult from several Métis Locals as of November 2019. The focus was to provide an overview of the Project and discuss Métis interests in the Project.

See Section 4.3.4.1.3 for a detailed discussion on this meeting. For more specifics about this activity, please see Appendix 4-A, ROC #62.

In 2019, PML delegated their Duty to Consult for the Project to the MN-S. From 2019, the MN-S has been representing PML in respect of engagement with Denison for the Project. For details on Denison's engagement with MN-S, see Section 4.3.4.1.

Future Engagement Activities

Denison expects to continue working with the PML, through the MN-S, throughout the remainder of the environmental assessment and approval process and into the licensing process, to coordinate engagement activities in relation to topics of interest in relation to the Project in accordance with an agreed-upon process.

4.3.2.4.3 Patuanak Métis Local Public Comments on Draft Environmental Impact Statement and Related Processes

An important part of the engagement of Interested Parties for the Project is facilitated by federal regulators and occurs vis-à-vis a public review of the draft EIS. During this public review of the draft EIS, Interested Parties can submit their views in writing on the adequacy of the information presented in the EIS, as measured against appropriate guidance materials, and on the technical merit of the information presented in the EIS.

The CNSC offered participant funding to assist Indigenous peoples, members of the public, and stakeholders in the review of the draft EIS. This participant funding offering was available from January 10, 2022, to March 14, 2022. On November 21, 2022, public comments were invited on the draft EIS by the CNSC.

On March 3, 2023, the MN-S submitted public comments on the draft EIS to the CNSC (Government of Canada 2024). As PML delegated their duty to consult to the MN-S, engagement on issues related to the environmental assessment are now represented by the MN-S.

On December 1, 2023, following work undertaken with the MN-S since receipt of the March 3, 2023, public comments, Denison provided responses to the MN-S' public comments made on the draft EIS (please see Appendix 4-A, ROC #973).

During this same time period, Denison and the MN-S met regularly to discuss the advancement of the Métis Knowledge Study and to discuss items in relation to the development of a MN-S defined process for engagement on the Project, including in relation to the resolution of the MN-S public comments and general issues and concerns. One of the key areas of concern raised by the MN-S was the inclusion of information obtained as a result of the completion of the Métis Knowledge Study into the EIS. The Métis Knowledge Study was received by Denison on October 24, 2023, and Denison has integrated relevant information from the Study into the EIS accordingly.

In July 2023, Denison and the MN-S began discussions pertaining to the development of a Joint Working Group process in relation to engagement with the MN-S about the Project. As of June 30, 2024, Denison and the MN-S had tentatively agreed to amendments to the existing Capacity

Funding Agreement in support of this mutually agreeable engagement process, with the amendments awaiting final approval as part of a process defined by MN-S.

Following further discussions between Denison and the MN-S during August 2024, MN-S outlined an additional process that MN-S desired take place between Denison and the MN-S, to occur in parallel to the earlier discussed mutually agreeable engagement process. It is Denison's understanding that the commencement of these parallel processes is expected to occur in the coming months.

For more information about the work undertaken with the MN-S, please see Section 4.3.4.1.

4.3.2.4.4 Patuanak Métis Local Key Interests, Issues and Concerns

A summary of key interests, issues, and concerns gathered throughout the course of engagement for the Project, including any formal submissions made through the regulatory process, are identified in Appendix 4-B. It is important to note that areas of identified interest, issues, or concerns are not always related to environmental effects as defined by CEAA 2012 (the regime under which the Project is undergoing regulatory assessment) - they can be reflective of *general* areas of interest in relation to the Project more broadly. Where appropriate, the table aims to provide clarity with respect to this distinction. As PML delegated their duty to consult to the MN-S in late 2019, the table is representative to the timeframe prior to the delegation of the duty to consult by the PML to the MN-S.

4.3.2.5 Engagement with Hatchet Lake First Nation

On March 18, 2019, YNLR sent a letter to Denison directing Denison to undertake engagement and communication solely with YNLR for the purposes of any activities requiring approval actions from the Athabasca Denesųłiné, such as the EA for the Project. The letter explicitly stated:

> "*Please be advised that in relation to all new and ongoing mining, milling, exploration, forestry, road building and other industrial and non-industrial developments and activities for which a federal or provincial licensing permit, regulatory process, environmental assessment or other approval is required the sole point of contact for Black Lake First Nation, Fond du Lac First Nation, Hatchet Lake First Nation, Stony Rapids, Wollaston Lake, Camsell Portage and Uranium City is to be the Ya'thi Néné Lands and Resource Office. Accordingly, we direct you to communicate solely with Ya'thi Néné Lands and Resource Office in all related matters and our staff will be in direct contact with the First Nations and Municipal communities as it relates to activities in the Athabasca Basin and the Athabasca First Nations traditional territory.*"

As a result, Denison's engagement activities with the Hatchet Lake First Nation have been undertaken through engagement activities with the YNLR. Please see Section 4.3.4.2 for a full discussion on these activities.

Hatchet Lake First Nation is a signatory to Treaty 10. Figure 4.3-1 illustrates where the communities are in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, Hatchet Lake First Nation is located 150 km away from the Project. In terms of travel distance by existing transportation routes Hatchet Lake First Nation is located 945 km away from the Project.

4.3.3 Engagement with Other Indigenous Communities

As noted in Section 4.3.1, engagement with Other Indigenous Communities focused on Indigenous community with a potential interest in the Project, which may include any Indigenous community identified by a Regulatory Agency as having a potential interest in the Project.

As described in Section 4.3.1, these Other Indigenous Communities include the following:

- Fond du Lac First Nation;
- Black Lake First Nation;
- Birch Narrows Dene Nation;
- Buffalo River Dene Nation;
- Lac La Ronge Indian Band;
- A La Baie Métis Local;
- Dore/Sled Lake Métis Local #67; and
- Peter Ballantyne Cree Nation.

4.3.3.1 Engagement with Fond du Lac First Nation and Black Lake First Nation

On March 18, 2019, YNLR sent a letter to Denison directing Denison to undertake engagement and communication solely with YNLR for the purposes of any activities requiring approval actions from the Athabasca Denesųłiné, such as the EA for the Project. The letter explicitly stated:

> "*Please be advised that in relation to all new and ongoing mining, milling, exploration, forestry, road building and other industrial and non-industrial developments and activities for which a federal or provincial licensing permit, regulatory process, environmental assessment or other approval is required the sole point of contact for Black Lake First Nation, Fond du Lac First Nation, Hatchet Lake First Nation, Stony Rapids, Wollaston Lake, Camsell Portage and Uranium City is to be the Ya'thi Néné Lands and Resource Office. Accordingly, we direct you to communicate solely with Ya'thi Néné Lands and Resource Office in all related matters and our staff will be in direct contact with the First Nations and Municipal communities as it relates to activities in the Athabasca Basin and the Athabasca First Nations traditional territory.*"

As a result, Denison's engagement activities with the Fond du Lac First Nation and Black Lake First Nation have been undertaken through engagement activities with the YNLR. Please see Section 4.3.4.2 for a full discussion on these activities.

Black Lake First Nation is a signatory to Treaty 8. Fond du Lac First Nation is a signatory to Treaty 8. Figure 4.3-1 illustrates where the communities are in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, Black Lake First Nation is located 180 km away from the Project. In terms of travel distance by existing transportation routes Black Lake First Nation is located 1130 km away from the Project. In terms of direct linear distance, Fond du Lac First Nation is located 230 km away from the Project. In terms of travel distance by existing transportation routes Fond du Lac First Nation is more than 1,200 km away, a portion of which is only accessible via winter road.

4.3.3.2 Engagement with Birch Narrows Dene Nation

Birch Narrows Dene Nation has territory at three (3) sites: 1) Turnor Lake 193B with 296.7 hectares (733 acres) 56.4726°N 108.6869°W, which adjoins the Northern Hamlet of Turnor Lake; 2) Churchill Lake 193A with 159.8 hectares (395 acres), which contains the historic site of Clear Lake 56.1408°N 108.2072°W at the junction of Churchill Lake and Frobisher Lake; 3) Turnor Lake 194 with 2,445.9 hectares (6,044 acres) 55.9353°N 108.8450°W, which is on Peter Pond Lake east of Dillon (MLTC n.d.a).

Birch Narrows Dene Nation is a signatory to Treaty 10. Figure 4.3-2 illustrates where the community is in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, BNDN is located 230 km away from the Project. In terms of travel distance by existing transportation routes BNDN is located 570 km away from the Project.

4.3.3.2.1 History of Interactions

With respect to the Project, BNDN was identified by the CNSC in 2019 as potentially interested in the Project. Since 2019, Denison has shared information with BNDN about the Project, with offers to meet and share information between each other about the Project and potential Treaty Rights in relation to the Project. Engagement efforts were temporarily suspended in March 2020 as a result of the COVID-19 pandemic.

In May 2021, BNDN informed the CNSC that they were interested in being consulted by the Crown. This correspondence was copied to Denison, following which Denison offered to meet with BNDN to provide information in relation to the Project. Denison did not receive a response from BNDN to this offer. In May 2022 a BNDN Councillor connected with Denison seeking information about the Project and Denison provided them all information that was requested.

On October 27, 2022, BNDN sent a letter to Denison accepting Denison's earlier offers to meet regarding the Project. The letter further identified that BNDN was concerned about the potential impacts to water, wildlife, and medicines from the Project and requested Denison enter into a process agreement between Denison and BNDN.

On November 11, 2022, Denison responded to BNDN’s October 27, 2022, letter. Denison identified its willingness to meet with BNDN to provide an overview of the Project to better understand BNDN’s interests in relation to the Project, before entering into a process agreement with BNDN.

Over the course of the next few months, Denison and BNDN worked together to establish a mutually agreeable time that would work for a meeting.

Meeting – February 14, 2023: On February 14, 2023, Denison and BNDN met in person, whereby Denison provided an overview of the Project and the related environmental assessment, the valued components for the Project, the Project technologies, and the schedule. During the meeting, several clarification questions were asked of Denison with respect to the Project. During the meeting BNDN stated that Denison was in the traditional territory of BNDN and had land use information in relation to the Project, and BNDN would share the information with Denison provided that Denison entered into a confidentiality agreement with BNDN. Denison indicated its willingness to do so, and reiterated its interest in receiving information from BNDN regarding BNDN activities in and around the Project(see Appendix 4-A, ROC #851).

Following the February 14, 2023, meeting, Denison and BNDN connected about the request from BNDN to enter into a confidentiality agreement in order for Denison to receive the traditional territory information and land use data pertinent to the Project. BNDN also requested that Denison fund a process to develop a Project agreement. On April 25, 2023, Denison provided BNDN with a draft confidentiality agreement for their review and consideration. To date, a confidentiality agreement has not been entered into between the parties.

Meeting – May 10, 2023: On May 10, 2023, Denison and BNDN met virtually to discuss next steps with respect to the Project. Denison reiterated its interest in receiving BNDN information in respect of BNDN uses of the land in and around Wheeler prior to making a determination about entering into further agreements with BNDN. BNDN suggested that the information that could be shared would be limited because Denison was not providing funding in respect of the existing information. On May 11, 2023, Denison provided BNDN a copy of the meeting notes from May 10, 2023, and they were confirmed as received.

Meeting – July 31, 2023: On July 31, 2023, Denison met with BNDN to discuss next steps and moving forward to resolve BNDN’s concerns raised about the Project. A course of action was recommended, which involved Denison responding to the March 3, 2023, public comments from BNDN, as well as providing a high-level summary of the broader potential impacts to people and the environment. See below for more information about these next steps.

Future Engagement Activities

Denison will continue to ensure BNDN is informed about the progression of the Project, and will be responsive to BNDN's future interests in the Project.

4.3.3.2.2 *Birch Narrows Dene Nation Public Comments on Draft Environmental Impact Statement and Related Processes*

An important part of the engagement of Interested Parties for the Project is facilitated by federal regulators, and occurs vis-à-vis a public review of the draft EIS. During this public review of the draft EIS, Interested Parties can submit their views in writing on the adequacy of the information presented in the EIS, as measured against appropriate guidance materials, and on the technical merit of the information presented in the EIS.

The CNSC offered participant funding to assist Indigenous peoples, members of the public, and stakeholders in the review of the draft EIS. This participant funding offering was available from January 10, 2022, to March 14, 2022. On November 21, 2022, public comments were invited on the draft EIS by the CNSC.

On March 3, 2023, BNDN provided public comments on the draft EIS for the Project (Government of Canada 2024), consisting of 88 technical comments. On November 29, 2023, following work undertaken with BNDN since receipt of the March 3, 2023, public comments (as described above), Denison provided responses to the BNDN public comments made on the draft EIS (please see Appendix 4-A, ROC #972).

On January 18, 2024, BNDN sent correspondence to Denison advising that Denison's responses to BNDN's public comments on the EIS had been deemed adequate, and that BNDN looked forward to receiving information about the progress of the Project in the future (please see Appendix 4-A, ROC #1036).

Denison will continue to ensure BNDN is informed about the progression of the Project, and will be responsive to BNDN's future interests in the Project.

4.3.3.2.3 *Birch Narrows Dene Nation Key Interests, Issues, and Concerns*

A summary of key interests, issues, and concerns gathered throughout the course of engagement for the Project, including any formal submissions made through the regulatory process, are identified in Appendix 4-B. It is important to note that areas of identified interest, issues or, concerns are not always related to environmental effects as defined by CEAA 2012 (they can be reflective of *general* areas of interest in relation to the Project more broadly). Where appropriate, the table aims to provide clarity with respect to this distinction.

4.3.3.3 Engagement with Buffalo River Dene Nation

Dillon is a village in the boreal forest of northern Saskatchewan, Canada. It is located on the western shore of Peter Pond Lake at the mouth of the Dillon River. The village is the administrative headquarters of the BRDN and is accessed by Highway 925 from Highway 155 (MLTC n.d.b).

The North West Company had a post near Dillon in 1790. It was called Lac des Boeufs Post (Buffalo Lake Post). In 1932 the name of the village of Buffalo River was officially changed to Dillon, the name of the river was changed from Buffalo River to Dillon River, and Buffalo Lake was renamed Peter Pond Lake.

Buffalo River Dene Nation is a signatory to Treaty 10. Figure 4.3-2 illustrates where the community is in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, BRDN is located 285 km away from the Project. In terms of travel distance by existing transportation routes BRDN is located 540 km away from the Project.

4.3.3.3.1 History of Interactions

With respect to the Project, BRDN was identified by the CNSC in 2019 as having a potential interest in the Project. Since 2019, Denison has shared information with BRDN about the Project, with offers to meet and share information between each other about the Project and potential Treaty Rights in relation to the Project. Engagement efforts were temporarily suspended, along with the EA, in March 2020 as a result of the COVID-19 pandemic. In 2021, Denison advised BRDN about the EA restart. As of June 2024, Denison has not received any engagement from BRDN to Denison expressing interests, issues, or concern.

Denison remains willing to engage with BRDN regarding the Project to the extent BRDN expresses interest in doing so.

4.3.3.4 Engagement with Lac La Ronge Indian Band

Located in north-central Saskatchewan, the LLRIB is the largest First Nation in Saskatchewan, and one of the 10 largest in Canada, with a population of 11,602, as of March 31, 2022. The LLRIB reserve lands extend from rich farmlands in central Saskatchewan, all the way north through the boreal forest to the mighty Churchill River and beyond. The central administration office for LLRIB is located in La Ronge, 241 km north of Prince Albert, on the edge of the Pre-Cambrian Shield. (Lac La Ronge Indian Band, n.d.)

The LLRIB is a signatory to Treaty 6. LLRIB has several reserves, such as Hall Lake, Stanley Mission, Grandmothers' Bay and others. The administrative centre for the LLRIB is located adjacent to La Ronge and Air Ronge. Figure 4.3-2 illustrates where this LLRIB reserve is in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, this location is 265 km away from the Project. In terms of travel distance by existing transportation routes, this location is 480 km away from the Project.

4.3.3.4.1 History of Interactions

With respect to the Project, engagement with the LLRIB started in December 2019 when they were informed about the Project and expressed an interest in learning more. A presentation was made at a meeting to the LLRIB Lands and Resources Sub-committee in February 2020. Notification of the temporary suspension of the EA in March 2020 as a result of the COVID-19 pandemic was communicated, as well as status updates later in 2020 and the restart of the EA in January 2021.

In early 2023, the LLRIB contacted the CNSC about the Project. As an outcome of this contact, LLRIB requested the shapefiles for the Project from Denison.

In February 2023 Denison and LLRIB discussed LLRIB's interest in the Project, including in relation to LLRIB's trapping activities in the area. Denison clarified to LLRIB that the Project is located in the ERFN N-18 furblock, and outside the LLRIB Traditionally Occupied Territory available publicly online. Denison committed to attending a LLRIB Lands and Resources Board meeting at a time that was mutually convenient.

On August 30, 2023, Denison attended, both in person and virtually, the LLRIB Land and Resources Board meeting to provide an update on the Project and provided information in response to issues raised by LLRIB during the public review of the draft EIS for the Wheeler River Project (see Appendix 4-A, ROC #956).

On June 12, 2024, Denison met with the Lac La Ronge Lands and Resource Board for an in-person meeting in Saskatoon, for the purpose of providing Wheeler River Project updates, as requested by LLRIB, to support the resolution of LLRIB's comments made of the draft EIS.

Future Engagement Activities

Denison will continue to make sure LLRIB is informed about the progression of the Project and will be responsive to LLRIB's future interests in the Project.

4.3.3.4.2 Lac La Ronge Indian Band Public Comments on Draft Environmental Impact Statement and Related Processes

An important part of the engagement of Interested Parties for the Project is facilitated by the federal regulators, and occurs vis-à-vis a public review of the draft EIS. During this public review of the draft EIS, Interested Parties can submit their views in writing on the adequacy of the information presented in the EIS, as measured against appropriate guidance materials, and on the technical merit of the information presented in the EIS.

The CNSC offered participant funding to assist Indigenous peoples, members of the public, and stakeholders in the review of the draft EIS. This participant funding offering was available from January 10, 2022, to March 14, 2022.On November 21, 2022, public comments were invited on the draft EIS by the CNSC.

On February 9, 2023, LLRIB submitted public comments on the draft EIS to the CNSC (Government of Canada 2024).

On November 4, 2023, following work undertaken with LLRIB since receipt of the February 9, 2023, public comments (as described above), Denison provided responses to the LLRIB public comments made on the draft EIS (please see Appendix 4-A, ROC #986).

On June 12, 2024, Denison met with the Lac La Ronge Lands and Resource Board for an in-person meeting in Saskatoon, for the purpose of providing Wheeler River Project updates, as requested by LLRIB, to support the resolution of LLRIB's comments made on the draft EIS. In this meeting, the LLRIB indicated that the Project was located within the boundaries specified in the Misinipiy Integrated Land Use Plan.

On June 12, 2024, following the meeting between the Lac La Ronge Lands and Resource Board and Denison, LLRIB provided Denison with a copy of the Misinipiy Integrated Land Use Plan (2012). Please see Appendix 4-A, ROC #1107.

On June 18, 2024, in response to the Misinipiy Integrated Land Use Plan (2012) provided to Denison by LLRIB following their recent meeting, Denison responded confirming this information was used throughout the planning of the Wheeler River Project. Denison provided a georeferenced map showing Denison's properties fall outside both the Misinipiy Planning Area, and the Lac La Ronge Indian Band Traditionally Occupied Territory, as depicted in the Misinipiy Integrated Land Use Plan (2012). Denison informed the LLRIB that, should activities fall within the area defined in the shared map, Denison would proactively reach out to the LLRIB for discussions. Please see Appendix 4-A, ROC #1108.

On June 18, 2024, following receipt of the georeferenced map provided by Denison, the LLRIB responded indicating that Misinipiy Integrated Land Use Plan (2012) had not been reviewed or amended since it was finalized in 2012, and that LLRIB's boundaries have been updated internally and that LLRIB considers the Wheeler River Project to be within their traditional territory, and therefore wishes to enter into an agreement with Denison. Please see Appendix 4-A, ROC #1109.

On June 28, 2024, Denison replied to the LLRIB, outlining the process Denison follows in relation to formal agreements. Denison reiterated their commitment to continuing efforts in responding positively to areas of interest identified by LLRIB in relation to business development/community investment. Please see Appendix 4-A, ROC#1113.

4.3.3.4.3 Lac La Ronge Indian Band Key Interests, Issues and Concerns

A summary of key interests, issues and concerns gathered throughout the course of engagement for the Project, including any formal submissions made through the regulatory process, are identified in Appendix 4-B. It is important to note that areas of identified interest, issues, or concerns are not always related to environmental effects as defined by CEAA 2012 (the regime under which the Project is undergoing regulatory assessment) - they can be reflective of *general* areas of interest in relation to the Project more broadly. Where appropriate, the table aims to provide clarity with respect to this distinction.

4.3.3.5 Engagement with A La Baie Métis Local #21

A La Baie Métis Local #21 is situated within the Community of Île-à-la-Crosse. The Community of Île-à-la-Crosse was designated as a National Historic Site in 1954 by the Federal Environment Minister on the advice of the Historic Sites and Monuments Board of Canada. Additionally, the entire community is considered a historical Métis community, and as such, contains a strong Métis identity throughout (Sakitawak Conservation n.d.a).

Île-à-la-Crosse is the birthplace of Louis Riel Sr. and is the gravesite of Sr. Marguerite Riel (the sister of Louis Riel). In countless history books and maps, the community of Île-à-la-Crosse is duly noted for its historical significance in settling this entire area. Sakitawak is the Cree name for Île-à-la-Crosse, which means “where the rivers meet” (MN-S n.d.c). Recently, the Sakitawak Conservation Project commenced, which is mandated to protect habitats of vulnerable species, advance Indigenous ways of life, identify knowledge systems, and implement stewardship activities. The first area identified for this work is the N-14 Furblock (Sakitawak Conservation n.d.b).

Figure 4.3-2 illustrates where Île-à-la-Crosse is in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, Île-à-la-Crosse is located 275 km away from the Project. In terms of travel distance by existing transportation routes Île-à-la-Crosse is located 460 km away from the Project.

4.3.3.5.1 History of Interactions

Since 2016, Denison has been engaging with ALBML. The type and frequency of engagement has reflected an evolving understanding of ALBML’s traditional activities and land use, including in the region of the Project. The Northern Village of Île-à-la-Crosse, and many of the community members residing in Île-à-la-Crosse, self-identify as Métis. In some instances, the elected officials of Métis Locals are also elected members of the municipality and, therefore, represent both their Indigenous community as well as their municipality. As a result, during the onset of engagement activities in 2016, there was overlap in engagement with the entities of ALBML and the Village of Île-à-la-Crosse.

In 2019, the ALBML delegated their Duty to Consult for the Project to the MN-S. Clear distinction between the Métis leadership and Citizens, and the Village leadership and residents was, therefore, necessary to make sure the MN-S was able to appropriately provide the representation of the Métis of ALBML, per the delegated Duty to Consult. As a result, Denison distinguished its engagement efforts between MN-S, on behalf of ALBML, and the general public of the Village of Île-à-la-Crosse, with no intended overlap in relation to Métis interests.

From 2019 onwards, the MN-S has been representing ALBML in respect of engagement with Denison for the Project.

For details on Denison’s engagement with MN-S, see Section 4.3.4.1.

4.3.3.5.2 Agreements Relative to the Environmental Assessment Process

A MOU was signed by Denison, ALBML and the Village of Île-à-la-Crosse in 2018. The signing of this MOU with both ALBML and the Village of Île-à-la-Crosse reflected the perspective of ALBML and the Village of Île-à-la-Crosse to represent both municipal residents and the Métis Citizens co-operatively. This non-binding MOU formalized the intent to work together in a spirit of mutual respect to cooperate to collectively identify practical means by which to avoid, mitigate, or otherwise address potential effects of the Project upon the exercise of the Indigenous Rights, Treaty Rights, and interests, to the extent they are identified in relation to the Project.

In 2019, ALBML delegated their Duty to Consult for the Project to the MN-S. From 2019, the MN-S has been representing ALBML in respect of engagement with Denison for the Project.

4.3.3.5.3 Key Engagement Activities

During the engagement activities undertaken with ALBML, several key engagement activities took place that have played a meaningful role in relation to the EA process. These key engagement activities were supported by ongoing engagement methods including, but not limited to, those outlined in Section 4.2.1. The main forms of engagement included meetings with leadership, a community meeting, a workshop on early infrastructure options (2018), a site visit (2019) and a meeting coordinated by the MN-S. Considerable engagement has also occurred between Denison and MN-S on behalf of ALBML and other Métis Locals, as described in Section 4.3.4.1.

Engagement Focus: Pre-Project Description - April 2016 to May 2019

Introductory meeting – December 7, 2016: This was the inaugural meeting between the senior management team of Denison and various entities associated with ALBML and the Village of Île-à-la-Crosse. The meeting focussed on clarifying the nature of Denison's activities, including the Project and related exploration activities, the interest in employment, business and training opportunities, reclamation requirements, agreement negotiation considerations, investment possibilities, environmental sampling and monitoring, and questions in relation to the nuclear industry in general and market related to uranium. For more specifics about this activity, please see Appendix 4-A, ROC #109.

Workshop – January 17, 2018: Denison hosted a workshop with many community members and students. The focus of the workshop was to obtain feedback on three alternatives/options for the proposed Project: the road alignment from Highway 914 into the Project Area; the potential treated effluent discharge location; and the mining method options. The workshop opened and concluded with questions pertaining to Denison and the Project, comments on the importance of training, agreement negotiations and other general items.

General questions were asked regarding the various alternatives and options, and points of clarification pertaining to aspects of the Project. Feedback was collected on the various options and has been incorporated into the final design for road alignment, and the treated effluent discharge location. Please see Section 2 for more details. For more information about this activity, please see Appendix 4-A, ROC #3.

Engagement Focus: Post-Project Description – July 2019 to October 2022

Site Tour – August 23, 2019: In August 2019, Denison hosted a site tour at the Project location. The focus of this engagement activity was to provide an in-field opportunity to understand the proposed Project and the various elements associated with the Project.

Attending the site tour was the President of ALBML. The tour involved an initial presentation regarding the Project, followed by travel around the Project site to the various locations for the proposed elements of the Project. Representatives from the CNSC and SK MOE were present.

For additional details about this activity, please see Appendix 4-A, ROC #1.

Meeting – November 5, 2019: Denison hosted a meeting with the MN-S President, the Northern Region 3 President, legal counsel, some administrators, and several Local Presidents and representatives, including ALBML in attendance. This engagement activity was coordinated with the MN-S, in response to the delegated Duty to Consult from several Métis Locals as of November 2019. The focus was to provide an overview of the Project and discuss Métis interests in the Project. See Section 4.3.4.1.3 for a detailed discussion on this meeting. For more information about this activity, please see Appendix 4-A, ROC #62.

In 2019, ALBML delegated their Duty to Consult for the Project to the MN-S. From 2019, the MN-S has been representing ALBML in respect of engagement with Denison for the Project. For details on Denison's engagement with MN-S, see Section 4.3.4.1.

Future Engagement Activities

Denison expects to continue working with the ALBML, through the MN-S, throughout the remainder of the environmental assessment and approval process and into the licensing process, to coordinate engagement activities in relation to topics of interest in relation to the Project, in accordance with an agreed upon process.

4.3.3.5.4 A La Baie Métis Local #21 Public Comments on Draft Environmental Impact Statement and Related Processes

An important part of the engagement of Interested Parties for the Project is facilitated by federal regulators, and occurs vis-à-vis a public review of the draft EIS. During this public review of the draft EIS, Interested Parties can submit their views in writing on the adequacy of the information presented in the EIS, as measured against appropriate guidance materials, and on the technical merit of the information presented in the EIS.

The CNSC offered participant funding to assist Indigenous peoples, members of the public, and stakeholders in the review of the draft EIS. This participant funding offering was available from January 10, 2022, to March 14, 2022. On November 21, 2022, public comments were invited on the draft EIS by the CNSC.

On March 3, 2023, the MN-S submitted public comments on the draft EIS to the CNSC (Government of Canada 2024). As ALBML delegated their duty to consult to the MN-S, engagement on issues related to the environmental assessment are now represented by the MN-S. On December 1, 2023, following work undertaken with the MN-S since receipt of the March 3, 2023, public comments, Denison provided responses to the MN-S' public comments made on the draft EIS (please see ROC #973).

On December 1, 2023, following work undertaken with the MN-S since receipt of the March 3, 2023, public comments, Denison provided responses to the MN-S' public comments made on the draft EIS (please see Appendix 4-A, ROC #973).

During this same time period, Denison and the MN-S met regularly to discuss the advancement of the Métis Knowledge Study and to discuss items in relation to the development of a MN-S defined process for engagement on the Project, including in relation to the resolution of the MN-S public comments and general issues and concerns. One of the key areas of concern raised by the MN-S was the inclusion of information obtained as a result of the completion of the Métis Knowledge Study into the EIS. The Métis Knowledge Study was received by Denison on October 24, 2023, and Denison has integrated relevant information from the Study into the EIS accordingly.

In July 2023, Denison and the MN-S began discussions pertaining to the development of a Joint Working Group process in relation to engagement with the MN-S about the Project. As of June 30, 2024, Denison and the MN-S had tentatively agreed to amendments to the existing Capacity Funding Agreement in support of this mutually agreeable engagement process, with the amendments awaiting final approval as part of a process defined by MN-S.

Following further discussions between Denison and the MN-S during August 2024, MN-S outlined an additional process that MN-S desired take place between Denison and the MN-S, to occur in parallel to the earlier discussed mutually agreeable engagement process. It is Denison's understanding that the commencement of these parallel processes is expected to occur in the coming months.

For more information about the work undertaken with the MN-S, please see Section 4.3.4.1.

4.3.3.5.5 A La Baie Métis Local #21 Key Interests, Issues and Concerns

A summary of key interests, issues and concerns gathered throughout the course of engagement for the Project, including any formal submissions made through the regulatory process, are identified in Appendix 4-B. It is important to note that areas of identified interest, issues or concerns are not always related to environmental effects as defined by CEAA 2012 (the regime under which the Project is undergoing regulatory assessment) - they can be reflective of general areas of interest in relation to the Project more broadly. Where appropriate, the table aims to provide clarity with respect to this distinction. As ALBML delegated their duty to consult to the MN-S in late 2019, the table is representative to the timeframe prior to the delegation of the duty to consult by the ALBML to the MN-S.

4.3.3.6 Dore/Sled Lake Métis Local #67

In November 2019, when Denison was advised by the MN-S that a number of Métis Locals had delegated to MN-S the Duty to Consult for the Project, Dore/Sled Lake Métis Local #67 was one of the Locals. As such, the MN-S has held the Duty to Consult for Dore/Sled Lake Métis Local #67 since that time and Denison has been engaging through the MN-S for the Project.

Figure 4.3-2 illustrates where the communities are in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, Sled Lake is located 363 km away from the Project. In terms of travel distance by existing transportation routes, Sled Lake is located 537 km away from the Project. In terms of direct linear distance, Dore Lake is located 344 km away from the Project. In terms of travel by existing transportation routes, Dore Lake is located 590 km away from the Project.

4.3.3.6.6 Key Engagement Activities

Engagement Focus: Post-Project Description – July 2019 to October 2022

Meeting – November 5, 2019: Denison hosted a meeting with the MN-S President, the Northern Region 3 President, legal counsel, some administrators, and several Local Presidents and representatives. This engagement activity was coordinated with the MN-S, in response to the delegated Duty to Consult from several Métis Locals as of November 2019. The focus was to provide an overview of the Project and discuss Métis interests in the Project.

The President of Dore/Sled Lake Métis Local #67 was in attendance. For more specifics about this activity, please see Appendix 4-A, ROC #62.

In 2019, Dore/Sled Lake Métis Local #67 delegated their Duty to Consult for the Project to the MN-S. From 2019, the MN-S has been representing Dore/Sled Lake Métis Local in respect of engagement with Denison for the Project. For details on Denison's engagement with MN-S, see Section 4.3.4.1.

Future Engagement Activities

Denison expects to continue working with the Dore/Sled Lake Métis Local through the MN-S, throughout the remainder of the environmental assessment and approval process and into the licensing process, to coordinate engagement activities in relation to topics of interest in relation to the Project in accordance with an agreed-upon process.

4.3.3.6.7 Dore/Sled Lake Métis Local Public Comments on Draft Environmental Impact Statement and Related Processes

An important part of the engagement of Interested Parties for the Project is facilitated by federal regulators, and occurs vis-à-vis a public review of the draft EIS. During this public review of the draft EIS, Interested Parties can submit their views in writing on the adequacy of the information presented in the EIS, as measured against appropriate guidance materials, and on the technical merit of the information presented in the EIS.

The CNSC offered participant funding to assist Indigenous peoples, members of the public, and stakeholders in the review of the draft EIS. This participant funding offering was available from January 10, 2022, to March 14, 2022. On November 21, 2022, public comments were invited on the draft EIS by the CNSC.

On March 3, 2023, the MN-S submitted public comments on the draft EIS to the CNSC (Government of Canada 2024). As Dore/Sled Lake Métis Local #67 delegated their duty to consult to the MN-S, engagement on issues related to the environmental assessment are now represented by the MN-S.

On December 1, 2023, following work undertaken with the MN-S since receipt of the March 3, 2023, public comments, Denison provided responses to the MN-S' public comments made on the draft EIS (please see Appendix 4-A, ROC #973).

During this same time period, Denison and the MN-S met regularly to discuss the advancement of the Métis Knowledge Study and to discuss items in relation to the development of a MN-S defined process for engagement on the Project, including in relation to the resolution of the MN-S public comments and general issues and concerns. One of the key areas of concern raised by the MN-S was the inclusion of information obtained as a result of the completion of the Métis Knowledge Study into the EIS. The Métis Knowledge Study was received by Denison on October 24, 2023, and Denison has integrated relevant information from the Study into the EIS accordingly.

In July 2023, Denison and the MN-S began discussions pertaining to the development of a Joint Working Group process in relation to engagement with the MN-S about the Project. As of June 30, 2024, Denison and the MN-S had tentatively agreed to amendments to the existing Capacity Funding Agreement in support of this mutually agreeable engagement process, with the amendments awaiting final approval as part of a process defined by MN-S.

Following further discussions between Denison and the MN-S during August 2024, MN-S outlined an additional process that MN-S desired take place between Denison and the MN-S, to occur in parallel to the earlier discussed mutually agreeable engagement process. It is Denison's understanding that the commencement of these parallel processes is expected to occur in the coming months.

For more information about the work undertaken with the MN-S, please see Section 4.3.4.1.

4.3.3.7 Peter Ballantyne Cree Nation

The Peter Ballantyne Cree Nation (PBCN) is a Woodland Cree First Nation in northern Saskatchewan consisting of eight communities: Denare Beach, Deschambault Lake, Kinoosao, Pelican Narrows, Prince Albert, Sandy Bay, Southend and Sturgeon Landing. The Peter Ballantyne Cree Nation are called Assin'skowitiniwak or Rocky Cree. Assin'skowitiniwak means "people of the rocky area".

PBCN is a signatory to Treaty 6. Figure 4.3-2 illustrates where the communities are in relation to the Project, both in terms of direct linear distance and travel distance. PBCN is comprised of eight communities, including Amisk Lake (Denare Beach), Deschaumbault Lake, Kinoosao, Pelican Narrows, Prince Albert, Sandy Bay, Southend, and Sturgeon Landing (PBCN 2024). In terms of direct linear distance and travel distance by existing transportation routes, the following information is provided: Amisk Lake (Denare Beach)(direct linear distance = 375 km; travel distance by existing transportation routes = 750 km), Deschambault Lake (direct linear distance = 310 km; travel distance by existing transportation routes = 650 km), Kinoosao (direct linear distance = 200 km; travel distance by existing transportation routes = 1,520 km), Pelican Narrows (direct linear distance = 296 km; travel distance by existing transportation routes = 715 km), Prince Albert (direct linear distance = 485 km; travel distance by existing transportation routes = 615 km), Sandy Bay (direct linear distance = 287 km; travel distance by existing transportation routes = 785 km), Southend (direct linear distance = 180 km; travel distance by existing transportation routes = 700 km), Sturgeon Landing (direct linear distance = 425 km; travel distance by existing transportation routes = 850 km).

4.3.3.7.1 History of Interactions

With respect to the Project, Denison was contacted by PBCN on March 6, 2023, notifying Denison of their interest in the Project. In this initial contact, PBCN provided Denison a draft traditional territory map dated February 8, 2023, which differed from that information published on their website, and showed a portion of the property associated with the Project within the PBCN traditional territory.

As a result of this initial contact, Denison and PBCN planned for an initial introductory meeting about the Project. This introductory meeting occurred on May 15, 2023. During this meeting, PBCN expressed its interest to Denison about entering into agreement with them in support of engagement activities on the Project. PBCN also identified its perspective that the Project may adversely affect PBCN's Aboriginal and / or Treaty rights. As a result, Denison requested PBCN provide Denison with information about activities in and around the Project area (Appendix 4-A, ROC #907).

Denison and PBCN planned for an additional meeting whereby Denison would provide an overview of the Project and responses to PBCN's public comments on the draft EIS and related concerns, and PBCN would provide information regarding PBCN activities in and around the Project area. Denison and PBCN agreed on Denison providing capacity funding in support of this engagement activity. This meeting was held on September 20, 2023. During this meeting, Denison provided an overview of the Project and responded to questions of clarifications related to the Project activities. PBCN also provided an overview of the PBCN history and relationship to Reindeer Lake, from Hatchet Lake to Pelican Narrows. As well, PBCN noted that Denison is in the traditional territory of PBCN. During this meeting, Denison requested information about specific PBCN land uses in and around the

Project in order to better understand the potential for adverse impacts to PBCN rights. In response to this, PBCN noted that the Director of Lands and Resources, who was prepared to speak to this information, was unable to attend due to illness.

PBCN also provided an overview of their Land and Resources Committee (LRC) and the process designed by the LRC to engage with industry and participate in the regulatory process, which has been delegated to them by the Chief and Council of PBCN. It was noted that part of this process is to ensure that projects and potential impacts are understood, and PBCN is engaged throughout the process, which also includes undertaking commercial conversations with PBCN in relation to understanding impacts and sharing of benefits. In response to this, Denison restated its perspective that in order to consider such arrangements it would need to have clearer information about the potential for the Project to adversely impact PBCN rights.

Due to time constraints, Denison was unable to complete the presentation developed in response to PBCN public comments on the EIS. In the correspondence follow-up to the meeting provided on October 10, 2023, Denison provided PBCN with the presentation related to the Project overview, the presentation prepared in response to the PBCN public comments on the draft EIS, a set of meeting notes referencing key points made by both parties, and some follow-up information in relation to PBCN concerns about the potential for adverse impacts to water quality and the relationship to PBCN communities, along with transparency regarding monitoring for the Project. For more details, please see Appendix 4-A, ROC #977.

On October 20, 2023, PBCN sent a letter to Denison following up on the September 20, 2023, meeting and to Denison's October 10, 2023, correspondence. In this letter, PBCN articulated how PBCN members shared the important link between community wellness and the natural environment, and the importance of PBCN Members to exercise their treaty and Aboriginal rights. PBCN restated that the Project is within the PBCN traditional territory and will have potential environmental and socio-economic impacts, and thus have related impacts to PBCN's Aboriginal and treaty rights. This letter noted that PBCN was in contact with the federal and provincial regulators to explain PBCN's treaty and Aboriginal rights. PBCN also reiterated its perspective that PBCN lacked the capacity needed to support PBCN's engagement with respect to the Project.

On November 22, 2023, Denison responded to PBCN's letter of October 20, 2023. Denison reiterated its interest to continued engagement with PBCN on the Project, and restated its request to receive information pertaining to PBCN's specific interests and land use activities in the Project area that would be adversely impacted by the Project. Denison also provided an overview of its history with the Wheeler River property since 2004, outlining the information used to date to identify those Indigenous communities who may be impacted by the Project, such as the wildlife and fur block management administrative areas, existing traditional land use information made available through Key Lake and McArthur River public review processes, anticipated transportation routes, and anticipated impacts to water and publicly available information about Indigenous Nations' traditional territories.

On December 12, 2023, PBCN responded to Denison's letter of November 22, 2023. PBCN requested that discussions commence regarding capacity funding from Denison to support PBCN's engagement with Denison on the Project and to complete a PBCN-specific traditional land and resources use study and report for the Project. PBCN highlighted that, during the September 20, 2023, meeting between PBCN and Denison, members of the Lands and Resources Committee shared information with Denison about uses in and around the Project area, demonstrating PBCN's concerns regarding the potential impacts of the Project on PBCN's Aboriginal and treaty rights and interests.

On January 10, 2024, Denison responded to PBCN's correspondence from December 12, 2023. In that correspondence Denison provided a history of engagement activities that had occurred between PBCN since interest was expressed by PBCN in the Project, along with a response from Denison with respect to the PBCN concerns regarding potential water contamination to Reindeer Lake, the main waterbody in proximity to Southend, SK. Denison also responded to PBCN's concerns regarding cumulative effects and provided some information in relation to the methodology undertaken by Denison in respect of cumulative effects related to water. Denison also stated that in order for it to undertake deeper engagement than has occurred to date with PBCN, Denison would appreciate receiving information about how the Project will adversely impact PBCN land uses and rights, and without such information, was unable to determine that a traditional land and resources use study and report for the Project was warranted.

A comprehensive listing of engagement activities between Denison and PBCN, including a brief description of the purpose or activity and outcome where appropriate, is included in the IER.

Future Engagement Activities

Denison has indicated its willingness to engage with PBCN about the Project and will continue to do so, provided mutually agreeable circumstances for such engagement can occur.

4.3.3.7.2 Peter Ballantyne Cree Nation Public Comments on Draft Environmental Impact Statement and Related Processes

An important part of the engagement of Interested Parties for the Project is facilitated by the federal regulators, and occurs vis-à-vis a public review of the draft EIS. During this public review of the draft EIS, Interested Parties can submit their views in writing on the adequacy of the information presented in the EIS, as measured against appropriate guidance materials, and on the technical merit of the information presented in the EIS.

The CNSC offered participant funding to assist Indigenous peoples, members of the public, and stakeholders in the review of the draft EIS. This participant funding offering was available from

January 10, 2022, to March 14, 2022. On November 21, 2022, public comments were invited on the draft EIS by the CNSC.

On March 3, 2023, PBCN submitted public comments on the draft EIS to the CNSC (Government of Canada 2024).

As noted earlier in the section, Denison and PBCN met on May 15, 2023, to hold an introductory meeting between the parties. On September 20, 2023, another meeting was held in which it was planned that Denison would respond to the March 3, 2023, PBCN public comments on the draft EIS. Due to time constraints, this did not occur. As a follow up to the meeting, Denison provided those responses to PBCN in written form.

Since that time, Denison has offered to further discuss the responses to the public comments made on the draft EIS with PBCN. As recent as January 10, 2024, Denison has indicated its willingness to engage with PBCN about the Project and PBCN issues and concerns, and expects efforts to be undertaken in the future in this regard, provided that mutually agreeable circumstances for such engagement can be reached.

4.3.3.7.3 Peter Ballantyne Cree Nation Key Interests, Issues and Concerns

A summary of key interests, issues and concerns gathered throughout the course of engagement for the Project, including any formal submissions made through the regulatory process, are identified in Appendix 4-B. It is important to note that areas of identified interest, issues or concerns are not always related to environmental effects as defined by CEAA 2012 (the regime under which the Project is undergoing regulatory assessment) - they can be reflective of general areas of interest in relation to the Project more broadly. Where appropriate, the table aims to provide clarity with respect to this distinction.

4.3.4 Engagement with Indigenous Organizations

4.3.4.1 Métis Nation – Saskatchewan

As the elected government of the Métis people of Saskatchewan, the MN-S plays an important role related to engagement activities. The MN-S is currently structured with a President, an Executive, a Provincial Métis Council, Regional Directors, and Local Presidents. The MN-S website states that '*consultations must be with the Métis government structures that are elected and supported by the Métis people*' (MN-S n.d.b). The Project is located within Métis Region 1; however, there are Métis Locals in the general area of interest from Northern Region 3. Figure 4.3-2 illustrates where these Métis Locals and Regions are in relation to the Project.

In November 2019, Denison was advised by the MN-S that Kineepik Métis Local 9 (Pinehouse), A La Baie Métis Local 21, Sipishik Métis Local 37 (Île-à-la-Crosse), Métis Local 67 (Dore Lake and Sled Lake), and Patuanak Métis Local 82 (Patuanak) had delegated to MN-S the Duty to Consult for the Project, and also advised that MN-S would provide direction regarding engagement activities with Northern Region 1, Northern Region 3 and any other entities of the MN-S. Since then, Denison has been following the request of the MN-S in this regard. In November 2021, Denison was informed that KML had revoked its delegation of the Duty to Consult to the MN-S that it had previously provided in November 2019. As of June 2022, the MN-S have been formally delegated the Duty to Consult for the Project by Sipishik Métis Local 37 (Beauval), A La Baie Métis Local 21 (Île-à-la-Crosse), Patuanak Métis Local 82 (Patuanak) and Local 67 (Dore Lake and Sled Lake).

4.3.4.1.1 *History of Interactions*

Since Denison's initial connection with the MN-S about the Project in June 2019, the main focus of the activities between the parties has been on the development of appropriate processes, deliverables, and budgets desired by MN-S to support its meaningful participation in the EA process, including the representation of those Métis Locals who have delegated the Duty to Consult to MN-S.

Throughout the engagement, Denison has repeatedly and consistently affirmed its interest in MN-S participation and the incorporation of Métis knowledge into the EIS, in addition to the information and input that has already been gathered with KML.

A comprehensive listing of engagement activities between Denison and MN-S, including a brief description of the purpose or activity and outcome where appropriate, is included in the IER.

4.3.4.1.2 *Agreements Relative to the Environmental Assessment Process*

Since being advised by the MN-S in October 2019 that a number of Métis Locals had delegated to the MN-S the Duty to Consult for the Project, Denison has been engaged in extensive ongoing discussions with the MN-S with the goal of reaching agreement regarding the EA process and MN-S' participation in it.

In recognition of the MN-S' potential interests in the Project, the parties have specifically agreed to a process between each other that will be funded by Denison and undertaken on behalf of the MN-S in connection with the EA of the Project: a Métis Knowledge Study, meetings to focus on VCs and preliminary effects, and regular meetings and associated costs for hosting such meetings.

A capacity funding agreement was signed relative to the above process with the MN-S in October 2022. As part of this agreement, Denison agreed to fully fund a Métis Knowledge Study. Denison received the Métis Knowledge Study from the MN-S on October 24, 2023, and has integrated relevant information from the Study into the EIS. For more information about the Métis Knowledge Study, please see Section 3 of the EIS.

On February 17, 2023, based on a request by the MN-S, Denison and the MN-S entered into an amendment to the Capacity Funding Agreement to provide additional funding to further support the MN-S technical review on the draft EIS.

In July 2023, Denison and the MN-S began discussions pertaining to the development of a Joint Working Group process in relation to engagement with the MN-S about the Project. As of June 30, 2024, Denison and the MN-S had tentatively agreed to amendments to the existing Capacity Funding Agreement in support of this mutually agreeable engagement process, with the amendments awaiting final approval as part of a process defined by MN-S.

Following further discussions between Denison and the MN-S during August 2024, MN-S outlined an additional process that MN-S desired take place between Denison and the MN-S, to occur in parallel to the earlier discussed mutually agreeable engagement process. It is Denison's understanding that the commencement of these parallel processes is expected to occur in the coming months.

4.3.4.1.3 Key Engagement Activities

During the engagement activities undertaken with MN-S, two engagement activities of note took place. These key engagement activities were supported by ongoing engagement methods including, but not limited to, those outlined in Section 4.2.1. The following describes the activities in more detail.

Engagement Focus: Post-Project Description – July 2019 to October 2022

Site Tour – August 23, 2019: In August 2019, Denison hosted a site tour at the Project location. The focus of this engagement activity was to provide an in-field opportunity to understand the proposed Project and the various elements associated with the Project.

Attending the site tour were the President of the MN-S, the President of MN-S Region 3, and a number of Métis Local Presidents and/or representatives, including the President and Executive Director of the KML, the Vice President of the SML, the President of PML, and the President of the ALBML. The tour involved an initial presentation regarding the Project, followed by travel around the Project site to the various locations for the proposed elements of the Project. Representatives from the CNSC and SK MOE were present.

Specific questions were raised by the MN-S representatives in relation to:

- confirmation that Denison was following the engagement protocols and direction set out by the MN-S in relation to the Regions and the Locals;
- queries regarding general Project particulars, such as waste management, wastewater, radiation monitoring and management, and the composition of the mining solution to be used, and the nature of this solution in relation to the grade of the ore; and
- confirmation that Denison will be using local contractors for the Project.

For more specifics about this activity, please see Appendix 4-A, ROC #1.

Meeting – November 5, 2019: In response to the delegated Duty to Consult from a number of Métis Locals provided in November 2019, Denison hosted a meeting with the MN-S President, the Northern Region 3 President, legal counsel, some administrators, and several Local Presidents and representatives, including from the KML, the SML, the ALBML, and the PML. The focus was to provide an overview of the Project and discuss Métis interests in the Project.

The MN-S noted that they are focused on supporting the Locals, and finding capacity within the organization to support efforts going forward with Denison.

The MN-S noted that they provided direction to legal counsel to seek an exploration agreement with Denison.

Questions were asked regarding location of Denison sites and focused interests, what would occur should the Project change ownership with a potential Impact Benefit Agreement and the relationship developed between Denison and MN-S, costs assessment of the Project, the relationship of share price and community investment expenditures, and the challenges related to securing business opportunities at sites for smaller communities.

Technical questions were asked regarding the ISR mining method: employment related to the ISR operation; the potential for other deposits in the Athabasca Basin to be mined using ISR; clarification that ISR is not the same as fracking, as fracking uses very high pressures to break the rock apart; the consequence of various types of accidents that could occur, such as a pumping or injection well breaking, the volume of acid required and requirement for transportation of the acid; and the transportation requirements for yellowcake.

Logistical questions were asked regarding the potential future mining of the Gryphon deposit, which is not part of the Project assessed herein. These questions were focused on the location for milling of Gryphon ore and whether the road connection between McArthur River and Cigar Lake would be part of the Gryphon project, if it were to proceed in the future.

Questions related to the environment and protection of people were asked, such as those focused on water sampling conducted to date, methodology of dealing with treated effluent, environmental monitoring in general, the interest of the Métis regarding transparent environmental monitoring data and access to such data, and understanding the potential for radiation doses from the operation.

The MN-S identified their interest in understanding the IK collected for the Project (from KML), if Denison was conducting additional work in this area, and if Denison would consider doing so. Denison indicated that IK, including land use data, is an integral part of the EIS development, and expects to receive direction from the MN-S on this topic as the process moves forward.

Discussion occurred regarding the concern about racism occurring at sites, include the Project exploration site, and how to make sure all people are treated with respect at the working sites, now and in the future. It was mutually expressed that the MN-S and Denison have a shared interest towards making sure values of respect are embedded into the Project development.

The MN-S identified that the land in which the Project is located is subject to a land claim, the resources within the land claim area are claimed by the Métis, and removal of the resources claimed by the Métis must result in a portion of the revenue going back to the Métis. The MN-S has a desire to create a legacy and generate wealth for its people.

For more information about this activity, please see Appendix 4-A, ROC #62.

Engagement Focus: Environmental Assessment Outcomes and Relationship to Licensing / Approvals – October 2022 to Present

Meetings – February 11and February 12, 2023: In February 2023 the MN-S coordinated meetings with the leadership of NR1 and NR3 separately, in order to support the MN-S' efforts towards processing the Métis Knowledge Study and contributions toward the MN-S' public comments on the draft EIS.

Subsequently, on February 11, 2023, Denison met with MN-S and NR1 leadership along with Two Worlds Consulting, the CNSC, and the Government of Saskatchewan. On February 12, 2023, Denison met with MN-S and NR3 leadership along with Two Worlds Consulting, the CNSC, and the Government of Saskatchewan. In both meetings, Denison presented an overview of the Project, the environmental assessment process, the valued components, and the environmental assessment outcomes. Generally, during both meetings, numerous questions were asked about the Project and the technical elements of the Project. There was also discussion about the importance of transparency with respect to environmental monitoring outcomes and ensuring that opportunities are available for Métis people beyond entry level positions. It is Denison's understanding that the MN-S utilized the engagement discussions to inform their contributions toward the MN-S' public comments on the draft EIS. For more information about this activity, please see Appendix 4-A, ROC #824 and ROC #835.

Future Engagement Activities

Denison expects to continue working with the MN-S, throughout the remainder of the environmental assessment process and into the licensing process, to coordinate engagement activities in relation to their topics of interest related to the Project, in accordance with an agreed-upon process.

4.3.4.1.4 Métis Nation – Saskatchewan Public Comments on Draft Environmental Impact Statement and Related Processes

An important part of the engagement of Interested Parties for the Project is facilitated by federal regulators, and occurs vis-à-vis a public review of the draft EIS. During this public review of the draft EIS, Interested Parties can submit their views in writing on the adequacy of the information presented in the EIS, as measured against appropriate guidance materials, and on the technical merit of the information presented in the EIS.

The CNSC offered participant funding to assist Indigenous peoples, members of the public, and stakeholders in the review of the draft EIS. This participant funding offering was available from January 10, 2022, to March 14, 2022. On November 21, 2022, public comments were invited on the draft EIS by the CNSC.

On March 3, 2023, the MN-S submitted public comments on the draft EIS to the CNSC (Government of Canada 2024), which comprised 125 technical comments.

On December 1, 2023, following work undertaken with the MN-S since receipt of the March 3, 2023, public comments, Denison provided responses to the MN-S' public comments made on the draft EIS (please see Appendix 4-A, ROC #973).

During this same time period, Denison and the MN-S have met regularly to discuss the advancement of the Métis Knowledge Study and to discuss items in relation to the development of a MN-S defined process for engagement on the Project, including in relation to the resolution of the MN-S public comments and general issues and concerns. One of the key areas of concern raised by the MN-S was the inclusion of information obtained as a result of the completion of the Métis Knowledge Study into the EIS. The Métis Knowledge Study was received by Denison on October 24, 2023, and Denison has integrated relevant information from the Study into the EIS accordingly.

In July 2023, Denison and the MN-S began discussions pertaining to the development of a Joint Working Group process in relation to engagement with the MN-S about the Project. As of June 30, 2024, Denison and the MN-S had tentatively agreed to amendments to the existing Capacity Funding Agreement in support of this mutually agreeable engagement process, with the amendments awaiting final approval as part of a process defined by MN-S.

Following further discussions between Denison and the MN-S during August 2024, MN-S outlined an additional process that MN-S desired take place between Denison and the MN-S, to occur in parallel to the earlier discussed mutually agreeable engagement process. It is Denison's understanding that the commencement of these parallel processes is expected to occur in the coming months.

4.3.4.1.5 Métis Nation – Saskatchewan Key Interests, Issues and Concerns

A summary of key interests, issues and concerns gathered throughout the course of engagement for the Project, including any formal submissions made through the regulatory process, are identified in Appendix 4-B. It is important to note that areas of identified interest, issues or concerns are not always related to environmental effects as defined by CEAA (they can be reflective of general areas of interest in relation to the Project more broadly). Where appropriate, the table aims to provide clarity with respect to this distinction.

4.3.4.2 Ya'thi Néné Lands and Resources Office

The YNLR was created as a not-for-profit organization to be the single point of contact between industry, government, and the local Athabasca communities of Hatchet Lake First Nation, Black

Lake First Nation, Fond du Lac First Nation, Camsell Portage, Stony Rapids, Uranium City, and Wollaston Post. As outlined on their website, their mission is to protect the lands and waters of the Athabasca Basin for the long-term benefit of its Denesųłiné First Nations and Athabasca communities, guided by their knowledge, traditions, and ambitions, while being a respected partner in relations with industries, governments, and organizations who seek to develop the Athabasca Basin's resources (YNLR n.d.).

In March 2019, Denison was notified by the YNLR that the Indigenous communities within the local Athabasca communities identified above were interested in the Project and that YNLR held the Duty to Consult from these communities. Prior to this, Denison followed the previously accepted approach by the CNSC and Province of Saskatchewan to engage with the Athabasca Basin communities (Indigenous and non-Indigenous communities) in relation to activities occurring in the northern part of the Athabasca Basin region (from Cigar Lake and north). The YNLR was also identified by the CNSC as having interests in the Project.

The Project Is located within the Nuhenéné (the Athabasca Denesųłiné territory) and, as such, Denison has engaged with YNLR to better understand the traditional land use activities that are currently being undertaken in the Project Area by the member Indigenous communities of YNLR.

As stated above, YNLR directed Denison to undertake engagement and communication solely with YNLR for the purposes of any activities requiring approval actions, such as an EA for the Project. As such, engagement activities undertaken with YNLR are, therefore, considered representative of the Indigenous communities of Hatchet Lake First Nation, Black Lake First Nation and Fond du Lac First Nation (unless otherwise specified), and the municipal non-Indigenous communities of Uranium City, Stony Rapids, Camsell Portage and Wollaston Lake.

4.3.4.2.1 History of Interactions

Since Denison's initial connection with the YNLR about the Project in March 2019, Denison has been engaging with YNLR in a variety of ways. A comprehensive listing of engagement activities between Denison and YNLR, including a brief description of the purpose or activity and outcome where appropriate, is included in the IER.

4.3.4.2.2 Agreements Relative to the Environmental Assessment Process

The Project is located within the Nuhenéné (the Athabasca Denesųłiné territory). As such, Denison entered into two letter agreements with YNLR in 2021 to support the YNLR's participation in the EA process for the Project:

1. A Letter Agreement outlining arrangements for Denison and YNLR to mutually plan and coordinate appropriate engagement activities in relation to the Project, with Denison fully funding the activities.
2. A Letter Agreement outlining a mutually agreeable process by which the YNLR would author a report for Denison to consider and include, as appropriate, into the EIS. This included a process

by which the YNLR would also pre-review the pertinent sections of the EIS in relation to their authored report to comment in respect of Denison's inclusion of the YNLR-authored materials.

As a result, several additional activities have been undertaken between Denison and YNLR, including YNLR's pre-review of pertinent sections of the EIS, which are further described below in Section 4.3.4.2.4.

4.3.4.2.3 Key Engagement Activities

During the engagement activities undertaken with YNLR, the main forms of engagement included meetings with YNLR leadership (including representation of various Chiefs, Councillors and municipal leaders), an online survey (2021), a virtual meeting targeted toward all of the YNLR communities, and an in-person series of community meetings. These key engagement activities were supported by ongoing engagement methods including, but not limited to, those outlined in Section 4.2.1.

The following describes the key engagement activities in more detail.

Engagement Focus: Post-Project Description – July 2019 to October 2022

Meeting – October 3, 2019: This meeting was the inaugural meeting between members of the senior management team of Denison and the leadership of the YNLR, including the administration of YNLR, three Chiefs each from Black Lake, Fond du Lac and Hatchet Lake, two Councillors each from Hatchet Lake and Black Lake, Board Directors of the YNLR and advisors and support team to the YNLR. Attendees asked questions on the following topics to Denison:

1. the nature of the mining solution and containment methods for the mining solution, including contingency measures if excursions occur outside of freeze dome;
2. details regarding the freeze concept;
3. details regarding groundwater in the area and number and location of the monitoring wells;
4. details on the type of ore body (grade, impurities, percentage recovered);
5. lifespan of the Project and opportunities for employment, training and business;
6. quality of treated effluent;
7. use of ISR methodology and relationship to other deposits in the area, such as Midwest; and
8. specific comments pertaining to Treaty and/or Indigenous Rights in or around the Project.

For additional details about this activity, please see Appendix 4-A, ROC #78.

Meetings (Leadership and Virtual) – September 29, 2021: On September 29, 2021, Denison hosted virtual meetings with YNLR including with leadership and staff members of the YNLR, two Chiefs each from Fond du Lac and Hatchet Lake, two Councillors each from Black Lake and Hatchet Lake and four municipal leaders each from Uranium City, Camsell Portage, Stony Rapids and Wollaston

Lake, as well as hosted a virtual meeting for community members from all the YNLR-represented communities. These meetings were planned in collaboration with the YNLR. The focus of these engagement activities was to provide information about the Project to the YNLR leadership and community members, present a preliminary list of VCs that Denison had identified as part of the EA process, provide an opportunity for members to give feedback on the proposed list of VCs, and ask questions about Project components of interest or concern to them.

The topics covered during the presentations at the meeting included the following:

- Denison company introduction and key staff members;
- introduction to regulators;
- location of the Project;
- ISR mining, in general;
- ISR mining at the Project, including the recent change in the Project design from freeze dome technology to a freeze wall containment method;
- past work undertaken by Denison on options analysis;
- employment opportunities;
- EA; and
- VCs.

Leadership Meeting – September 29, 2021: Denison hosted the leadership meeting over Zoom. There were 20 leadership participants, including with leadership and staff members of the YNLR, two Chiefs each from Fond du Lac and Hatchet Lake, two Councillors each from Black Lake and Hatchet Lake and four municipal leaders each from Uranium City, Camsell Portage, Stony Rapids and Wollaston Lake:

Questions and comments focussed on:

- the importance of engagement with the Athabasca Denesų̨łiné;
- opportunities from the Project;
- access through the Key Lake Gate;
- general agreement comments (in relation to other Collaboration Agreements, exploration agreements);
- technical questions pertaining to the mining method including the amount of water to be used, treatment;
- use of the method in other locations;
- managing the potential effects to the land; and

- training opportunities.

For more information about this activity, please see Appendix 4-A, ROC #570.

Virtual Meeting – September 29, 2021: Denison hosted the virtual community presentation over Zoom. The virtual meeting was advertised on the radio and social media, and posters were placed in community buildings. Denison delivered a presentation over Zoom. Athabasca Basin community members were invited to ask questions during the presentation, share their thoughts through a survey questionnaire, or email Denison directly with feedback. At least nine Zoom accounts were used to attend the presentation; however, more than one person may have viewed the presentation from each account. Throughout the meeting, Denison encouraged attendees to share their questions in the Zoom chat feature. Attendees did not post any questions in the chat during the meeting. The Provincial regulator was in attendance. For additional details about this activity, please see Appendix 4-A, ROC #571.

Online Survey**:** During and following the YNLR meeting(s), members were invited to provide feedback on VCs through an online survey. The purpose of the survey was to seek feedback on the importance of the VCs to members, and identify interests or concerns related to the Project, providing an additional means by which feedback could be provided to Denison. Those who were unable to attend the presentation were also encouraged to provide feedback through the survey. The survey was marketed using Facebook and radio advertisements.

The survey was open for feedback from September 29 until October 10, 2021. No responses from Athabasca Basin residents were received during this time.

Engagement Focus: Environmental Assessment Outcomes and Relationship to Licensing / Approvals – October 2022 to Present

Meetings – January 23 to January 25, 2023: In January 2023 a series of community meetings were jointly coordinated with the YNLR and Denison, during which information was shared about the Project. In addition to providing an overview on exploration activities and the recently signed Exploration Agreement, Denison also provided an update to community members pertaining to the Wheeler River Project. Live translations were carried out throughout the presentation. The presentation pertained to Project components, Project technologies, Project schedule, the regulatory process, and the environmental impact assessment process and outcomes. Booklets were available for community members to take home that included, but were not limited to, detail on Project components, Project technologies, regulatory process, Project schedule and the EIS including valued components, significance findings, monitoring, and mitigation. A one-page summary on the WRP was available for community members to take home in English, Cree, and Dene. The in-person meetings were as follows:

January 23, 2023 (evening): Black Lake First Nation (Please see Appendix 4-A, ROC #823)

January 24, 2023 (daytime): Uranium City (Please see Appendix 4-A, ROC #842)

January 24, 2023 (evening): Fond du Lac First Nation (Please see Appendix 4-A, ROC #845)

January 25, 2023 (evening): Hatchet Lake First Nation (Please see Appendix 4-A, ROC #846)

Site Tour – November 2, 2023: In accordance with a previous commitment to the YNLR, Denison worked with the YNLR to coordinate a site visit to the Project in 2023. On September 15, 2023, Denison and the YNLR representatives attempted to fly to the Project site to undertake the site visit, but due to poor visibility, were unable to complete this activity. Subsequently, on November 2, 2023, Denison and the YNLR successfully visited the Project site. An overview of the work done to date on the Project was provided, including the 2022 and 2023 Feasibility Field Test in support of the Project.

Meeting - February 22, 2024: In support of resolution of issues raised by the YNLR on the draft EIS for the Project, Denison and the YNLR held an in-person technical meeting focused on cumulative effects, with both Denison's and YNLR's technical experts in attendance. Both YNLR and Denison provided presentations centered around cumulative effects, and YNLR provided an overview on environmental monitoring and management with reference to Denison's responses to YNLR comments on the environmental impact statement for the Wheeler River Project.

Athabasca Basin Community Meetings – June 10 to June 13, 2024: In June 2024, Denison and the YNLR collaboratively facilitated a series of in person meetings for Athabasca communities. In addition to Denison's and the YNLR's participation in these meetings, members of the Saskatchewan Ministry of Environment were also in attendance. The CNSC was also invited but, due to a conflict with other commitments, was unable to attend.

In advance of these meetings, Denison and the YNLR met virtually for discussion at regular intervals for the purpose of discussing logistics and planning. Through this process, engagement materials were developed by Denison that incorporated YNLR feedback.

At the recommendation of the YNLR, engagement focused largely on introducing the in situ recovery mining method at a conceptual level. Specifics pertaining to the Wheeler River Project were then shared with community members and included Project stage, Project components, and mitigation and monitoring, and future employment and business opportunities. This information was shared through PowerPoint presentation and accompanying hardcopy booklets. Live translations were carried out throughout the presentations and associated dialogue, and a one-page summary of the Wheeler River Project was available, in hard copy, in English, Cree, and Dene. Presentations were additionally conducted by the YNLR and the Saskatchewan Ministry of Environment.

The in-person meetings and associated themes central to discussion are as follows:

Stony Rapids Community Meeting – July 10, 2024 (afternoon): Throughout the Stony Rapids Community Meeting, the most prominent and recurrent theme expressed by attendees related to socio-economic wellbeing and was often expressed in terms of economic benefits such as employment, training, and business opportunities. The importance of providing youth with opportunities for training and employment relative to the mining industry was expressed. Attendees emphasized the importance of developing relationships to further socio-economic benefits. In addition to highlighting employment, training, and business opportunities, attendees expressed the need for improved infrastructure, emphasizing the poor quality of the road connecting Stony Rapids to Points North.

During this community meeting, questions were asked specific to Project technology and Project components. Some attendees expressed support of the small Project footprint and the low impact mining method, while others emphasized hesitancy based on expressed perspectives related to the sharing of benefits. Attendees additionally stressed the importance of ongoing communication and information sharing. It was indicated by one attendee that trapping is impacting by the onset of surrounding exploration activities. Please see Appendix 4-A, ROC #1102 for more information on this meeting.

Black Lake First Nation Community Meeting – June 10, 2024 (evening): During the Black Lake Community Meeting, attendees asked Project specific questions following the presentation provided by Denison such as the life of the Wheeler River Mine, the depth of the Phoenix ore body, and clarifications surrounding the leaching process as part of the in situ recovery mining method. Dialogue that followed these questions centred around employment and training opportunities, with attendees placing emphasis on enabling community members to obtain and retain meaningful employment. The importance of training opportunities was highlighted. Please see Appendix 4-A, ROC #1103 for more information on this meeting.

Uranium City Community Meeting with Camsell Portage Attending Virtually – June 11, 2024 (evening): During the Uranium City Community Meeting, dialogue was primarily related to Project technologies and notably centred around freeze wall technology. Attendees sought information on the freeze wall through questions such as, “Are the freeze walls keyed into the basement rock?” and, “How thick is the freeze wall once it's in place?” Similarly, attendees sought clarity on processes by which groundwater is protected. This was shown through questions relating to groundwater remediation, monitoring wells, and the potential for mining fluid to migrate outside of the mining area. Please see Appendix 4-A, ROC #1104 for more information on this meeting.

Fond du Lac First Nation Community Meeting – June 12, 2024 (canceled): Denison was informed by the YNLR on June 7, 2024, of the cancellation of the community meeting in Fond du Lac, owing to unforeseen circumstances.

Hatchet Lake First Nation Community Meeting – June 13, 2024 (evening): Dialogue that occurred throughout the Hatchet Lake First Nation Community Meeting centred largely around the mining area, particularly with respect to containment and the freeze wall. This was emphasized through questions such as, “Will those chemicals be able to escape out of the freeze wall?” Similarly, attendees looked to confirm the freeze wall timeline in relation to a phased approach to mining through questions such as, “Mining will be done in phases. What do you do with the freeze wall when you move on to future phases?” and, “Will the freeze walls of earlier phases stay frozen while later phases are mined? In the long run will anything escape to the environment?” A common theme can be inferred from this dialogue: the potential impacts associated with the ISR mining process and related mitigation and contingency measures. By asking for clarification on the potential for an accidental release should the freeze wall fail and expressing a consideration of remediation, attendees emphasized a regard for subsurface impacts in both short terms and long-term contexts, evidenced by the questions: “How will you protect against radiation from escaping the leaching area?”

While the primary point of emphasis throughout the Hatchet Lake First Nation Community meeting related to the subsurface environment, additional topics were discussed as guided by questions and comments expressed by attendees: i) Attendees asked questions and shared thoughts about engagement processes, ii) Attendees asked questions and shared thoughts about the impacts of sulfuric acid on vegetation, iii) Attendees shared thoughts about impacts to the fishing economy as a result of reporting, iv) Attendees looked to confirm that Denison would have a water treatment plant, v) Attendees shared thoughts about water quality requirements per federal and provincial legislation in the context of fishing and food industry standards, vi) Attendees asked questions about Project components, vii) One attendee referenced the Project footprint, stating that, “[The] small footprint of the project is ok, but the community looks at the new disturbance along with a lot of other activities that are happening on the landscape. Cumulatively, the footprint of mining is not small to communities.” Please see Appendix 4-A, ROC #1105 for more information on this meeting.

Future Engagement Activities

Denison expects to continue working with the YNLR, throughout the remainder of the environmental assessment and approval process and into the licensing process, to coordinate engagement activities in relation to topics of interest in relation to the Project.

4.3.4.2.4 Engagement Activities Associated with Ya’thi Néné Lands and Resources Office-Specific Processes

As noted in Section 4.3.4.2.2, Denison entered into two Letter Agreements with the YNLR in relation to the Project in 2021 to provide capacity support to enable YNLR to contribute to the EIS. As a result of the Letter Agreements, YNLR and Denison have developed engagement activities specific to YNLR, funded by Denison:

1. In March 2022, the YNLR transmitted and expressed support for inclusion in the EIS of their report entitled *An Exploration of Recorded Athabasca Denesųłiné Traditional Knowledge, Land Use and Occupancy Information in the Vicinity of Denison Mines Wheeler River Project* (see Appendix 3-A in Section 3). This report, funded by Denison, focused primarily on the Athabasca Denesųłiné First Nations, including Hatchet Lake, Black Lake, and Fond du Lac. Indigenous

Knowledge and LK within this report, as well as publicly available information, has been integrated into the EIS with focus on the Athabasca Denesųłiné communities. This report is an amalgamation of known information from YNLR and was not collected explicitly for the purposes of the Project and, as such, should be interpreted with caution.

These reports have contributed to the information Denison is presenting in the EIS with respect to the knowledge and information by and about YNLR. Please see Table 3.5-1 in Section 3 for more information.

2. Review by YNLR of EIS information prior to filing draft EIS with Regulators.
   a. Denison shared EIS information (in the forms of specific sections of the EIS) with YNLR prior to filing the draft EIS with the Regulators, to provide YNLR an opportunity to review information made in reference to YNLR, including that information provided to Denison in the report authored by YNLR, as identified above. As a result, the sections shared with YNLR were:
      i. Section 3 Indigenous and Local Knowledge; and
      ii. Section 11 Land and Resource Use.

During this pre-review, YNLR expressed concern regarding the classification of the Athabasca Denesųłiné First Nations (specifically Hatchet Lake First Nation) as Indigenous Communities rather than Indigenous Communities of Interest. Denison responded to this concern in a letter to YNLR in early October 2022, which also included a disposition table responding to each specific concern identified by YNLR. As necessary, Denison has also addressed these other concerns in the relevant sections of the EIS.

4.3.4.2.5 Ya'thi Néné Lands and Resources Office Public Comments on Draft Environmental Impact Statement and Related Processes

An important part of the engagement of Interested Parties for the Project is facilitated by federal regulators, and occurs vis-à-vis a public review of the draft EIS. During this public review of the draft EIS, Interested Parties can submit their views in writing on the adequacy of the information presented in the EIS, as measured against appropriate guidance materials, and on the technical merit of the information presented in the EIS.

The CNSC offered participant funding to assist Indigenous peoples, members of the public, and stakeholders in the review of the draft EIS. This participant funding offering was available from January 10, 2022, to March 14, 2022. On November 21, 2022, public comments were invited on the draft EIS by the CNSC.

On March 4, 2023, the YNLR submitted public comments on the draft EIS to the CNSC (Government of Canada 2024), which comprised 64 technical comments.

On July 18, 2023, Denison and the YNLR met to discuss the YNLR’s public comments on the draft EIS.

On July 20, 2023, the YNLR sent Denison a letter outlining the YNLR’s preferred approach for Denison to respond to the YNLR’s public comments on the draft EIS, which was that they wished to have Denison provide a written response to all items raised in the public comments on the draft EIS (see Appendix 4-A, ROC #920).

On November 23, 2023, following work undertaken with the YNLR since receipt of the July 20, 2023, letter to Denison from the YNLR, Denison responded to YNLR’s public comments made on the draft EIS (see Appendix 4-A, ROC #971).

On February 2, 2024, following Denison’s response to YNLR’s public comments made on the draft EIS, in advance of the technical meeting between Denison and the YNLR in support of resolution of issues raised by the YNLR on the draft EIS for the Project, YNLR provided a letter to Denison outlining their perspective on the status of comments (see Appendix 4-A, ROC #1044).

On February 22, 2024, in support of resolution of issues raised by the YNLR on the draft EIS for the Project, Denison and the YNLR held an in person technical meeting focused on cumulative effects, with both Denison's and YNLR's technical experts in attendance. Both YNLR and Denison provided presentations centered around cumulative effect methodology, and YNLR provided an overview on environmental monitoring and management with reference to Denison's responses to YNLR comments on the environmental impact statement for the Wheeler River Project.

On February 23, 2024, following their recent technical meeting, Denison emailed the YNLR and provided to YNLR copies of: i) the meeting agenda, ii) Denison's presentation, iii) The Caribou Management Framework that was filed with the revised draft environmental impact statement for the Wheeler River Project, iv) the WRP draft EIS Section 16- Summary of Monitoring & Follow-up Programs for Wheeler River, and v) Denison's commitments register updated as of filing of the draft EIS on February 10, 2024 (see Appendix 4-A, ROC #1081).

On March 13, 2024, the YNLR provided additional comments on Denison’s November 23, 2023, EIS responses. The YNLR indicated that Denison’s initial November 23, 2023, responses on pages 19 to 39 dealt with woodland caribou, cumulative effects, and other terrestrial matters and as such they were addressed in the February 22, 2024, meeting with Denison and representatives from Ecometrix (see Appendix 4-A, ROC #1084).

On April 5, 2024, Denison provided responses to YNLR’s March 13, 2024, comments and indicated that Denison would consider YNLR’s comments resolved in instances where no follow up comment has been provided. This correspondence from Denison outlined a number of specific commitments from Denison in respect of the draft EIS comments made and the further March 13, 2024, comments. (see Appendix 4-A, ROC#1085).

On April 30, 2024, Denison requested an update on the status of comment resolution from Ya'thi Néné Lands and Resource Board, following a recent meeting between Denison and the YNLR in which a number of items were discussed (see Appendix 4-A, ROC #1089)

On June 19, 2024, the YNLR provided a letter to update Denison on the status of YNLR comments made on the draft EIS for the Wheeler River Project following measures taken in pursuit of comment resolution to date. YNLR indicated that they do not consider any of their concerns expressed in their February 2, 2024, and March 13, 2024, letter to be resolved (see Appendix 4-A, ROC #1110).

On June 28, 2024, Denison provided a response to the YNLR, clarifying Denison's position on the various endeavours undertaken in pursuit of comment resolution, and seeking clarity from the YNLR in relation to the process by which YNLR desires to have undertaken in order to move forward toward the resolution of outstanding concerns. This correspondence reiterated several commitments made by Denison in response to the concerns and requests made by the YNLR over the entirety of the public review process for the Project (see Appendix 4-A, ROC #1112).

Denison expects to continue working with the YNLR to coordinate engagement activities related to their topics of interest related to the Project.

4.3.4.2.6 Ya'thi Néné Lands and Resources Office Key Interests, Issues and Concerns

A summary of key interests, issues and concerns gathered throughout the course of engagement for the Project, including any formal submissions made through the regulatory process, are identified in Appendix 4-B. It is important to note that areas of identified interest, issues or concerns are not always related to environmental effects as defined by CEAA 2012 (the regime under which the Project is undergoing regulatory assessment) - they can be reflective of general areas of interest in relation to the Project more broadly. Where appropriate, the table aims to provide clarity with respect to this distinction.

4.3.4.3 Meadow Lake Tribal Council and Prince Albert Grand Council

As noted in the introduction to this section, Denison corresponded with MLTC and PAGC to keep them informed of key project stages. As interactions were few, they have been grouped together in this subsection.

In 2019, MLTC and PAGC were identified by the CNSC as potentially having an interest in the Project. As a result, Denison sent correspondence to them in 2019 with information about the Project; in March 2020 informing them of the temporary suspension of the EA; and in January 2021 about the Project Restart. As of January 2024, Denison has not been contacted by either Council in respect of the Project.

On March 5, 2023, the PAGC submitted public comments on the draft EIS to the CNSC (Government of Canada 2024). Due to an administrative error, Denison was unaware these comments had been submitted to the CNSC. Upon realization of this situation, Denison provided a direct response to the PAGC comments.

On June 6, 2024, Denison responded to the PAGC's public comments on the draft EIS (Please see Appendix 4-A, ROC #1099).

4.4 Engagement with the General Public

As noted in Section 4.2, Denison determined that engagement with the General Public would focus on four groups:

- Non-Indigenous COI;
- Other Non-Indigenous Communities;
- Nearby Land Users; and
- Organizations.

The rationale for inclusion of these groups to receive engagement is as follows: A municipality or non-Indigenous COI community located near the existing transportation infrastructure used by the Project may experience efforts by Denison to offer employment, training, and business opportunities in connection with the Project and, therefore, may experience socioeconomic effects from the Project. Nearby Land Users such as commercial trappers or fishers, cabin/lease owners, or commercially operated lodges in the vicinity of the Project have the potential to experience effects from the Project. Several relevant groups or organizations represent various interests relevant to the Project. Each of these groups are discussed in Sections 4.4.1, 4.4.2, and 4.4.3.

4.4.1 Engagement with Non-Indigenous Communities of Interest

Engagement with Non-Indigenous COI included the following:

- Northern Village of Pinehouse;
- Northern Village of Beauval; and
- Northern Hamlet of Patuanak.

4.4.1.1 Engagement with the Northern Village of Pinehouse

The NVP has a history dating back to the times of the North West Company and the Hudson's Bay Company. The 1906 Canada Census used the name Serpent Lake on the Churchill River to describe the community. A townsite was established in the 1940s and a Roman Catholic church (St. Dominic) was built in 1944, followed by a store, and in 1948 a school. In 1954, the community was renamed Pinehouse Lake. Pinehouse was originally named Snake Lake (kinêpiko-sâkahikam in Cree) and Elders still use this name in reference to the community. Although officially named Pinehouse, numerous official sources including the official road map of Saskatchewan issued by the province, identify the community by the name Pinehouse Lake. Eighty houses were built between 1967 and

1980 and Pinehouse Lake was connected to the power grid in 1984, replacing a diesel generator set up around 1970. The first road to the community was built from Highway 2 in 1977 (Pinehouse Lake n.d.).

Figure 4.3-1 illustrates where NVP is in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, NVP is located 230 km away from the Project. In terms of travel distance by existing transportation routes NVP is located 270 km away from the Project.

4.4.1.1.1 History of Interactions

Since 2016, Denison has been engaging with the NVP in a variety of ways. In some instances, the elected members of the municipality are also officials of Métis Locals and, therefore, represent both their municipality as well as their Indigenous community. As a result, during the onset of engagement activities in 2016, the entities of KML and the Village of Pinehouse Lake had some overlap. In 2019, the KML delegated their Duty to Consult for the Project to the MN-S. Clear distinction between the Métis leadership and Citizens, and the NVP leadership and residents was, therefore, necessary to make sure the MN-S was able to appropriately provide the representation of the Métis of KML, per the delegated Duty to Consult. As a result, Denison distinguished its engagement efforts between MN-S, on behalf of KML, and the general public of the Village of Pinehouse, with no intended overlap in relation to Métis interests.

4.4.1.1.2 Agreements Relative to the Environmental Assessment Process

A MOU was signed between Denison, KML and the NVP in 2017. The signing of this MOU with both KML and the NVP reflected the perspective of KML and the NVP to represent both municipal residents and the Métis Citizens co-operatively. This non-binding MOU formalized the intent to work together in a spirit of mutual respect to cooperate to collectively identify practical means by which to avoid, mitigate, or otherwise address potential effects of the Project upon the exercise of the Indigenous Rights, Treaty Rights, and interests.

In 2018, Denison, the KML and the NVP signed an addendum to the original MOU whereby Denison committed to financially supporting an initiative to undertake a second phase of land use and occupancy mapping representing the KML and the NVP. This work was subsequently undertaken in 2018 and shared with Denison for use in documents in relation to regulatory proceedings associated with its activities, including the Project.

In 2019, the KML delegated their Duty to Consult for the Project to the MN-S. Thereafter, as directed, Denison engaged with MN-S on behalf of KML (and other Métis Locals which likewise delegated their Duty to Consult to MN-S).

In 2021, the KML revoked their delegated Duty to Consult to the MN-S. Denison re-engaged the KML directly in respect of the Project while continuing to engage separately with the general public of the NVP.

In 2022, Denison, KML/NVP built upon the 2017 MOU and signed a Participation Agreement and associated Letter Agreement, which outlined a mutually agreeable framework and applicable funding arrangements to facilitate KML's/NVP's participation and engagement in the EA process for the Project—including KML's/NVP's contribution to Denison's environmental understanding of the Project in a holistic way that respected KML's rights and interests. As a result, several additional activities have been undertaken between KML/ NVP and Denison, which are further described in Section 4.3.2.2.3 and Section 4.4.1.1.3.

In July 2024, KML and the NVP and Denison concluded an Agreement in respect of the Project that provides, among other matters, various procedural and substantive commitments by Denison to KML/NVP and the support and consent of KML/NVP for the development and operation of the Project in a sustainable manner which respects KML's inherent Aboriginal rights, advances reconciliation with Indigenous peoples, and provides economic opportunities and other benefits to KML/NVP.

4.4.1.1.3 Key Engagement Activities

During the engagement activities undertaken with the NVP, several key engagement activities took place that have played a meaningful role in relation to the EA process. These key engagement activities were supported by ongoing engagement methods including, but not limited to, those outlined in Section 4.2.1. The main forms of engagement included meetings with leadership, community meetings, a workshop on early infrastructure options (2018), a site visit (2019), two online surveys (2021 and 2022), and a meeting and information session on preliminary effects and mitigation (2022). As noted in Section 4.2.1, due to the COVID-19 pandemic, engagement switched to virtual meetings in 2021. In mid-2022, appropriate engagement activities moved back to in-person. The following text describes several of the key engagement activities.

Engagement Focus: Pre-Project Description - April 2016 to May 2019

Introductory meeting in the NVP – September 7, 2016: This was the inaugural meeting between the senior management team of Denison and residents of the NVP. About 20 individuals were in attendance, along with the Mayor of the NVP. Much of the meeting focussed on clarifying the nature of Denison's activities, including the Project and related exploration activities, the interest in employment and business opportunities, the interest in protection of the environment from exploration and Project activities, including consideration of cumulative effects, and questions in relation to the nuclear industry in general and the market related to uranium. For more information about this activity, please see Appendix 4-A, ROC #105.

Workshop – January 16, 2018: Denison hosted a workshop with grade 11 and 12 students, plus a number of community members. The focus of the workshop was to obtain feedback on three alternatives/options for the proposed Project: the road alignment from Highway 914 into the Project Area; the potential treated effluent discharge location; and the mining method options. General questions were asked regarding the various alternatives and options, and points of clarification pertaining to aspects of the Project. Feedback was collected on the various options and has been incorporated into the final design for road alignment, and the treated effluent discharge location. Please see Section 2 for more details. For more specifics about this activity, please see Appendix 4-A, ROC #2.

Engagement Focus: Post-Project Description – July 2019 to October 2022

The focus of this engagement activity was to provide an in-field opportunity to understand the proposed Project and the various elements associated with the Project.

In August 2019, Denison hosted a site tour at the Project location. Attending the site tour was the Mayor of the NVP. The tour involved an initial presentation regarding the Project, followed by travel around the Project site to the various locations for the proposed elements of the Project. Representatives from the CNSC and SK MOE were present. For more specifics about this activity, please see Appendix 4-A, ROC #1.

Meetings – February 11, 2021: On February 11, 2021, Denison hosted virtual meetings with the leadership of the NVP, as well as virtual meeting for the residents of the NVP. The focus of these engagement activities was to provide information about the Project to the NVP and residents, present a preliminary list of VCs that Denison had identified as part of the EA process, and provide an opportunity for members to provide feedback on the proposed list of VCs, and ask questions about Project components of interest or concern to them.

During the leadership meeting with the NVP, Denison confirmed it was acceptable to continue hosting the virtual meeting for the residents of the NVP, given concerns raised by the MN-S related to the Métis nature of the NVP. The leadership of the NVP confirmed it was acceptable to host the virtual meeting for the residents. Denison confirmed to MN-S that it respected the delegation of the Duty to Consult to MN-S by the Métis Locals. As a result, the purpose of these community meetings was to seek feedback with respect to the Project from the general public residing in Beauval, and not to gather information about the distinct interests of the Métis regarding the Project. The virtual meeting for residents was advertised on the radio and social media, and posters were placed in community buildings. The Zoom platform was used, but the meeting was also broadcasted live through CFNK-FM 89.9. At least 52 Zoom accounts were used to attend the presentation, although it is possible that more than one person viewed the presentation from each account. Representatives from the CNSC and the Province of Saskatchewan were present during both virtual meetings.

Topics covered during the virtual presentations include the following:

- Denison company introduction and key staff members;
- introduction to regulators;
- location of the Project;

- ISR mining, in general;
- ISR mining at the Project, including the recent change in the Project design from freeze dome technology to a freeze wall containment method;
- employment opportunities;
- EA; and
- VCs.

Meeting participants were encouraged to complete Denison's online survey in relation to the VCs considered important to residents of the NVP. Following the presentation, Denison answered questions that were put into the online chat function.

Key themes that emerged from the questions posed at the NVP meetings, which indicated either interests or concerns, are summarized as follows:

- the ISR mining method, including volumes of water used and evidence regarding the efficacy of the freeze wall techniques and its potential to affect the environment;
- the reclamation process at the Project, and Denison's interest in working together with the NVP regarding baseline information and expectations, also in relation to climate change;
- emergency response measures in relation to the transportation of the chemicals used in the mining process, protection of the Churchill River in respect of a potential spill, involvement of the NVP in emergency planning; and
- economic opportunities, including job opportunities, training opportunities, business opportunities and community liaison concepts.

For additional details about this activity, please see Appendix 4-A, ROC #440 and ROC #444.

Denison provided a report to the NVP regarding what was heard by Denison during the engagement activities. This report was shared in hard copy form (sent to the NVP Office), shared with the NVP for posting to a website, posted on the Denison website (www.wheelerriverproject.ca) and a video was made by Denison for those who prefer oral communications, also on the Denison website.

Online Survey**:** During and following the NVP meeting(s), attendees were invited to provide feedback on VCs through an online survey. The purpose of the survey was to seek feedback on the importance of the VCs to members, and identify interests or concerns related to the Project, providing an additional mean by which feedback could be provided to Denison. People who were unable to attend the presentation were also encouraged to provide feedback through the survey. The survey was marketed to members using Facebook and radio advertisements.

The survey was open for feedback from February 9 to 23, 2021, for a total of 14 days. Twenty responses were received, with 100% rate of survey completion.

The survey included reach and marketing questions about how respondents heard about the survey and if they attended a presentation. This information helped Denison to determine which event marketing efforts were most effective.

The survey also asked respondents to disclose voluntary demographic information such as age, primary residence, and identity, to help Denison determine if there were large demographic groups whose perspectives were not represented in the results.

Following the reach and marketing and demographic questions, the survey included questions specific to the preliminary list of VCs. These questions were followed by the opportunity for respondents to share their thoughts on opportunities and challenges related to the Project.

Demographics

Most survey respondents (70%) were between the ages of 35 and 64, compared to 30% who were between the ages of 16 to 34, and none who identified as age 65 or older. Most respondents self-identified as Indigenous peoples, with the majority (40%) of people identifying as Métis, 30% identifying as First Nations, 10% identifying as non-status, and 5% identifying as Indigenous but did not indicate a specific group. Additionally, 10% of respondents did not self-identify as Aboriginal and 5% preferred not to answer.

Valued Components

A total of 26 interconnected VCs were proposed to respondents. Respondents were asked to select from the list which VCs they felt were important for Denison to research further as part of the EA. While all 26 VCs were identified as important by at least one respondent, the following environmental components were identified as important to more than half of respondents:

- traditional land and resource use;
- air quality;
- fish;
- groundwater quality;
- employment;
- surface water;
- fish habitat and aquatic plants;
- local economy;
- public safety; and
- birds.

The importance of traditional land and resource use, the potential for environmental effects, and local employment and business opportunities were echoed in the questions asked by those who attended the virtual presentation. Respondents explained that these VCs are important to them because they are most at risk of disturbance, most important to the well-being and survival of all humans, and they are components that are increasing in value. Respondents also noted the importance of jobs and new opportunities for community members. Respondents from Pinehouse and area felt that the following VCs were missing and important so should be added to the list:

- housing; and
- community participation.

Just over 25% of respondents identified VCs that they felt were not important to study further. These VCs included:

- noise level;
- outfitting;
- birds;
- industry use;
- heritage resources; and
- ungulates.

Of these, noise level was the only VC that was selected as not important more often than it was identified as important.

The complete list of VCs included in this EIS is available in Section 5.3.1 in Section 5.

<u>Opportunities and Challenges</u>

Respondents were asked, based on what they knew so far about the Project, to share the aspects of the Project that they felt could benefit or work well for the community.

Some of the unique or specific opportunities mentioned included the following items:

- training opportunities;
- increased employment;
  - potential for jobs in Pinehouse that could benefit community members who can't work away from home;
- potential for funding to the community;
- potential for collaborative agreements;
- potential for Denison to form a partnership with the community; and

- an increase in opportunities for community improvement and participation.

Respondents were then asked what aspects of the Project they felt would be challenging or cause concern for their community. Responses included:

- the potential to interrupt wildlife and traditional land users access to the land;
- the potential for mining activities to affect the environment and displace wildlife;
- being asked to choose between the land and the economic opportunities;
- an increase in traffic affecting road quality;
- the transportation of dangerous chemicals to and from the Project;
- the potential for the contamination of the environment;
- concerns about the transport of dangerous chemicals; and
- the possibility that residents won't be able to take advantage of the opportunities presented to them by the project due to existing social issues like the lack of housing.

For more information about this activity, please see Appendix 4-A, ROC #446.

Engagement Focus: Post-Project Description – July 2019 to October 2022

Meetings – June 1, 2022: On June 1, 2022, engagement activities were undertaken in collaboration with KML to occur in the Village of Pinehouse Lake, in the Village Hall and be open to KML members and the NVP residents. The structure and layout of the meeting was jointly established between Denison and KML. The focus of these engagement activities was to share the preliminary findings of the EA, proposed mitigation measures, preliminary conclusions of the EIS, and to facilitate dialogue related to this information.

Engagement activities were conducted as a focused leadership meeting with KML representatives and the Village of Pinehouse representatives (at their joint request), and as a general open house. Date and location of the open house meeting was advertised on local radio stations, Facebook pages, TV channels, and posters. During the open house, attendees were able to complete a survey, in hard copy or digital format, to express their opinions. Comments and questions were also captured by Denison in a record-keeping notebook and transcribed following the event.

To communicate EA findings and Projects details, Denison created and displayed three models and 15 informational poster boards. The three models depicted: 1) the uranium ore body and projected, below ground, extraction infrastructure; 2) the Project site surface with associated infrastructure; and 3) a 1:294 scale map of the area surrounding the Project site. The 15 informational poster boards presented EA findings in relation to VCs identified as important during previous rounds of engagement activities, as well as detail on technologies, regulatory processes, and procedures.

KML and Village of Pinehouse Leadership Meeting – June 1, 2022: The leadership meeting was held in at the Pinehouse Lake gas bar on June 1, 2022, with invited representatives of KML and the Village of Pinehouse Lake. Denison provided an overview of the Project that included information on project specifics, current status, predicted timeline, and preliminary EA findings.

The dialogue between Denison and the leadership related to Project specifics, including inquiries about the dimensions of the ore body and freeze wall. Questions surrounding employment and training were also expressed. A need for a culturally sensitive training model was expressed. This bridged to discussion of the reduced footprint of the Project translating to fewer employment opportunities. Leadership expressed a desire for appropriate training for community residents to adequately compete as Project related jobs become available. Representatives from the CNSC and SK MOE were present. For more information about this activity, please see Appendix 4-A, ROC #623.

Open House in Village of Pinehouse Lake – June 1, 2022: The open house was co-planned between Denison and the KML. The open house was held at the Pinehouse Community Centre, welcoming members of the surrounding area. A total of 52 attendees signed the sign-in sheet. Some individuals chose not to sign in, making the attendance at the Pinehouse open house slightly higher than recorded by the sign-in sheet. Through dialogue at the open house, community members expressed a general interest in the Project and Project-specific information. Questions such as "*How does ISR mining work?"* and "*How does calcium chloride (CaCl) cool and freeze the ground?*" illustrate this interest. Other questions, while primarily geared toward gaining clarity on Project details, suggest consideration for mitigation measures, human health, and the biophysical environment. Examples of this include questions such as "*Where will the drinking water [for the camp] come from?*" and inquiries over potential effects of work schedules on worker health. Representatives from the CNSC and SK MOE were present. For more information about this activity, please see Appendix 4-A, ROC #620.

Online Survey: During and following the meeting(s), attendees were invited to provide feedback on preliminary effects, mitigation, and monitoring through an online survey. Denison created a survey, available in hardcopy and digital formats during each open house and available in digital format for two weeks following the open house. The survey was comprised of four core questions:

1. Are there any topics of particular concern that Denison needs to pay special attention to?
2. Are there any things missing that Denison should consider to reduce the effects of the Project to the environment?
3. Are there any topics that you would like to see included in monitoring plans?
4. What additional information would be helpful for you to understand the Project and its potential impacts to people and the environment?

The 25 survey respondents indicated that they were from Pinehouse, with 15 self-identifying as Métis, nine as First Nation, and one as Indigenous without further specification. Survey respondents primarily heard of the survey through word of mouth, indicated by 10 survey respondents. Five survey respondents indicated that they heard of the survey through Facebook, and five indicated they heard of the survey through "other" means. Three respondents heard of the survey through posters, and two through radio. Most survey respondents were in the 35 to 64 age cohort, indicated in 16 instances. Five respondents indicated that they were in the 16 to 34 cohort and four indicated that they were in the 65+ age cohort.

When asked the question **"Are there any topics of particular concern that Denison needs to pay special attention to?"** five respondents provided incomplete answers. Six survey respondents expressed that they had no concerns, with statements ranging from variations of the word "no" to positive statements such as "*I think Denison covered all the main topics very well*." Five respondents emphasized employment and training, one of which framed this emphasis in a northern context. Five survey respondents highlighted a concern for the environment; one of these responses focused on water quality, two on environmental restorations, one on the general environment, and one on mining source water treatment and runoff, presumably as it relates to the environment. One response expressed a concern over recycling. The remaining responses touched on a variety of topics. One survey respondent supplied a community benefits inquiry. Accessibility of the Project site and Project buildings was a concern for another respondent. Concern over the potential for future Covid-19 restrictions and possible vaccination requirement was expressed, though this response may be extended to include pandemic planning in general.

When asked the question **"Are there any things missing that Denison should consider to reduce the effects of the Project to the environment?"** 10 survey respondents indicated that they felt nothing was missing. These responses, ranged from "no" to positive commentary such as "*No- work at Denison Mine couple shifts, like the safe orientated culture and respect of land and native people that live near the mine sites*." One additional survey response stated "*May in the future*." This may express no concern and/or a desire for forward planning. One survey respondent directly referenced forward planning in addition to stressing the importance of wildlife, and caribou habitat management. Waste management was referenced by one respondent emphasizing recycling and providing the suggestion of recycling paper. One survey respondent emphasized air quality, while another inquired "*Are these surface pipes [spill] ready at all times*?" One survey response suggested the inclusion of LK and TK, suggesting Denison "learn from the people around this project." One survey respondent expressed concern for land users and wanted it to be affirmed that mining methods were safe. Seven survey respondents provided incomplete responses.

When asked the question **"Are there any topics that you would like to see included in the monitoring plans?"** five respondents supplied incomplete answers and nine indicated that there was nothing additional they felt needed to be considered. Several responses did not relate to the survey question: two suggested a focus on local employment opportunities; one inquired about water quality as per human consumption and treatment; one requested more local meetings; one inquired about double plated pipes and spill readiness; one stated that someone to teach safety was required; and one requested more Project context. Responses related to the survey question related to water quality, with one response simply stating water sampling and the other emphasizing monitoring of aquatic environments as well as budgeting appropriately for long-term monitoring. Similarly, another survey respondent stated "*future-wise*", potentially referring to long-term monitoring or incorporating topics into the monitoring plan in a future context. One survey response indicated they would like to see ongoing reporting on Project Operation.

When asked the question **"What additional information would be helpful for you to understand the Project and its potential impacts to people and the environment?"** six indicated that no additional information was needed and five provided incomplete responses. Several survey respondents provided unrelated suggestions to this survey question. Forming mutually beneficial agreements was suggested through the response "Always explain the motto 'help us help you."". Two respondents focused on opportunities for youth, one in terms of employment and the other in terms of scholarships. One survey respondent emphasized general opportunity for future employment, while another suggested employment considerations for people with disabilities. Waste management was focused on, with one survey respondent suggesting an increase in practice of recycling as well as questioning water quality and sampling. One respondent suggested Elder representation in decision making. Responses that related to the survey question generally suggested a need for high level information including Project timeline, more information on environmental effects, water quality changes from Project Operation, and general Project site information including potential jobs and tasks. The importance of ongoing dialogue was emphasized in responses that suggested continued transparency and regular community meetings.

Most of the information shared with Denison regarding the survey questions has been captured and addressed by Denison as part of the current work on the EA and the Project, in general. In a few instances, the recommendations in relation to sharing of information in the future, such as with respect to environmental monitoring and employment opportunities will be carried through into ongoing discussions between Denison and KML. For additional details about this activity, please see Appendix 4-A, ROC #652.

Engagement Focus: Environmental Assessment Outcomes and Relationship to Licensing / Approvals – October 2022 to Present

Open House – October 24, 2023: On October 24, 2023, engagement activities were undertaken in collaboration with KML to occur in the Village of Pinehouse Lake, in the Village Hall. This collaboration includes general residents of the NVP, in addition to KML Citizens. The focus of these engagement activities was to share the findings of the EA, mitigation measures, monitoring, significance, cumulative effects, the conclusions of the EIS, and the relationship between the environmental assessment and the ultimate licensing / approvals process for the Project.

The structure and layout of the meeting was jointly established between Denison and KML. Engagement activities were conducted as a focused leadership meeting with KML land users, and as a general open house with a specified time period for an overview presentation. The date and location of open house meetings were advertised on local radio stations, Facebook pages, TV channels, and posters. Comments and questions were also captured by Denison in a record-keeping notebook, and transcribed following the event.

To communicate EA findings, Project details, and the relationship to the licensing / approvals process, Denison displayed three models and 6 informational poster boards. The three models depicted: 1) the uranium ore body and projected, below ground, extraction infrastructure; 2) the Project site surface with associated infrastructure; and 3) a 1:294 scale map of the area surrounding the Project site. The 6 informational poster boards presented EA findings and related licensing / approvals actions in relation to VCs identified as important during previous rounds of engagement activities.

***Open House in Village of Pinehouse Lake – October 24, 2023*:** In coordination with KML, Denison hosted an open house event in the Northern Village of Pinehouse to share information about the Project, with a particular focus on the flow of information from the environmental assessment into licensing, permits, and commitments. Denison advertised the event with social media posts and posters around the community. In addition to members of KML, 48 residents were recorded as in attendance. Information boards and area models were displayed, information booklets were provided. Denison prepared a formal presentation, and a translator was present to translate as needed. The Canadian Nuclear Safety Commission and the Saskatchewan Ministry of Environment were invited by Denison and were in attendance. For additional details about this activity, please see Appendix 4-A, ROC #978.

Site Tour (Student) – May 7, 2024: In coordination with Kineepik Métis Local, Denison Mines hosted a site tour at the Wheeler River Project for Pinehouse high school students.

Meeting (Land User) – May 8, 2024: In coordination with Kineepik Métis Local, Denison hosted a land user meeting at the Pinehouse Village Hall. The focus of the meeting was to share updates on the Wheeler River Project, to answer land user questions, to facilitate discussion, and to provide information on Project stage and licensing progression. The event was planned and invitations extended as part of the process in place led by KML. Denison prepared a presentation and distributed informational handouts to attendees. The meeting was attended by 38 land users and 4 KML staff. For additional details about this activity, please see Appendix 4-A, ROC #1088.

Future Engagement Activities

Denison and KML/NVP have an agreed-upon process to regularly engage about ongoing matters related to the Project and the associated regulatory approval process. KML leads this process but also includes the NVP. Denison expects to continue working with KML/NVP, throughout the remainder of the environmental assessment and approval process and into the licensing process, to coordinate engagement activities in relation to topics of interest to them in relation to the Project.

4.4.1.1.4 Northern Village of Pinehouse Public Comments on Draft Environmental Impact Statement and Related Processes

An important part of the engagement of Interested Parties for the Project is facilitated by federal regulators, and occurs vis-à-vis a public review of the draft EIS. During this public review of the draft EIS, Interested Parties can submit their views in writing on the adequacy of the information presented in the EIS, as measured against appropriate guidance materials, and on the technical merit of the information presented in the EIS.

The CNSC offered participant funding to assist Indigenous peoples, members of the public, and stakeholders in the review of the draft EIS. This participant funding offering was available from January 10, 2022, to March 14, 2022.

On November 21, 2022, public comments were invited on the draft EIS by the CNSC.

On Feb 17, 2023, KML submitted public comments on the draft EIS to the CNSC (Government of Canada 2024), consisting of 11 technical comments.

On June 11, 2023, following work undertaken together since receipt of the February 17, 2023, public comments, Denison provided KML with an updated table of issues, concerns and interests capturing engagement efforts over the years for both KML and the NVP – including Denison’s responses to those issues, concerns and interests, as associated with the Project draft EIS. KML provided feedback and stated that they were satisfied with updated table, including Denison’s responses to the issues, concerns, and interests (see Appendix 4-A, ROC #917).

On November 22, 2023, Denison provided KML with specific responses to KML’s February 17, 2023, public comments (see Appendix 4-A, ROC #970). On December 5, 2023, KML confirmed to Denison that Denison’s responses to the February 17, 2023, public comments had resolved KML’s comments / concerns on the draft EIS and the Project (see Appendix 4-A, ROC #1027).

4.4.1.1.5 Northern Village of Pinehouse Support for the Project

On August 1, 2024, KML/NVP provided a letter to the CNSC and the Province of Saskatchewan that outlined NVP’s specific support for the Project, subject to Denison materially fulfilling its commitments to KML/NVP. The letter further noted KML/NVP’s intent to participate in the ongoing regulatory approval processes for the Project in a manner consistent with the agreement between the two parties.

4.4.1.1.6 Northern Village of Pinehouse Key Interests, Issues and Concerns

A summary of key interests, issues and concerns gathered throughout the course of engagement for the Project, including any formal submissions made through the regulatory process, are identified in Appendix 4-B. It is important to note that areas of identified interest, issues or concerns are not always related to environmental effects as defined by CEAA 2012 (the regime under which the Project is undergoing regulatory assessment) - they can be reflective of general areas of interest in relation to the Project more broadly. Where appropriate, the table aims to provide clarity with respect to this distinction.

4.4.1.2 Engagement with the Northern Village of Beauval

Beauval—"Beautiful Valley”"—is located in Northern Saskatchewan overlooking the lovely Beaver River Valley providing a striking view of the river and surrounding nature. The Beaver River offers world-class pickerel fishing, and nearby lakes stocked with abundant Trout and Northern Pike makes Beauval an ideal destination for anglers. The community has a proud history of culture, language, and heritage. In history, Beauval was a trading post location along the Churchill River trade route for the Hudson’s Bay Company, this route is still travelled via canoe by history buffs and avid outdoors people for the pristine scenes and memorable nature experience with historic influence (Village of Beauval n.d.).

Figure 4.3-1 illustrates where Beauval is in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, Beauval is located 295 km away from the Project. In terms of travel distance by existing transportation routes Beauval is located 375 km away from the Project.

4.4.1.2.1 History of Interactions

Since 2016, Denison has been engaging with the NVB in a variety of ways. In some instances, the elected members of the municipality are also officials of Métis Locals and, therefore, represent both their municipality as well as their Indigenous community. As a result, during the onset of engagement activities in 2016, the entities of SML and the NVB had some overlap between each other. In 2019, the SML delegated their Duty to Consult for the Project to the MN-S. Clear distinction between the Métis leadership and Citizens, and the NVP leadership and residents was, therefore, necessary to make sure the MN-S was able to appropriately provide the representation of the Métis of KML, per the delegated Duty to Consult. As a result, Denison distinguished its engagement efforts between MN-S, on behalf of SML, and the general public of the NVB, with no intended overlap in relation to Métis interests.

4.4.1.2.2 Agreements Relative to the Environmental Assessment Process

To formalize Denison’s commitment to SML, a MOU was signed between Denison, SML and the NVB in 2018. The signing of this MOU with both SML and the NVB reflected the perspective of SML and the NVB to represent both municipal residents and the Métis co-operatively. This non-binding

MOU formalized the intent to work together in a spirit of mutual respect to cooperate to collectively identify practical means by which to avoid, mitigate, or otherwise address potential effects of the Project upon the exercise of the Indigenous Rights, Treaty Rights, and interests, to the extent they are identified in relation to the Project.

In 2019, SML delegated their Duty to Consult for the Project to the MN-S. From 2019, the MN-S has been representing SML in respect of engagement with Denison for the Project.

In March 2024, an Agreement was concluded in respect of the Wheeler River Project between Denison and Northern Village of Beauval, along with of Île-à-la Crosse, Jans Bay, and Cole Bay, that provides, among other matters, various commitments by Denison to these four communities and includes specific support of the Northern Village of Beauval, Île-à-la Crosse, Jans Bay, and Cole Bay for the development and operation of the Project.

4.4.1.2.3 Key Engagement Activities

During the engagement activities undertaken with the NVB, several key engagement activities took place that have played a meaningful role in the EA process. These key engagement activities were supported by ongoing engagement methods including, but not limited to, those outlined in Section 4.2.1. The main forms of engagement included meetings with leadership, community meetings, a workshop on early infrastructure options (2018), a site visit (2019), two online surveys (2021 and 2022), and a meeting and information session on preliminary effects and mitigation (2022). As noted in Section 4.2.1, due to the COVID-19 pandemic, engagement switched to virtual meetings in 2021. In mid-2022, appropriate engagement activities moved back to in-person. The following text describes several of the key engagement activities.

Engagement Focus: Pre-Project Description - April 2016 to May 2019

Introductory Meeting in the NVB – December 6, 2016: This was the inaugural meeting between the senior management team of Denison and various entities associated with SML and the Village of Beauval. Much of the meeting focussed on clarifying the nature of Denison's activities, including the Project and related exploration activities, the interest in employment and business opportunities, opportunities and considerations for the long-term, and questions in relation to the nuclear industry in general and the market related to uranium. For more information about this activity, please see Appendix 4-A, ROC #107.

Workshop – January 18, 2018: Denison hosted a workshop with a number of community members. The focus of the workshop was to obtain feedback on three alternatives/options for the proposed Project: the road alignment from Highway 914 into the Project Area; the potential treated effluent discharge location; and the mining method options. General questions were asked regarding the various alternatives and options, and points of clarification pertaining to aspects of the Project. Feedback was collected on the various options and has been incorporated into the final design for road alignment, and the treated effluent discharge location. Please see Section 2 for more details. For more information about this activity, please see Appendix 4-A, ROC #4.

Engagement Focus: Post-Project Description – July 2019 to October 2022

The focus of this engagement activity was to provide an in-field opportunity to understand the proposed Project and the various elements associated with the Project.

In August 2019, Denison hosted a site tour at the Project location. Attending the site tour was the Mayor of the NVB. The tour involved an initial presentation regarding the Project, followed by travel around the Project site to the various locations for the proposed elements of the Project. Representatives from the CNSC and SK MOE were present. For additional details about this activity, please see Appendix 4-A, ROC #1.

Meeting – February 9, 2021: On February 9, 2021, Denison hosted a virtual meeting for the residents of the NVB. The virtual meeting for residents was advertised on the radio and social media, and posters were placed in community buildings. The focus of these engagement activities was to provide information about the Project to the NVB and residents, present a preliminary list of VCs that Denison had identified as part of the EA process, provide an opportunity for members to provide feedback on the proposed list of VCs, and ask questions about Project components of interest or concern to them. The Zoom platform was used, but the meeting was also broadcasted live through Beauval's radio station (94.1). At least 15 Zoom accounts were used to attend the presentation, although it is possible that more than one person viewed the presentation from each account. Representatives from the CNSC and the Province of Saskatchewan were present during both virtual meetings.

Topics covered during the virtual presentations include the following:

- Denison company introduction and key staff members;
- introduction to regulators;
- location of the Project;
- ISR mining, in general;
- ISR mining at the Project, including the recent change in the Project design from freeze dome technology to a freeze wall containment method;
- employment opportunities;
- EA; and
- VCs.

Meeting participants were encouraged to complete Denison's online survey in relation to the VCs considered important to residents of the NVB. Following the presentation, Denison answered questions that were put into the online chat function.

Key themes that emerged from the questions posed at the NVB meeting, which indicated either interests or concerns, are summarized as follows:

- the length of the EA process;
- the processing of the uranium into product and the quality of the uranium ore body; and
- training opportunities with northern training institutions.

For additional information about this activity, please see Appendix 4-A, ROC #442.

Denison provided a report to the NVB regarding what was heard by Denison during the engagement activities. This report was shared in hard copy form (sent to the NVB Office), shared with the NVB for posting to a website, posted on the Denison website (www.wheelerriverproject.ca) and a video was made by Denison for those who prefer oral communications, also on the Denison website.

Online Survey: During and following the NVB meeting, attendees were invited to provide feedback on VCs through an online survey. The purpose of the survey was to seek feedback on the importance of the VCs to members, and identify interests or concerns related to the Project, providing an additional mean by which feedback could be provided to Denison. People who were unable to attend the presentation were also encouraged to provide feedback through the survey. The survey was marketed to members using Facebook and radio advertisements.

The survey was open for feedback from February 9 to 23, 2021, for a total of 14 days. A total of 10 responses were received, with 100% rate of survey completion.

The survey included reach and marketing questions about how respondents heard about the survey and if they attended a presentation. This information helped Denison to determine which event marketing efforts were most effective.

The survey also asked respondents to disclose voluntary demographic information such as age, primary residence, and identity, to help Denison determine if there were large demographic groups whose perspectives were not represented in the results.

Following the reach and marketing and demographic questions, the survey included questions specific to the preliminary list of VCs. These questions were followed by the opportunity for respondents to share their thoughts on opportunities and challenges related to the Project.

<u>Demographics</u>

Most survey respondents (70%) were between the ages of 16 and 34, compared to 30% who were between the ages of 35 and 64, and none who identified as age 65 or older. All respondents self-identified as Indigenous peoples, with the majority (60%) of people identifying as Métis, and 40% identifying as First Nations people.

<u>Valued Components</u>

A total of 26 interconnected VCs were proposed to respondents. Respondents were asked to select from the list which VCs they felt were important for Denison to research further as part of the EA. While all 26 VCs were identified as important by at least one respondent, the following environmental components were identified as important to more than half of respondents:

- local economy;
- employment;
- training;
- traditional land and resource use;
- birds;
- fish;
- air quality;
- fish habitat and aquatic plants;
- soil;
- surface water; and
- groundwater quality.

The importance of local economy, jobs, training, and the need for environmental monitoring were echoed in the questions asked by those who attended the virtual presentation. Respondents explained that these VCs are important to them because they do not want the land to be damaged and feel that these components are important to the well-being of life on the planet.

Respondents from Beauval and area did not identify any VC that were important to them but missing from the list.

A total of 80% of respondents identified VCs that were not important to study further. Most VCs selected as not important were only selected as such by two or fewer respondents. The VCs considered not important included:

- noise level;
- fish;
- infrastructure and services;
- business activity;
- soil;
- surface water;
- heritage resources;

- furbearers; and
- industry uses.

The number of respondents who indicated that noise levels and outfitting tourism were not important was greater than the number who felt they were important. For all other VCs, more respondents felt they were important than not important.

The complete list of VCs included in this EIS is available in Section 5.3.1 in Section 5.

Opportunities and Challenges

Respondents were asked, based on what they knew so far about the Project, to share the aspects of the Project that they felt could benefit or work well for the community.

Some of the unique or specific opportunities mentioned included the following items:

- training opportunities;
- increased employment and reduced unemployment;
- employee transportation to site from communities;
- the possibility of a legacy fund for the impacted communities; and
- the possibility of a collaboration agreement between Beauval and Denison.

Respondents were then asked what aspects of the Project they felt would be challenging or cause concern for their community. Responses included:

- environmental monitoring;
- mistrust between community members and regulatory bodies and industry;
- the importance to have an outside, impartial body conducting monitoring to ensure that the results can be trusted by the community;
- effects to mental health due to the development of the land;
- potential damage to the land as many people still lie off the land; and
- community safety with an increase in traffic.

For additional details about this activity, please see Appendix 4-A, ROC #446.

Meetings (Mayor and Council and Open House Meetings) – May 31, 2022: On May 31, 2022, engagement activities were undertaken in the Beauval area, at the ERFN La Plonge reserve at the Silver Building. The focus of these engagement activities was to share the preliminary findings of the EA, proposed mitigation measures, preliminary conclusions of the EIS, and to facilitate dialogue related to this information.

This meeting originally was planned to occur at the Beauval Community Centre, but owing to a set of community circumstances, was moved to the La Plonge Reserve Silver Building the day of the event. The change in venue was communicated via radio.

Mayor and Council Meeting – May 31, 2022: Engagement activities were conducted as a focused meeting with the Mayor and Council and as a general open house. Date and location of the open house meeting was advertised on local radio stations, Facebook pages, TV channels, and posters. During the open house, attendees were able to complete a survey, in hard copy or digital format, to express their opinions. Comments and questions were also captured by Denison in a record-keeping notebook and transcribed following the event.

To communicate EA findings and Projects details, Denison created and displayed three models and 15 informational poster boards. The three models depicted: 1) the uranium ore body and projected, below ground, extraction infrastructure; 2) the Project site surface with associated infrastructure; and 3) a 1:294 scale map of the area surrounding the Project site. The 15 informational poster boards presented EA findings in relation to VCs identified as important during previous rounds of engagement activities, as well as detail on technologies, regulatory processes, and procedures. For more information about this activity, please see Appendix 4-A, ROC #619.

Open House in Beauval Region – May 31, 2022: The open house in La Plonge was held at the Silver Building. The ERFN La Plonge members and residents of Beauval and the surrounding area were invited to attend. Fourteen attendees signed the sign-in sheet. Several individuals chose not to sign in, making the attendance at the La Plonge open house higher than implied by the sign-in sheet. Spatial restraints led Denison to display only 7 poster boards. Brochures containing all poster board imagery and information were distributed, accommodating for the absent poster board information.

Dialogue during the open house expressed regard for groundwater and geology. Community members asked questions relating to methodology, inquiring as to effects of Project specifics on characteristics of groundwater and geology. Additional questions predominantly pertained to Project-specific information. For additional details about this activity, please see Appendix 4-A, ROC #619.

Online Survey: During and following this meeting, attendees were invited to provide feedback on preliminary effects, mitigation, and monitoring through an online survey. Denison created a survey, available in hardcopy and digital formats during each open house and available in digital format for two weeks following the open house. No responses were received by those identifying as residents of Beauval. For more information about this activity, please see Appendix 4-A, ROC #652.

Engagement Focus: Environmental Assessment Outcomes and Relationship to Licensing / Approvals – October 2022 to Present

Meeting – October 23, 2023: On October 23, 2023, Denison hosted a meeting with the leadership of the Northern Village of Beauval. The focus of these engagement activities was to share the findings of the EA, mitigation measures, monitoring, significance, cumulative effects, the conclusions of the EIS, and the relationship between the environmental assessment and the ultimate licensing / approvals process for the Project. See Appendix 4-A, ROC #981 for more information.

Open House – October 23, 2023: On October 23, 2023, Denison hosted an open house event in the Northern Village of Beauval to share information about the Wheeler River Project. The focus of these engagement activities was to share the findings of the EA, mitigation measures, monitoring, significance, cumulative effects, the conclusions of the EIS, and the relationship between the environmental assessment and the ultimate licensing / approvals process for the Project. Denison advertised the event with social media posts and posters around the community. 24 attendees signed the sign in sheet. Information boards and area models were displayed, information booklets were provided, Denison staff were available to answer questions, and a translator was present to translate as needed. The CNSC and the Saskatchewan Ministry of Environment were invited by Denison and were in attendance.

To communicate EA findings, Project details and the relationship to the licensing / approvals process, Denison displayed three models and 6 informational poster boards. The three models depicted: 1) the uranium ore body and projected, below ground, extraction infrastructure; 2) the Project site surface with associated infrastructure; and 3) a 1:294 scale map of the area surrounding the Project site. The 6 informational poster boards presented EA findings and related licensing / approvals actions in relation to VCs identified as important during previous rounds of engagement activities. See Appendix 4-A, ROC #957 for more information.

Future Engagement

Denison expects to continue working with the NVB, throughout the remainder of the environmental assessment and approval process and into the licensing process, to coordinate engagement activities related to their topics of interest related to the Project.

4.4.1.2.4 Northern Village of Beauval Support for the Project

In March 2024, an Agreement was concluded in respect of the Wheeler River Project between Denison and Northern Village of Beauval, along with of Île-à-la Crosse, Jans Bay, and Cole Bay, that provides, among other matters, various commitments by Denison to these four communities and includes specific support of the Northern Village of Beauval, Île-à-la Crosse, Jans Bay, and Cole Bay for the development and operation of the Project.

4.4.1.2.5 Northern Village of Beauval Key Interests, Issues and Concerns

A summary of key interests, issues, and concerns gathered throughout the course of engagement for the Project, including any formal submissions made through the regulatory process, are identified in Appendix 4-C. It is important to note that areas of identified interest, issues, or concerns are not always related to environmental effects as defined by CEAA 2012 (the regime under which the Project is undergoing regulatory assessment) - they can be reflective of general areas of interest in relation to the Project more broadly. Where appropriate, the table aims to provide clarity with respect to this distinction.

4.4.1.3 Engagement with the Northern Hamlet of Patuanak

The Northern Hamlet of Patuanak is a community in northern Saskatchewan, Canada. The community consists of the Northern Hamlet of Patuanak with residents governed by a Mayor and three Councillors. Patuanak is about 92 km (57 miles) north of Beauval at the end of Highway 918 (Planning for Growth Northern Saskatchewan n.d.a).

Figure 4.3-1 illustrates where Patuanak is in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, Patuanak is located 230 km away from the Project. In terms of travel distance by existing transportation routes Patuanak is located 460 km away from the Project.

4.4.1.3.1 History of Interactions

Up until 2019, Denison was undertaking engagement activities in the Patuanak area more broadly through work done in relation to the ERFN Wapachewunak reserve, consistent with ERFN's strong interconnections in the area. In mid-2019, Denison was advised by the Hamlet of Patuanak of its distinct interest in the Project. As a result, beginning in June 2019, Denison began engaging directly with the Hamlet of Patuanak. This included sending correspondence to the Hamlet of Patuanak about the Project description, the Project postponement, and the Project EA restart, as well as offering for their participation in a site visit (2019) and offers to participate in virtual and in-person meetings. To date, the Hamlet of Patuanak has not responded to the engagement efforts initiated by Denison, but Denison continues to make offers to engage with the Hamlet of Patuanak as they wish to do so.

4.4.2 Engagement with Other Non-Indigenous Communities

Engagement with Other Non-Indigenous Communities included the following:

- Northern Village of Île-à-la-Crosse;
- Northern Hamlet of Stony Rapids;
- Northern Hamlet of Uranium City;
- Northern Hamlet of Camsell Portage; and

- Northern Settlement of Wollaston Lake.

4.4.2.1 Engagement with the Northern Village of Île-à-la-Crosse

The Northern Village of Île-à-la Crosse (NVILX) is located in north-central Saskatchewan at the base of a peninsula extending into Lac Île-à-la Crosse. The village is the second oldest community in northern Saskatchewan, established in 1776. In 1846, Roman Catholic Missionaries arrived and constructed the Chateau St. Jean Mission and a neighbouring school. The Sisters of Charity of the Roman Catholic Church was initiated soon after and still plays a prominent role within the community. This strong Métis community is the birthplace of Louis Riel Sr. and was home to Sister Margaret Riel, sister of Louis Riel. The Village has a population of 1,425 (2021 Census) and prominent Aboriginal architect Douglas Cardinal designed Rossignol Elementary School (Planning for Growth Northern Saskatchewan n.d.b).

Figure 4.3-1 illustrates where Île-à-la Crosse is in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, Île-à-la-Crosse is located 275 km away from the Project. In terms of travel distance by existing transportation routes Île-à-la-Crosse is located 460 km away from the Project.

4.4.2.1.1 History of Interactions

Since 2016, Denison has been engaging with the NVILX in a variety of ways. In some instances, the elected members of the municipality are also officials of Métis Locals and, therefore, represent both their municipality as well as their Indigenous community. As a result, during the onset of engagement activities in 2016, the entities of ALBML and the NVILX had some overlap. In 2019, the ALBML delegated their Duty to Consult for the Project to the MN-S. Clear distinction between the Métis leadership and Citizens, and the NVP leadership and residents was, therefore, necessary to make sure the MN-S was able to appropriately provide the representation of the Métis of ALBML, per the delegated Duty to Consult. As a result, Denison distinguished its engagement efforts between MN-S, on behalf of ALBML, and the general public of the NVILX, with no intended overlap in relation to Métis interests.

4.4.2.1.2 Agreements Relative to the Environmental Assessment Process

A MOU was signed by Denison, ALBML and the NVILX in 2018. The signing of this MOU with both ALBML and the NVILX reflected the perspective of ALBML and the NVILX to represent both municipal residents and the Métis co-operatively. This non-binding MOU formalized the intent to work together in a spirit of mutual respect to cooperate to collectively identify practical means by which to avoid, mitigate, or otherwise address potential effects of the Project upon the exercise of the Indigenous Rights, Treaty Rights, and interests, to the extent they are identified in relation to the Project.

In 2019, ALBML delegated their Duty to Consult for the Project to the MN-S. From 2019, the MN-S has been representing ALBML in respect of engagement with Denison for the Project.

In March 2024, an Agreement was concluded in respect of the Wheeler River Project between Denison and Île-à-la Crosse, along with the Northern Village of Beauval, Jans Bay, and Cole Bay, that provides, among other matters, various commitments by Denison to these four communities and includes specific support of Île-à-la Crosse, the Northern Village of Beauval, Jans Bay, and Cole Bay for the development and operation of the Project.

4.4.2.1.3 Key Engagement Activities

During the engagement activities undertaken with the NVILX, several key engagement activities took place that have played a meaningful role in relation to the EA process. These key engagement activities were supported by ongoing engagement methods including, but not limited to, those outlined in Section 4.2.1. The main forms of engagement included meetings with leadership, community meetings, a workshop on early infrastructure options (2018), a site visit (2019), and one online survey (2021). An open house for the general public was planned to be hosted in 2022 on preliminary effects and mitigation, but due to concerns identified by MN-S about hosting a public open house in a community with a significant Métis population, this meeting was postponed by Denison. Denison looks forward to rescheduling the meeting in collaboration with the MN-S. As noted in Section 4.2.1, due to the COVID-19 pandemic, engagement switched to virtual meetings in 2021. In mid-2022, appropriate engagement activities moved back to in-person. The following text describes several of the key engagement activities in more detail.

Engagement Focus: Pre-Project Description - April 2016 to May 2019

Introductory Meeting – December 7, 2016: This was the inaugural meeting between the senior management team of Denison and various entities associated with ALBML and the NVILX . The meeting focussed on clarifying the nature of Denison's activities, including the Project and related exploration activities, the interest in employment, business and training opportunities, reclamation requirements, agreement negotiation considerations, investment possibilities, environmental sampling and monitoring, and questions in relation to the nuclear industry in general and the market related to uranium. For more information about this activity, please see Appendix 4-A, ROC #109.

Workshop – January 17, 2018: Denison hosted a workshop with many community members and students. The focus of the workshop was to obtain feedback on three alternatives/options for the proposed Project: the road alignment from Highway 914 into the Project Area; the potential treated effluent discharge location; and the mining method options. The workshop opened and concluded with questions pertaining to Denison and the Project, comments on the importance of training, agreement negotiations, and other general items.

General questions were asked regarding the various alternatives and options, and points of clarification pertaining to aspects of the Project. Feedback was collected on the various options and has been incorporated into the final design for road alignment, and the treated effluent discharge location. Please see Section 2 for more details. For additional details about this activity, please see Appendix 4-A, ROC #3.

Engagement Focus: Post-Project Description – July 2019 to October 2022

Site Tour – August 23, 2019: In August 2019, Denison hosted a site tour at the Project location. The focus of this engagement activity was to provide an in-field opportunity to understand the proposed Project and the various elements associated with the Project. Attending the site tour was the Mayor of the NVILX and a Councillor of the NVILX. The tour involved an initial presentation regarding the Project, followed by travel around the Project site to the various locations for the proposed elements of the Project. Representatives from the CNSC and SK MOE were present. For more information about this activity, please see Appendix 4-A, ROC #1.

Meetings – February 10, 2021: On February 10, 2021, Denison hosted virtual meetings with the leadership of the NVILX, as well as virtual meeting for the residents of the NVILX. The focus of these engagement activities was to provide information about the Project to the NVILX and residents, present a preliminary list of VCs that Denison had identified as part of the EA process, provide an opportunity for members to give feedback on the proposed list of VCs, and ask questions about Project components of interest or concern to them.

During the leadership meeting with the NVILX, Denison confirmed it was acceptable to continue hosting the virtual meeting for the residents of the NVILX, given concerns raised by the MN-S related to the Métis nature of the NVILX. The leadership of the NVILX confirmed it was acceptable to host the virtual meeting for the residents. The virtual meeting for residents was advertised on the radio and social media, and posters were placed in community buildings. The Zoom platform was used, but the meeting was also broadcasted live through 92.5 FM. At least 34 Zoom accounts were used to attend the presentation, although it is possible that more than one person viewed the presentation from each account. Representatives from the CNSC and the Province of Saskatchewan were present during both virtual meetings.

Topics covered during the virtual presentations include the following:

- Denison company introduction and key staff members;
- introduction to regulators;
- location of the Project;
- ISR mining, in general;
- ISR mining at the Project, including the recent change in the Project design from freeze dome technology to a freeze wall containment method;
- employment opportunities;
- EA; and

- VCs.

Meeting participants were encouraged to complete Denison's online survey in relation to the VCs considered important to residents of the NVILX. Following the presentation, Denison answered questions that were put into the online chat function.

Key themes that emerged from the questions posed at the NVILX meetings, which indicated either interests or concerns, are summarized as follows:

- the ISR mining method, the length of the Project, the novelty of ISR for uranium mining in Canada, the processing of the uranium bearing solution, water treatment processes;
- monitoring during mining operations and closure monitoring, monitoring of groundwater in relation to the freeze wall;
- critical habitats in relation to the potential effects of the Project;
- transportation issues, such as the need for an airstrip and the trucking routes for uranium ore concentrate;
- economic opportunities, including job opportunities, training opportunities, business opportunities; and
- considerations of revenue sharing.

For more specifics about this activity, please see Appendix 4-A, ROC #443.

Denison provided a report to the NVILX regarding what was heard by Denison during the engagement activities. This report was shared in hard copy form (sent to the NVILX Office), shared with the NVILX for posting to a website, posted on the Denison website (www.wheelerriverproject.ca) and a video was made by Denison for those who prefer oral communications, also on the Denison website.

Online Survey: During and following the NVILX meeting(s), attendees were invited to provide feedback on VCs through an online survey. The purpose of the survey was to seek feedback on the importance of the VCs to members, and identify interests or concerns related to the Project, providing an additional mean by which feedback could be provided to Denison. People who were unable to attend the presentation were also encouraged to provide feedback through the survey. The survey was marketed to members using Facebook and radio advertisements.

The survey was open for feedback from February 9 to 23, 2021, for a total of 14 days. Thirty responses were received.

The survey included reach and marketing questions about how respondents heard about the survey and if they attended a presentation. This information helped Denison to determine which event marketing efforts were most effective.

The survey also asked respondents to disclose voluntary demographic information such as age, primary residence, and identity, to help Denison determine if there were large demographic groups whose perspectives were not represented in the results.

Following the reach and marketing and demographic questions, the survey included questions specific to the preliminary list of VCs. These questions were followed by the opportunity for respondents to share their thoughts on opportunities and challenges related to the Project.

Demographics

Most survey respondents (67%) were between the ages of 16 and 34, compared to 30% who were between the ages of 35 and 64, and 3% who identified as age 65 or older. Most respondents self-identified as Indigenous peoples with the majority (60%) of people identifying as Métis, 17% identifying as First Nations people, and 7% identifying as Indigenous but preferring not to specify. The remaining respondents identified as non-Indigenous (10%) or preferred not to answer (7%).

Valued Components

A total of 26 interconnected VCs were proposed to respondents. Respondents were asked to select from the list which VCs they felt were important for Denison to research further as part of the EA. While all 26 VCs were identified as important by at least one respondent, the following environmental components were identified as important to more than half of respondents:

- traditional land and resource use;
- air quality;
- employment;
- local economy; and
- training.

The importance of local economy, jobs, training and the need for environmental monitoring were echoed in the questions asked by those who attended the virtual presentation. Respondents explained that these VCs are important to them because they help to build for future community health and growth, promote the importance of valuing and protecting the earth and Indigenous cultural practices and beliefs, and encourage strong local economies and employment opportunities for northerners.

Respondents from Île-à-la-Crosse felt that the following VCs were missing and should be added to the list:

- housing; and
- community participation.

Fewer than 50% of respondents identified VCs that were not important to study further. These VCs included:

- noise level;
- employment;
- outfitting;
- business activity;
- soil;
- training;
- traditional land and resources use;
- infrastructure and services;
- vegetation; and
- birds.

Of these, noise level was the only VC that was selected as not important more often than it was identified as important.

The complete list of VCs included in this EIS is available in Section 5.3.1 in Section 5.

Opportunities and Challenges

Respondents were asked, based on what they knew so far about the Project, to share the aspects of the Project that they felt could benefit or work well for the community.

Some of the unique or specific opportunities mentioned included the following items:

- training and education opportunities;
- employment opportunities for skilled local people at all intervals throughout the life of the mine;
- donations to school groups;
- potential for a northern company to complete environmental monitoring;
- business partnerships or involvement opportunities;
- opportunity for joint ventures; and
- potential for communities in the north to work together.

Respondents were then asked what aspects of the Project they felt would be challenging or cause concern for their community. Responses included:

- issues that arise after the mines close, including decline in employment and mental health concerns;
- potential effects to the environment;
- potential political issues and communities not able to work in partnership;
- a lack of transparency in terms of environmental effects;
- potential for spills, pollution, and water contamination and lack of transparency about these occurrences;
- safe transportation of uranium; and
- lack of education about potential benefits of the uranium industry for the community.

For more information about this activity, please see Appendix 4-A, ROC #446.

Engagement Focus: Environmental Assessment Outcomes and Relationship to Licensing / Approvals – October 2022 to Present

Meeting - October 25, 2023: On October 25, 2023, Denison hosted a meeting with the leadership of the NVILX to share information about the Wheeler River Project. The focus of these engagement activities was to share the findings of the EA, mitigation measures, monitoring, significance, cumulative effects, the conclusions of the EIS, and the relationship between the environmental assessment and the ultimate licensing / approvals process for the Project. A strong focus of the meeting by the NVILX leadership was about industry signing formal agreements with Indigenous communities and the municipalities not being included.

Open House – October 25, 2023: On October 25, 2023, Denison hosted an open house event in the NVILX to share information about the Wheeler River Project. The focus of these engagement activities was to share the findings of the EA, mitigation measures, monitoring, significance, cumulative effects, the conclusions of the EIS, and the relationship between the environmental assessment and the ultimate licensing / approvals process for the Project. Denison advertised the event with social media posts and posters around the community. Information boards and area models were displayed, information booklets were provided, Denison staff were available to answer questions, and a translator was present to translate as needed. The CNSC and the Saskatchewan Ministry of Environment were invited by Denison and were in attendance.

To communicate EA findings, Project details and the relationship to the licensing / approvals process, Denison displayed three models and 6 informational poster boards. The three models depicted: 1) the uranium ore body and projected, below ground, extraction infrastructure; 2) the Project site surface with associated infrastructure; and 3) a 1:294 scale map of the area surrounding the Project site. The 6 informational poster boards presented EA findings and related licensing / approvals actions in relation to VCs identified as important during previous rounds of engagement activities.

Please see Appendix 4-A, ROC #1034 for more details about this engagement activity.

Future Engagement

Denison expects to continue working work with the NVILX, throughout the remainder of the environmental assessment and approval process and into the licensing process, to coordinate engagement activities in relation to their topics of interest related to the Project.

4.4.2.1.4 *Northern Village of Île-à-la-Crosse Support for the Project*

In March 2024, an Agreement was concluded in respect of the Wheeler River Project between Denison and Île-à-la Crosse, along with the Northern Village of Beauval, Jans Bay, and Cole Bay, that provides, among other matters, various commitments by Denison to these four communities and includes specific support of Île-à-la Crosse, the Northern Village of Beauval, Jans Bay, and Cole Bay for the development and operation of the Project.

4.4.2.1.5 *Northern Village of Île-à-la-Crosse Key Interests, Issues and Concerns*

A summary of key interests, issues and concerns gathered throughout the course of engagement for the Project, including any formal submissions made through the regulatory process, are identified in Appendix 4-C. It is important to note that areas of identified interest, issues, or concerns are not always related to environmental effects as defined by CEAA 2012 (the regime under which the Project is undergoing regulatory assessment) - they can be reflective of general areas of interest in relation to the Project more broadly. Where appropriate, the table aims to provide clarity with respect to this distinction.

4.4.2.2 Engagement with the Northern Hamlet of Stony Rapids

The Northern Hamlet of Stony Rapids is a non-Indigenous community that participated in engagement with Denison through YNLR. Please see Section 4.3.4.2 for additional information on engagement.

Figure 4.3-1 illustrates where Stony Rapids is in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, Stony Rapids is located 195 km away from the Project. In terms of travel distance by existing transportation routes Stony Rapids is located 1,145 km away from the Project.

4.4.2.3 Engagement with the Northern Settlement of Uranium City

The Northern Settlement of Uranium City is a non-Indigenous community that participated in engagement with Denison through YNLR. Please see Section 4.3.4.2 for additional information on engagement.

Figure 4.3-1 illustrates where Uranium City is in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, Uranium City is located 295 km away from the Project. In terms of travel distance by existing transportation routes Uranium City is more than 1,200 km away, a portion of which is only accessible via winter road.

4.4.2.4 Engagement with the Northern Settlement of Camsell Portage

The Northern Settlement of Camsell Portage is a non-Indigenous community that participated in engagement with Denison through YNLR. Please see Section 4.3.4.2 for additional information on engagement.

Figure 4.3-1 illustrates where Camsell Portage is in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, Camsell Portage is located 325 km away from the Project. In terms of travel distance by existing transportation routes Camsell Portage is more than 1,200 km away, a portion of which is only accessible via winter road.

4.4.2.5 Engagement with the Northern Settlement of Wollaston Lake

The Northern Settlement of Wollaston Lake is a non-Indigenous community that participated in engagement with Denison through YNLR. Please see Section 4.3.4.2 for additional information on engagement.

Figure 4.3-1 illustrates where Wollaston Lake is in relation to the Project, both in terms of direct linear distance and travel distance. In terms of direct linear distance, Wollaston Lake is located 160 km away from the Project. In terms of travel distance by existing transportation routes, Wollaston Lake is located 945 km away from the Project, a portion of which is only accessible via winter road.

4.4.3 Engagement with Nearby Land Users

As part of engagement with the category of the General Public, Denison identified three types of Nearby Land Users who have the potential to experience effects from the Project, including:

- commercially licensed trappers and fishers; and
- cabin/lease owners and commercially operated lodges.

Figure 4.4-1 illustrates where cabin, lease owners, and commercially operated lodges are located.

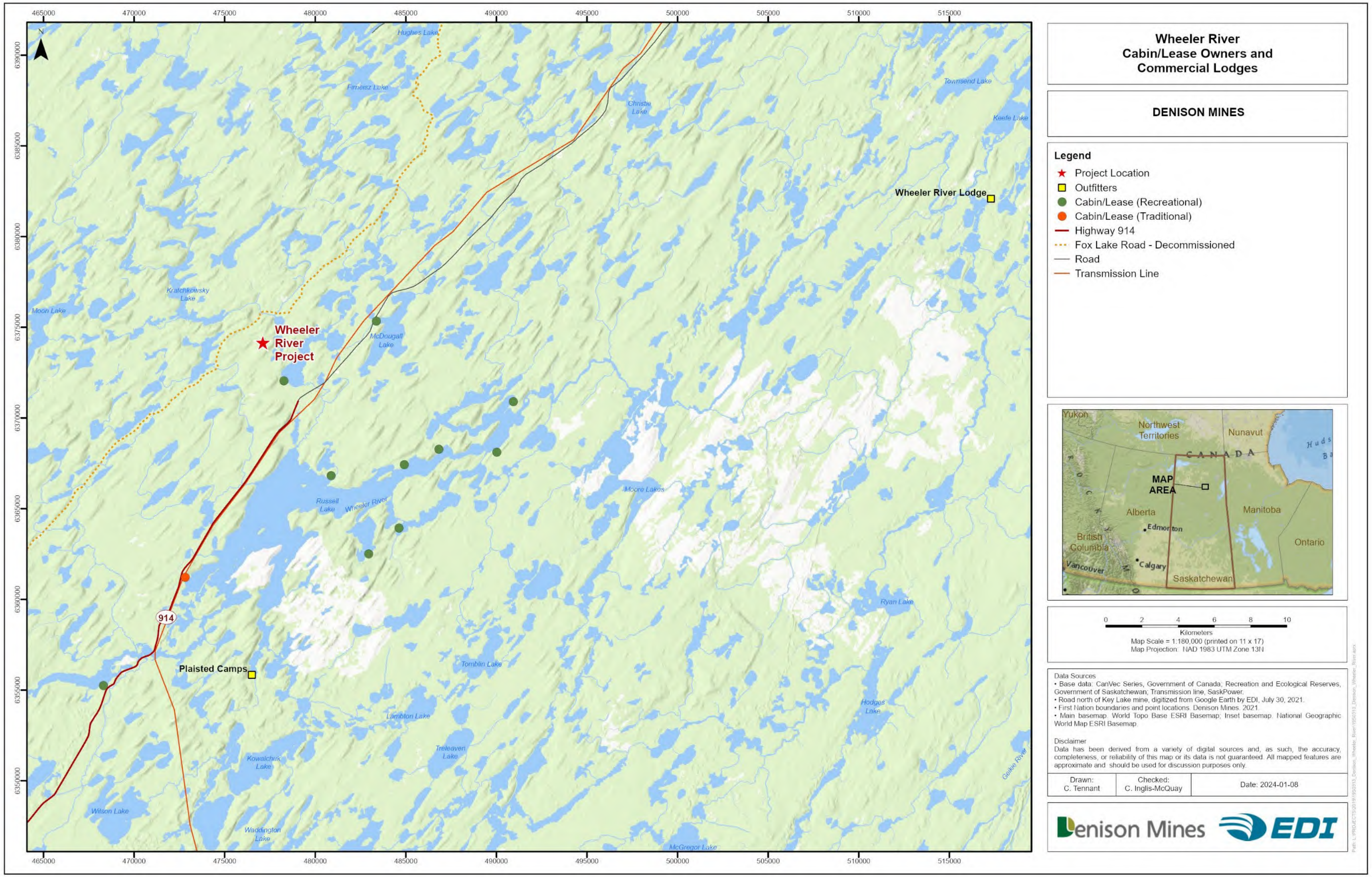

Figure 4.4-1: Cabin/Lease Owners and Commercial Lodges Near the Project

4.4.3.1 Engagement with Commercially Licensed Trappers and Fishers

For the Project, Denison engaged regularly with one commercially licensed trapper and fisher (who was also a member of ERFN; referred to herein as the ERFN Trapper) in relation to the Project. Denison worked closely with this individual to gather detailed land and resource use information. The individual maintained a main cabin on the Wheeler River and secondary cabins on Russell Lake, Philips Lake, and a family cabin on Creek Lake. Unfortunately, prior to the time of filing the EIS, the ERFN Trapper passed away.

Denison has also shared information with the Chairperson of the N-18/N-16 furblock, as the representative responsible for the commercial trapping activities within these two furblocks.

4.4.3.1.1 History of Interactions

Throughout regular exploration activities in the area where the Project occurs, Denison had been regularly engaging with the ERFN Trapper on various matters. With the onset of the filing of the Project Description in 2019, Denison and the ERFN Trapper shifted engagement activities toward the Project and sharing of information on between the ERFN Trapper and Denison in respect of the ERFN Trapper's specific information about the area in which the Project is located, key concerns, and feedback on pilot activities in relation to mitigation planning. This resulted in several key engagement activities, the outcomes of which have informed several components of the EIS. These key engagement activities were supported by ongoing engagement methods including, but not limited to, those outlined in Section 4.2.1.

4.4.3.1.2 Key Engagement Activities

Engagement Focus: Pre-Project Description - April 2016 to May 2019

The focus of this engagement activity was to provide an in-field opportunity to understand the proposed Project and the various elements associated with the Project.

During a tour with the ERFN Chief and Elders, the ERFN Trapper was included. The tour involved an initial presentation regarding the Project, followed by travel around the Project site to the various locations for the proposed elements of the Project. Over the course of the site visits, the ERFN Trapper made comments or queried about:

- the proposed ISR mining method (makeup of mining solution); and
- the general effect of the Project on the surrounding lands.

For more information about this activity, please see Appendix 4-A, ROC #140.

Engagement Focus: Post-Project Description – July 2019 to October 2022

Denison and the ERFN Trapper undertook a full-day on-site interview in order for Denison to receive input and land knowledge about the existing environment, and also in relation to general questions and/or concerns the ERFN Trapper might have regarding the Project. Notes from this interview were finalized and approved for use on January 2, 2020. The interview findings were subsequently shared with all discipline leads and have been included throughout the EIS and more prominently in Sections 9 and 11. Please see Appendix 4-A ROC#134 for more details.

In 2021, Denison sought feedback from the ERFN Trapper on a multi-year test program to test options for the Project in relation to mitigation of linear features. While this test program is not formally considered part of the EA as it is intended as a test to support future potential programming, Denison considered it important to make sure the ERFN Trapper was suitably informed about the program to provide feedback and guidance to Denison's team. General concerns were noted about cutlines, and corridors being used by wolves to gain better access to caribou were identified. Later that summer, the ERFN Trapper was provided an opportunity to see the test program in place and again provided feedback to Denison regarding the measures installed. Noted concerns were the aesthetic issue with mounding of earth to block linear features and recommended alternatives. These concerns have been considered as part of the overall test plan, in terms of including criteria to determine successful mitigation strategies that consider community and local land user concerns. Please see Appendix 4-A ROC#506 and ROC#516 for more details.

4.4.3.1.3 Nearby Land Users (Commercially Licensed Trappers and Fishers) Key Interests, Issues and Concerns

A summary of key interests, issues, and concerns gathered throughout the course of engagement for the Project, including any formal submissions made through the regulatory process, are identified in Appendix 4-C. It is important to note that areas of identified interest, issues or concerns are not always related to environmental effects as defined by CEAA 2012 (they can be reflective of general areas of interest in relation to the Project more broadly). Where appropriate, the table aims to provide clarity with respect to this distinction.

4.4.3.2 Engagement with Cabin/Lease Owners and Commercially Operated Lodges

Denison regularly shares information with and seeks feedback from several cabin/lease owners and a commercially operated lodge. These Nearby Land Users are generally defined as those within a 20-km radius to the Project site.

Figure 4.4-1 illustrates where cabin/lease owners and commercially operated lodges are in relation to the Project, both in terms of direct linear distance and travel distance. The figure shows that there are ten known recreational cabin/lease owners, one known traditional cabin/lease owner, and two known commercial lodges within a 20 km radius of the Project site.

4.4.3.2.1 History of Interactions

With the onset of the filing of the Project Description in 2019, Denison commenced engagement activities with the cabin/lease owners and the commercially operated lodge. This included sharing information about the Project description, the pause of the EA, the EA restart, and importantly, seeking feedback from these Interested Parties in respect of their interests in the Project. Key engagement activities were supported by ongoing engagement methods including, but not limited to, those outlined in Section 4.2.1. A survey was conducted in January 2020 when Denison sent known local cabin/lodge leaseholders a survey in the mail to be completed regarding their interests in the Project. Since then, update information has been sent to this group of Interested Parties.

4.4.3.2.2 Key Engagement Activities

One of the key engagement activities undertaken with the cabin/lease owners and the commercially operated lodge occurred in January 2020 when Denison sent known local cabin/lodge leaseholders a survey in the mail to be completed regarding their interests in the Project. Denison received six responses from the survey (five cabin/lease owners and one commercially operated lodge), which has informed Denison's understanding of leaseholder uses in the area and interests regarding elements to be assessed as part of the EA. A copy of the survey sent to cabin owners in January 2020 can be found in Appendix 4-A as ROC #267.

The five cabin/leaseholders in the area that responded to the survey noted they have been leaseholders of their property for less than 5 years (n=1), 5 to 10 years (n=2), 10 to 15 years (n=1) and over 15 years (n=1). Use of these cabins ranges from 4 to 5 times per year (n=3) to more than five years (n=2). Users generally spend between 2 to 5 weeks (n=2) or 5 to10 weeks (n=3) using their facilities. The cabins are located between 5 and 20 km away from the Project site, and users travel across the landscape to conduct their various activities in a range of 5 to 10 km (n=1) and over 10 km (n=4). Cabins are used for a variety of activities, with all respondents using it for fishing, enjoying nature, and family time; three users noted the additional use for ATVing and boating, hunting, and trapping; and one user noted the additional use for plant harvesting/collecting and accessing cultural sites.

According to the owner of Wheeler River Lodge, the lodge and land in the area are used for recreational and commercial fishing, hunting, and trapping, ATVing and boating, enjoying nature, and family time. The owner expressed concerns over potential Project effects to these activities.

As Appendix 4-C indicates, the issue of maintaining the gated access at Key Lake is important to four of the five respondents of the cabin/lease owners due to concerns over vandalism to property and infrastructure if more users were granted access to the area. Another concern was effects to overall land and resource use, especially hunting, fishing, ATVing, and boating (four of the five cabin/lease holders), with one respondent also commenting on the concern over hunting and fishing pressure by Project staff. Concern was also noted (by three of the five respondents) about increased traffic, particularly on Highway 914. Conflicts with outfitter and cabin owners were noted by all five cabin/lease owners.

Similar to the other Nearby Land Users, maintaining the existing controlled access at Key Lake was a recurring concern for the Wheeler River Lodge owner. Having the gatehouse removed would increase access to the area, opening it up to increased use, and potential vandalism/theft to his property and belongings. The increased access would then put increased pressure on fishing, hunting and other outdoor recreation activities in the area, potentially affecting his lodge business (see Appendix 4-C). Conflicts with outfitters and cabin owners was also noted.

The Wheeler River Lodge owner expressed a concern that the name of lodge and the Project are similar, and resulting in searches on the internet confusing and/or concerning potential future clients about the proximity of a new mining operation in relation to his lodge—with the potential for loss of business.

4.4.3.2.3 Nearby Land Users (Cabin/Lease Owners and Commercial Lodge Owners) Key Interests, Issues and Concerns

A summary of key interests, issues, and concerns gathered throughout the course of engagement for the Project, including any formal submissions made through the regulatory process, are identified in Appendix 4-C. It is important to note that areas of identified interest, issues, or concerns are not always related to environmental effects as defined by CEAA 2012 (the regime under which the Project is undergoing regulatory assessment) - they can be reflective of general areas of interest in relation to the Project more broadly. Where appropriate, the table aims to provide clarity with respect to this distinction.

4.4.3.3 Engagement with Organizations

Denison identified three organizations to engage with, as part of the General Public:

- Northern Saskatchewan Environmental Quality Committee (NSEQC);
- Saskatchewan Mining Association; and
- Northern Labour Market Committee.

Generally, Denison engages with these organizations on an as-requested basis, providing presentations and/or information requested. It is expected that as the Project continues to advance through the regulatory process, more engagement will occur with these, and other, organizations as they identify their interest to Denison.

As of Q2, 2022, Denison had provided two presentations to the NSEQC (2017 and 2022), one presentation to the Northern Labour Market Committee, and several presentations to the Saskatchewan Mining Association various forums and meetings over the years.

4.4.3.3.1 Key Issues and Concerns

A summary of key interests, issues, and concerns gathered throughout the course of engagement for the Project, including any formal submissions made through the regulatory process, are identified in Appendix 4-C. It is important to note that areas of identified interest, issues, or concerns are not always related to environmental effects as defined by CEAA 2012 (the regime under which the Project is undergoing regulatory assessment) - they can be reflective of general areas of interest in relation to the Project more broadly. Where appropriate, the table aims to provide clarity with respect to this distinction.

4.5 Engagement with Regulatory Agencies

The Project will undergo a joint provincial-federal EA process led by SK MOE's Environmental Assessment and Stewardship Branch and the CNSC. As government entities were involved in the assessment and regulatory process, engagement included both organizations, starting with meetings in 2018 prior to the submission of the Technical Proposal and Project Description to provide agency staff with information on the Project and the regulatory submission plans.

Denison carried out proactive and early engagement to align the process with existing guidance documents, with CNSC and SK MOE staff. Engagement was initiated during completion of prefeasibility engineering and early collection of environmental baseline data in early 2018. Meeting held in late 2018 were intended to serve as pre- engagement meetings for submission of the Technical Proposal and Project Description. Denison provided a Project overview, sought guidance, and addressed questions before submission of the Technical Proposal and Project Description.

Regular engagement activities continued throughout the EA development phase from 2019 through 2024. Table 4.5-1 outlines the engagement activities that took place between 2018 up until the submission of the Final EIS.

Table 4.5-1: Engagement Activities with Regulatory Agencies

Date	Organization	Engagement Type	Purpose
February 14, 2018	Canadian Nuclear Safety Commission (CNSC) – Uranium Mines and Mills Division (UMMD)	Meeting	Introduced Denison and the Project; provided an overview of the Project from the Preliminary Economic Assessment and scope for the Prefeasibility Study, which is underway; discussion and Q&A.
March 1, 2018	SK MOE	Meeting	Introduced Denison and the Project; provided an overview of the Project from the Preliminary Economic Assessment and scope for the Prefeasibility Study, which is underway; discussion and Q&A.
April 25, 2018	CNSC	Meeting	Introduced Denison and the Project; provided an overview of the Project from the Preliminary Economic Assessment and scope for the Prefeasibility Study, which is underway; discussion and Q&A.
November 13, 2018	CNSC	Meeting	Denison provided a Project update, including an overview of the Prefeasibility Study and the Project scope for the Project Description; answered any questions about the Project. Denison advised on plans to submit a Project Description in 2019; the group discussed plans for the regulatory process moving forward.

Date	Organization	Engagement Type	Purpose
November 21, 2018	SK MOE	Meeting	Denison provided a Project update, including an overview of the Prefeasibility Study and the Project scope for the Technical Proposal. Denison advised on plans to submit a Technical Proposal in 2019; the group discussed plans for the regulatory process moving forward.
December 3, 2018	SK MOE – Mines and Mills	Meeting	Denison provided a Project update, including an overview of the Prefeasibility Study and the Project scope for the Technical Proposal. Denison advised on plans to submit a Technical Proposal in 2019; the group discussed plans for the regulatory process moving forward.
February 19, 2019	SK MOE, CNSC	Submission	Denison filed the Technical Proposal and Project Description to initiate the EA process under the Saskatchewan *Environmental Assessment Act* and the CEAA 2012.
March 7, 2019	SK MOE	Submission	Denison submitted the Wheeler River Terms of Reference to the Province of Saskatchewan as a requirement of the provincial EA process.
May 1, 2019	CNSC	Meeting	Denison and the CNSC held a meeting to discuss Denison's responses to CNSC comments on the Project Description and the Aboriginal Engagement Report.
May 15, 2019	SK MOE, CNSC	Submission	Denison filed the revised Technical Proposal and Project Description, revised Terms of Reference, and Indigenous Engagement Report.
June 19, 2019	CNSC	Meeting	Denison presented on the recommended approach to engagement for the Project EA.
August 7, 2019	SK MOE, CNSC	Meeting	Denison presented an overview of engagement conducted and planned for the Project EA.
August 23, 2019	SK MOE, CNSC	Site tour	Denison hosted the MN-S President, MN-S Minister of Environment/MN-S Region 3 President, and the Presidents of the Métis Locals at the Project site for a site tour and to discuss the Project, along with representatives from the CNSC and SK MOE.
January 22, 2020	CNSC	Information Letter	Denison provided the CNSC with the draft Wheeler River Engagement Plan for consideration.
March 19, 2020	SK MOE, CNSC	Notification Letter	Denison filed a notice of suspension of the Wheeler River EA, citing significant social and economic disruption that emerged because of the COVID-19 pandemic, and the Company's commitment to ensure employee safety, support public health efforts to limit transmission of COVID-19, and exercise prudent financial discipline.
July 7, 2020	CNSC	Meeting	Denison provided a general update on 2020 activities pertaining to the Wheeler River exploration program.
July 16, 2020	SK MOE	Meeting	Denison provided a general update on 2020 activities pertaining to the Wheeler River exploration program.
September 30, 2020	SK MOE, CNSC	Meeting	Denison presented information on the trade-off study conducted for the Wheeler River freeze wall design.

Date	Organization	Engagement Type	Purpose
November 12, 2020	SK MOE, CNSC	Notification	Denison filed a notification letter of the plans to restart the Wheeler River EA in January 2021.
December 22, 2022	SK MOE, CNSC	Submission	Denison filed an updated Technical Proposal and Project Description to reflect the change in freeze wall design.
January 15, 2021	SK MOE, CNSC	Meeting	Monthly discussions provided updates on the progress of the EA, including technical details, regulatory requirements, and engagement.
February 17, 2021	SK MOE, CNSC	Meeting	Monthly discussions provided updates on the progress of the EA, including technical details, regulatory requirements, and engagement.
March 9, 2021	SK MOE, CNSC	Meeting	Monthly discussions provided updates on the progress of the EA, including technical details, regulatory requirements, and engagement.
April 14, 2021	SK MOE, CNSC	Meeting	Monthly discussions provided updates on the progress of the EA, including technical details, regulatory requirements, and engagement.
April 23, 2021	CNSC	Meeting	Discussion regarding federal participant funding for review of the EA.
May 19, 2021	SK MOE, CNSC	Meeting	Monthly discussion provided updates on the progress of the EA, including technical details, regulatory requirements, and engagement.
May 20, 2021	CNSC	Meeting	Discussion regarding engagement records to be filed with the draft EIS.
June 16, 2021	SK MOE, CNSC	Meeting	Monthly discussion provided updates on the progress of the EA, including technical details, regulatory requirements, and engagement.
July 27, 2021	SK MOE, CNSC	Meeting	Monthly discussion provided updates on the progress of the EA, including technical details, regulatory requirements, and engagement.
August 11, 2021	SK MOE, CNSC	Meeting	Monthly discussion provided updates on the progress of the EA, including technical details, regulatory requirements, and engagement.
September 17, 2021	SK MOE, CNSC	Technical Meeting	Denison's assessment team provided a presentation to members and provincial and federal technical reviewers, including an overview of the atmospheric modelling for the Wheeler River EA.
October 12, 2021	SK MOE, CNSC	Meeting	Monthly discussion provided updates on the progress of the EA, including technical details, regulatory requirements, and engagement.
November 8, 2021	SK MOE, CNSC	Meeting	Monthly discussion provided updates on the progress of the EA, including technical details, regulatory requirements, and engagement.
December 7, 2021	CNSC, Environment and Climate Change Canada	Technical Meeting	Denison's assessment team provided a presentation to several members of the federal EIS technical review team, including an overview of the atmospheric modelling for the Wheeler River EA.
December 13, 2021	SK MOE, CNSC	Meeting	Monthly discussion provided updates on the progress of the EA, including technical details, regulatory requirements, and engagement.
January 17, 2022	SK MOE, CNSC	Meeting	Monthly discussion provided updates on the progress of the EA, including technical details, regulatory requirements, and engagement.
January 22, 2022	SK MOE, Saskatchewan Ministry of Energy and Resources	Meeting	Introduction to Denison, the supporting Saskatchewan team, and the objectives and near-term deliverables for the Project.
January 26, 2022	SK MOE, CNSC	Meeting	Denison provided a presentation on the 2022 plans for the Feasibility Field Test and how the information from the test work will inform future regulatory submissions and engineering design.
February 1, 2022	SK MOE, CNSC, Natural Resources Canada, Water Security	Technical Meeting	Denison's assessment team provided a presentation to several members of the federal EIS technical review team, including an overview of the groundwater modelling for the Wheeler River EA.

Date	Organization	Engagement Type	Purpose
	Agency, Environment and Climate Change Canada		
February 14, 2022	SK MOE, CNSC	Meeting	Monthly discussion provided updates on the progress of the EA, including technical details, regulatory requirements, and engagement.
March 14, 2022	SK MOE, CNSC	Meeting	
April 11, 2022	SK MOE, CNSC	Meeting	
May 9, 2022	SK MOE, CNSC	Meeting	
June 13, 2022	SK MOE, CNSC	Meeting	
July 7, 2022	SK MOE, CNSC	Meeting	
August 8, 2022	SK MOE, CNSC	Meeting	
September 29, 2022	SK MOE, CNSC	Site Tour	Denison hosted representatives from the SK MOE and CNSC at the Project site to present details on the scope of the Project as presented in the draft EIS and to tour the proposed Project location. The site tour took place during the active 2022 Advanced Exploration Feasibility Field Test.
October 21, 2022	SK MOE, CNSC	Submission	Denison filed the Wheeler River Project draft EIS.
November 25, 2022	CNSC, ECCC, NRCan, Fisheries and Oceans Canada (DFO), Health Canada, Transport Canada, ERFN	Technical Meeting	Denison's assessment team provided an overview of the draft EIS and its key findings to the Federal-Indigenous Review Team (FIRT) to kick-off their 90-day technical review of the Wheeler River Project draft EIS.
2023 (monthly meetings throughout the year)	SK MOE, CNSC	Meetings	Monthly discussion provided updates on the progress of the EA, including technical details, regulatory requirements, and engagement.
January 11, 2023	CNSC, NRCan, DFO, ECCC	Technical Meeting	Denison's assessment team presented information on the geology and groundwater assessments in the draft EIS to the FIRT and responded to questions. This meeting was in support of the FIRT's technical review of the draft EIS.
January 12, 2023	SK MOE		Denison receives provincial technical review comments (TRCs) on the draft EIS.
January 16, 2023	CNSC, Health Canada, ECCC	Technical Meeting	Denison's assessment team presented information on the accidents and malfunctions assessment in the draft EIS to the FIRT and responded to questions. This meeting was in support of the FIRT's technical review of the draft EIS.
January 27, 2023	CNSC, ECCC	Technical Meeting	Denison's assessment team presented information on meteorology in the draft EIS to the FIRT and responded to questions. This meeting was in support of the FIRT's technical review of the draft EIS.
March 20, 2023	CNSC		Denison receives FIRT information requirements (IRs) on the draft EIS.

Date	Organization	Engagement Type	Purpose
April 6, 2023	CNSC, ECCC	Technical Meeting	Denison's assessment team met with key individuals on the FIRT following receipt of the draft EIS information requirements (IRs) on March 20, 2023. This meeting's purpose was to discuss a subset of the seven IRs where the FIRT identified that a technical discussion was required; specifically, IR-223 and IR-224 related to freeze wall integrity and post decommissioning seismic events.
April 19, 2023	CNSC, ECCC	Technical Meeting	Denison's assessment team met with key individuals on the FIRT following receipt of the draft EIS IR on March 20, 2023. This meeting's purpose was to discuss a subset of the seven IRs where the FIRT identified that a technical discussion was required; specifically, ECCC's comment IR-10 related to freeze wall design and integrity.
April 19, 2023	CNSC, ECCC	Technical Meeting	Denison's assessment team met with key individuals on the FIRT following receipt of the draft EIS IRs on March 20, 2023. This meeting's purpose was to discuss a subset of the seven IRs where the FIRT identified that a technical discussion was required; specifically, IRs-103, -104, -235, -236 from ECCC related to precipitation under current and future climate scenarios, hydrology, and probable maximum precipitation.
April 20, 2023	CNSC, ECCC	Technical Meeting	Denison's assessment team met with key individuals on the FIRT following receipt of the draft EIS IRs on March 20, 2023. This meeting's purpose was to discuss IRs related to woodland caribou (IRs-137, -143, -144, -145, -148, -149, -152, -156, -157), species at risk (IRs-131, -132, -142, -158, -161, -174), and data granularity/baseline data available in the context of EIS approach and assumptions (IRs-143,-144, -145, -152, -159, -160, -163, -164).
April 20, 2023	CNSC	Information Session	Denison's Wheeler River Project team met with representatives from CNSC's Regulatory Operations Branch, Technical Support Branch and the Regulatory Affairs Branch. The meeting purpose was to provide the CSNC with an overview of the Project components, a summary of Project engagement activities and to discuss areas of regulatory uncertainty.
May 18, 2023	SK MOE	Technical Meeting	Denison's assessment team met with SK MOE (Environmental Assessment Branch staff and Resource Management Division staff) to present and discuss Denison's framework for a conceptual Caribou Mitigation Plan.
June 1, 2023	SK MOE	Submission	Denison submits responses to provincial TRCs on the draft EIS.
June 5, 2023	SK MOE	Technical Meeting	Denison's assessment team and SK MOE (Environmental Assessment Branch staff and Resource Management Division staff) discuss the Project's conceptual Caribou Mitigation Plan.
June 19 and 20, 2023	CNSC	Site tour	Denison hosted representatives from the CNSC at the Project site to discuss the Project and tour the proposed Project location.
July 14, 2023	CNSC	Submission	Denison submits responses to FIRT IRs on the draft EIS.

Date	Organization	Engagement Type	Purpose
July 26, 2023	SK MOE		Denison receives results of provincial review of Denison's TRC responses (i.e., second round of TRCs on the draft EIS).
August 18, 2023	CNSC	Submission	Denison re-submits responses to the FIRT IRs to address the CNSC's feedback on their completeness check.
September 14, 2023	SK MOE	Submission	Denison submits responses to second round of provincial TRCs.
October 17, 2023	SK MOE	Technical Meeting	SK MOE provides Denison with an overview of the caribou habitat offset calculator.
October 26, 2023	SK MOE	Technical Meeting	SK MOE provides Denison with results of the caribou habitat offset calculator which incorporates initial Wheeler River Project footprints and activities in the calculation
October 31, 2023	SK MOE		SK MOE provides notification to Denison that the ministry is satisfied with the TRC responses provided and proposed updates to the draft EIS.
December 5, 2023	CNSC		Denison receives results of FIRT review of Denison's IR responses (i.e., second round of FIRT comments on the draft EIS, aka round 2 IRs).
December 11, 2023	CNSC	Meeting	Path forward and confirmation on process for Denison to address second round of IRs to meet requirements under CEAA 2012 and for the FIRT to draw conclusions on the EA process.
2024 (monthly meetings throughout the year)	SK MOE, CNSC	Meetings	Monthly discussion provided updates on the progress of the EA, including technical details, regulatory requirements, and engagement.
January 4, 2024	SK MOE	Technical Meeting	SK MOE provides an update to Denison on the caribou habitat offset calculation framework and expectations for the offset at the EA stage.
February 10, 2024	CNSC	Submission	Denison submits responses to FIRT round 2 IRs on the draft EIS, along with Version 1 of the Commitments Register, the revised draft EIS, and the Indigenous Engagement Report updated to January 2024.
May 24, 2024	CNSC		Denison receives draft of the FIRT's review of Denison's responses to Round 2 IRs (i.e., round 3 IRs).
May 31, 2024	CNSC		Denison receives updated draft of the FIRT's review of Denison's responses to Round 2 IRs (i.e., round 3 IRs).
June 5, 2024	CNSC, HC, ECCC	Technical Meeting	Denison's assessment team met with key individuals on the FIRT following receipt of the draft round 3 IRs, specifically IR-100, IR-190, IR-198-R1, IR-107, and IR-110.
June 6, 2024	CNSC, ECCC	Technical Meeting	Denison's assessment team met with key individuals on the FIRT following receipt of the draft round 3 IRs, specifically IR-89 and IR-89-R1, IR-115 and IR-115-R1, IR-124 and IR-124-R1, IR-126, IR-134 and IR-134-R1, IR-142, IR-159, IR-167-R1, IR-170, IR-174, IR-194, IR-197, IR-149, IR-149-R1A, IR-149-R1B, and IR-157.
June 14, 2024	CNSC, ECCC	Technical Meeting	Denison's assessment team met with key individuals on the FIRT following receipt of the draft round 3 IRs, specifically IR-12, IR-12-

Date	Organization	Engagement Type	Purpose
			R1A and IR-12-R1B, IR-18, IR-101, IR-108 and IR-108-R1, IR-113 and IR-113-R1, IR-114, IR-193, IR-195, and IR-103.
June 18, 2024	CNSC	Site visit	Denison hosted representatives from the CNSC at the Project site to discuss the Project and tour the proposed Project location.
June 21, 2024	SK MOE	Technical Meeting	Discussion with SK MOE on the caribou habitat offset framework.
June 27 to July 9, 2024	CNSC	Submissions	Denison submits responses to all FIRT round 3 IRs, on an IR-by-IR basis.
July 11, 2024	CNSC	Submission	Denison submits responses to FIRT round 3 Advice Comments.
July 17, 2024	CNSC	Submission	Denison submits the Indigenous Engagement Report updated to July 10, 2024.
July 17, 2024	CNSC	Submission	Denison submits responses to Public Comments.

The intent of engagement with regulatory staff was to share relevant information on the progress and scope of the EA, Project components, and methodologies used to technically assess the effects on the biophysical and human environments. Denison facilitated several presentations focused on the specific technical assessment methods, with federal and provincial technical experts in attendance. These presentations allowed for the technical experts to learn about the Project scope and modelling approaches to assess effects on the receiving environment.

Regulatory agencies were also provided with the opportunity to attend Denison's engagement activities with other Interested Parties (either virtually or in-person), primarily with Denison's Indigenous and non-Indigenous COI. Over the course of the assessment, the regulatory agencies attended most or all of Denison's key engagement activities with Interested Parties in 2019 (i.e., site visit), 2021 (i.e., virtual meetings), 2022, 2023, and 2024 (i.e., in-person meetings). Denison plans to continue engagement activities going forward.

4.6 Influence of Engagement on the Assessment

The interests, issues, and concerns shared as a result of engagement activities have meaningfully informed the Project and the EA process. This includes valuable perspectives that were provided and influenced the Project, the selection of VCs, identification and consideration of potential effects, as well as mitigation and monitoring of effects.

Details about how information received from each interested party is documented in Section 4.3 (Indigenous Groups), and Section 4.4 (General Public).

Specific information on how engagement activities have influenced the assessment process for each VC is provided in the following:

- Section 6 Atmospheric and Acoustic Environment:
  - Section 6.1.2 for Air Quality; and

- Section 6.2.2 for Noise.
- Section 7 Geology and Groundwater, Section 7.2.
- Section 8 Aquatic Environment:
- Section 8.1.2 for Surface Water Quantity;
- Section 8.2.2 for Surface Water Quality;
- Section 8.3.2 for Fish and Fish Habitat;
- Section 8.4.2 for Sediment Quality and Benthic Invertebrates; and
- Section 8.5.2 for Fish Health.
- Section 9 Terrestrial Environment:
- Section 9.1.2 for Terrain, Soil, and Organic Matter/Peat;
- Section 9.2.2 for Vegetation and Ecosystems;
- Section 9.3.2 for Ungulates, Furbearers, and Woodland Caribou; and
- Section 9.4.2 for Raptors, Migratory Breeding Birds, and Bird Species at Risk.
- Section 10 Human Health, Section 10.1.2.
- Section 11 Land and Resource Use:
- Section 11.1.2 for Indigenous Land and Resource Use;
- Section 11.2.2 for Other Land and Resource Use; and
- Section 11.3.2 for Heritage Resources.
- Section 12 Quality of Life:
- Section 12.1.2 for Cultural Expression;
- Section 12.2.2 for Community Well-being; and
- Section 12.3.2 for Infrastructure and Services.
- Section 13 Economics, Section 13.1.4.

4.7 Future Engagement Activities

Denison believes that the development of positive and effective working relationships with Interested Parties will not conclude with the completion of the assessment and licensing process. Denison believes that there is considerable value in sustaining opportunities for engagement with Indigenous communities and organizations, the general public, and regulatory agencies. Denison is committed to ongoing engagement throughout the entire Project lifespan.

4.7.1 Future Indigenous Engagement Activities

With Denison's adoption of the IPP in 2021, the commitment to take action towards advancing reconciliation with Indigenous peoples in Canada and the identified action plan focus areas of engagement, empowerment, environment, employment and education, reflect a commitment to implementation of the continuously evolving RAP. Ongoing and meaningful engagement is one of the foundational action areas that Denison is committed to interweave the principles of reconciliation throughout all areas of operations.

Just as the Project engagement process has evolved to date, specific activities will be identified in discussion with Indigenous Interested Parties to make sure they align with specific areas of interest or concern. This may include some of the following:

- follow-up to specific feedback received on the EIS and identified areas of concern or questions;
- benefit agreements and implementation working groups;
- monitoring (environment or other); and
- any other items of interest.

For each Indigenous Community of Interest, Other Indigenous Community, or Indigenous Organization, future engagement activities are described in those relevant sections.

4.7.2 Future Public Engagement Activities

Engagement activities involving the General Public Interested Parties will continue after the submission of the EIS and completion of the EA process. Denison believes that there is considerable value in ongoing opportunities for discussion. Specific activities will be developed in discussion with interested public parties to ensure, among other things, potential effects continue to be minimized and Project benefits have opportunity to be maximized.

Denison expects that opportunities to share information on Project status and receive information on issues and concerns will include activities that focus on communication (website, newsletters) and direct interaction (e.g., workshops, youth/elder sessions, meetings with community leadership, ongoing discussion with resource harvesters) would be reasonable initial activities to implement.

Where appropriate, Denison has described any future engagement for the General Public, in those relevant sections.

4.7.3 Future Regulatory Engagement Activities

Regulatory engagement activities following submission of the EIS can be expected to occur to review initial EA results, respond to questions and concerns that may be identified, and identify and consider regulatory or assessment areas of interest that had not been previously defined or addressed.

Engagement with regulatory agencies is expected to continue throughout the lifespan of the Project to confirm regulatory requirements are adequately fulfilled.

4.8 References

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Appendix 4-A Supporting Materials

See file “S4_App 4-A Supporting Materials_Wheeler River.pdf”

Appendix 4-B Interests, Issues and Concerns Tables: Indigenous Communities of Interest, Other Indigenous Communities, Indigenous Organizations

See file “S4_App 4-B Interests, Issues and Concerns Tables_Indigenous.pdf”

Appendix 4-C Interests, Issues and Concerns Tables: General Public

See file “S4_App 4-C Interests, Issues and Concerns Tables_General Public.pdf”

Denison Mines

Wheeler River Project

Final Environmental Impact Statement

November 2024

Powering PEOPLE, PARTNERSHIPS AND PASSION.

Wheeler River Project

Final Environmental Impact Statement

Section 5 – Approach and Methodology of the Assessment

November 2024

Denison Mines

Denison Mines Corp.

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Roadmap

This roadmap of the Wheeler River Project Environmental Impact Statement (EIS) has been provided to summarize the main document sections and appendices of the EIS.

Wheeler River Project Environmental Impact Statement

Executive Summary

Part I: Introduction and Context	Part II: Biophysical Environmental Assessments	Part III: Human Environment Assessments	Part IV: Integrated Topics and Summary
Section 1: Project Introduction and Overview	Section 6: Atmospheric and Acoustic Environment	Section 10: Human Health	Section 14: Accidents and Malfunctions
Section 2: Project Description	Section 7: Geology and Groundwater	Section 11: Land and Resource Use	Section 15: Effects of the Environment on the Project
Section 3: Indigenous and Local Knowledge	Section 8: Aquatic Environment	Section 12: Quality of Life	Section 16: Assessment Summary and Conclusions
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Section 5: Approach and Methodology of the Assessment			

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Abbreviations, Acronyms, and Units

Abbreviation / Acronym	Definition
CEA	Cumulative effects assessment
CEAA	Canadian Environmental Assessment Agency
CNSC	Canadian Nuclear Safety Commission
COPC	Constituent of potential concern
Denison	Denison Mines Corp.
EA	Environmental Assessment
EIS	Environmental Impact Statement
ERFN	English River First Nation
IK	Indigenous Knowledge
ISR	In situ recovery
KI	Key Indicator
KML	Kineepik Métis Local #9
LK	Local Knowledge
LSA	Local Study Area
MP	Measurable Parameter
RSA	Regional Study Area
SARA	*Species at Risk Act*
SVS	Shared Value Solutions
TSP	Total suspended particulate
VC	Valued Component

Units	Definition
%	percent
ha	hectare
km	kilometre
km^2	square kilometre
m	metre
m^2	square metre
m^3/s	cubic metre per second
mg/kg	milligram per kilogram
mg/L	milligram per litre

Glossary

Term	Definition
Cumulative effect	A cumulative effect occurs when a residual adverse effect of the Project on a given valued component overlaps spatially and/or temporally with the same residual adverse effects on the valued component from other past, present, and reasonably foreseeable projects or activities.
Environmental Assessment	An assessment of potential environmental consequences of a project. The environmental assessment considers the existing environment where the Project is to be located (including, but not limited to, Indigenous and Local Knowledge), predicts potential effects to valued components of the environment, identifies mitigation measures used to limit the effects of the project on the local environment, classifies potential effects remaining after mitigation, and describes monitoring and follow-up programs.
Environmental Impact Statement	A document that contains the environmental assessment for a project, and can also include details on the project description, engagement, mitigation measures, residual and cumulative effects, accidents and malfunctions, and effects of the environment on the project.
Follow-up program	A follow-up programs addresses uncertainties identified during the environmental assessment process (e.g., to verify predictions made during the environmental assessment; determine the effectiveness of proposed and implemented mitigation measures) and to determine if and when to implement adaptive management measures.
Indigenous Knowledge	The unique and collective knowledge of Indigenous peoples that may include, but is not limited to, the environmental, cultural, economic, political, and spiritual conditions of a community or region.
Intermediate Valued Component	Intermediate Valued Components (VCs) are VCs that are fully characterized in the residual effect evaluation, with significance determination completed on related, receptor VCs. The intermediate VCs in this assessment are: Air Quality, Noise, Geology, Groundwater Quality, Groundwater Quantity, Surface Water Quantity, Surface Water Quality, and Sediment Quality.
Key indicator	An important component or aspect of a valued component that is expected to be affected (changed) as a result of the Project.
Local Knowledge	Specialized knowledge developed through long-term association, interaction, and cumulative experience.
Local Study Area	The area that surrounds the Project Area where both direct and indirect effects resulting from Project activities can be reasonably measured.
Measurable parameter	A parameter or metric associated with a key indicator that can be used to detect and measure Project-related changes.
Mitigation/Mitigation Measure	Mitigation is the elimination, reduction, or control of the adverse effects of the Project and includes restitution for any damage to a valued component caused by such effects through replacement, reclamation, compensation, or any other means. Mitigation measures refer to Project-specific mitigation and can include, but are not limited to, engineering design features and responses, best management practices, management plans, emergency response programs, and training.
Monitoring program	A monitoring program is designed to meet regulatory requirements (e.g., permit or license conditions), and/or to demonstrate compliance with environmental commitments made in the Environmental Impact Statement.
Project Area	The area within which the Project and all components/activities are located (i.e., the Project footprint with an applied buffer; the area of maximum physical disturbance).

Term	Definition
Receptor Valued Component	Receptor Valued Components (VCs) are generally biological or integrated assessment endpoints. A change in an intermediate VC may lead to an effect on a receptor VC.
Regional Study Area	The area that surrounds and includes the LSA, established to assess the potential, largely indirect effects of the Project in a regional context.
Residual effect	The potential adverse effect of the Project on a valued component after mitigation measures have been considered.
Valued Component	Aspects of the biophysical and human environments that will likely be affected (adversely or positively) by the Project. The valued components selected reflect identified scientific, Local Knowledge, Indigenous Knowledge, and community interests.

5 Approach and Methodology of the Assessment

5.1 Introduction

This Environmental Impact Statement (EIS) addresses the recommended guidelines and legislated requirements, pursuant to *The Environmental Assessment Act* (Government of Saskatchewan 2018) and the *Canadian Environmental Assessment Act*, 2012 (Government of Canada 2019b). Denison considers the Environmental Assessment (EA) to be a planning and decision-making tool that assesses the potential effects of the Project in a careful and precautionary manner, including appropriate engagement with Indigenous communities and communities of interest, so that mitigation can be designed and applied to support of the approval of the Project by the appropriate regulators (i.e., Saskatchewan Ministry of Environment [SK MOE] and the Canadian Nuclear Safety Commission [CNSC]). As such, the EA is a process for identifying the Project's potential interactions with the biophysical and human environment, predicting potential adverse effects, identifying mitigation measures, and evaluating residual and cumulative effects remaining after mitigation. The EA also outlines the proposed efforts for monitoring and reporting to verify compliance with the terms and conditions of approval and the follow-up to assess the accuracy and effectiveness of predictions and mitigation measures presented in the EA.

This section presents the approach and methodology used to identify and assess the effects that are likely to occur as a result of the Project. The methods used are current, proven, and accepted EA approaches and best practices and have been developed and used to provide a thorough and rigorous analysis, while presenting the assessment results in a clear, concise, and well-organized manner. Indigenous Knowledge (IK) and Local Knowledge (LK) of the existing biophysical and human environments and potential effects have been integrally incorporated throughout this EIS.

The EA aspect of this EIS involves predicting and evaluating the likely adverse effects of the Project, which are generally defined as changes the Project is likely to cause in the biophysical and human environments. The EA approach involves 'overlaying' the Project onto the existing environment, and then considering the proposed mitigation, to identify and describe whether, how, and to what degree components of the environment are likely to change after application of the mitigation measures (i.e., residual effects), and evaluating the change (Figure 5.1-1).

The key elements of the EA involve:

- defining the scope of the assessment in terms of Valued Components (VCs), selected Key Indicators (KIs) for each VC, Measurable Parameters (MPs), and the spatial and temporal boundaries for the assessment;
- identifying the influence of IK, LK, and engagement on the assessment;
- describing the existing environment for each VC;
- determining which Project components and/or activities interact with the VCs;

- determining potential Project effects and applicable mitigation measures (e.g., design features) and operational methods that will be used to avoid or limit adverse effects resulting from the construction, operation, decommissioning, and reclamation activities of the Project;
- completing a residual effects evaluation (e.g., characterizing anticipated adverse effects remaining after implementing appropriate mitigation);
- determining the significance, when applicable, of the identified adverse residual effects;
- identifying cumulative effects, i.e., the spatial and/or temporal overlapping of residual Project effects with the same residual effects resulting from other past, present, and reasonably foreseeable projects or activities (including characterization of cumulative effects and significance determination);
- describing monitoring and follow-up programs that will be completed; and
- summarizing, in plain language, the main points of the assessment, including potential residual and cumulative effects to the VC/KI from the Project and relevant mitigation, monitoring and follow-up.

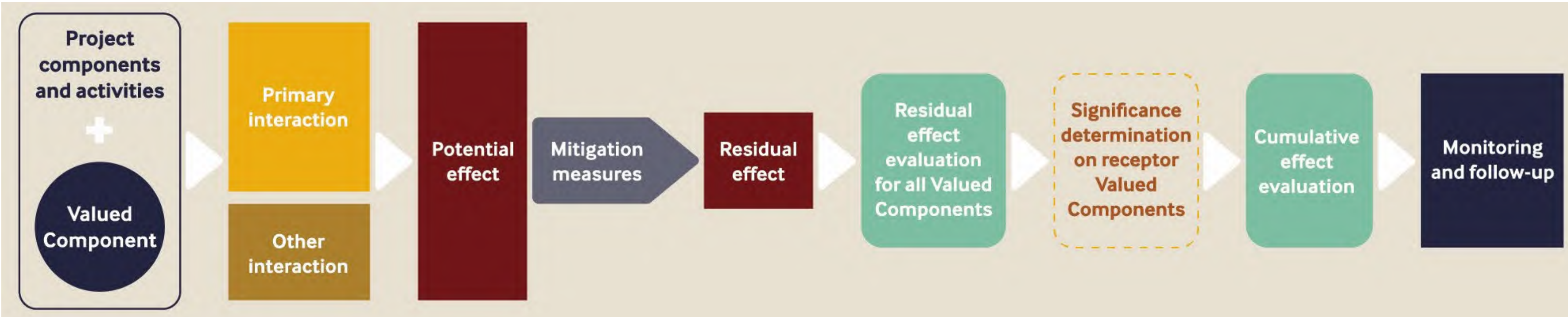

Figure 5.1-1: Environmental Assessment Process for the Wheeler River Project

5.2 Areas of Assessment

The EA for the Project is made up of two broad areas of assessment (Figure 5.2-1): the biophysical environment (Part II of the EIS) and the human environment (Part III of the EIS). The biophysical environment has been organized into the following sub-categories:

- atmospheric and acoustic environment;
- geology and groundwater;
- aquatic environment; and
- terrestrial environment.

The human environment has been organized into the following sub-categories:

- human health;
- land and resource use;
- quality of life; and
- economics.

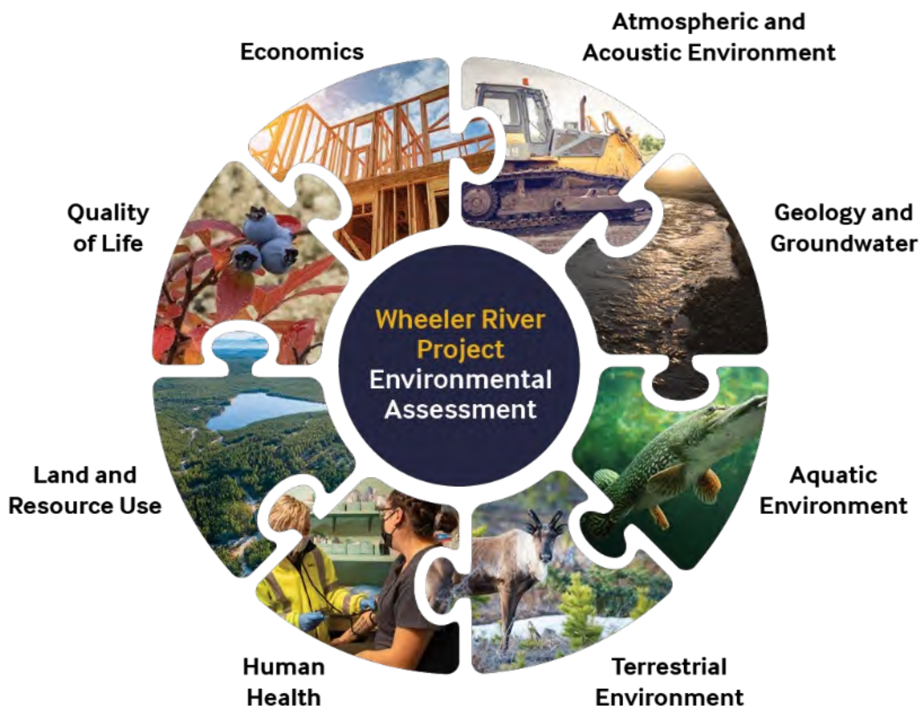

Figure 5.2-1: Biophysical and Human Environment Assessments for the Wheeler River Project Environmental Assessment

Part IV of the EIS contains integrated topics and summaries including:

- accidents and malfunctions;
- effects of the environment on the project;
- assessment summary and conclusions, which contains appendices summarizing:
  - potential residual effects;
  - potential cumulative effects; and
  - monitoring and follow-up programs.

5.3 Scope of the Assessment

5.3.1 Valued Components Selection

As per standard, accepted EA practice, this EA is organized by and focused on VCs. The VCs are aspects of the biophysical and human environments that will likely be affected (adversely or positively) by the Project. The VCs reflect identified scientific, LK and IK, and community interests regarding the Project and its potential effects and are typically identified early in the EA process as a result of questions and concerns raised through engagement with government departments and agencies, Indigenous and community groups, and the general public.

Initial direction and input into VC selection were obtained through discussions with Indigenous groups, government agencies, and the public. Denison reviewed and considered this input to develop a VC list that reflects the key environmental, socio-economic, heritage, and human health components and interests to focus the detailed assessment for the EA.

The VC list provided in the Terms of Reference (Denison 2019) was evaluated, consolidated, and organized to allow for the logical assessment of Project effects, and is presented in Table 5.3-1. Some of the initial VCs outlined in the Terms of Reference have been addressed as KIs, discussed in the subsequent subsections. Each VC-specific section in Parts II and III of this EIS expands on the rationale for VC inclusion provided herein.

As shown in Figure 5.1-1, all VCs selected for this EA go through a thorough residual effect evaluation. The VCs selected for this assessment were further identified as being either intermediate or receptor VCs. A change in an intermediate VC may lead to an effect on a receptor VC. Receptor VCs are generally biological or integrated assessment endpoints. The intermediate VCs in this EA are: Air Quality, Noise, Geology, Groundwater Quality, Groundwater Quantity, Surface Water Quantity, Surface Water Quality, and Sediment Quality. Significance determination is not completed on intermediate VCs, but integrated into the residual effect evaluation, residual effect characterization, and significance determination for related receptor VCs.

Table 5.3-1: Valued Components and Rationale for Their Inclusion in the Environmental Assessment

Valued Component	Rationale
Biophysical Environment	
Atmospheric and Acoustic	
Air Quality	Project-related air emissions could reduce the air quality, resulting in implications for human health and well-being as well as the aquatic and terrestrial environments (receptor VCs).
Noise	Project activities may result in increased noise levels above ambient conditions that may cause temporary disturbance to local land users or wildlife (receptor VCs), which could result in temporary avoidance of the area and other behavioural responses.
Geology and Groundwater	
Geology	Project activities may alter underlying surficial geological material through terrain destabilization and accelerated erosion, which may affect the land use and economic activity in proximity to the Project and may also affect biological functions in proximity to the Project.
Groundwater Quality	Project activities may result in a change to the quality of groundwater, which may in turn influence surface water quality, resulting in public concern and non-compliance with regulations or permit conditions.
Groundwater Quantity	Project activities may result in a change to the quantity of groundwater, which may in influence surface water quantity, resulting in public concern and non-compliance with regulations or permit conditions.
Aquatic Environment	
Surface Water Quantity	Project activities may result in a change to existing surface drainage patterns resulting in change in surface water flows and/or levels. Such changes have the potential to influence water quality, biodiversity, and biological function. Surface water quantity change may affect Indigenous values, public concern, non-compliance with regulations or permit conditions.
Surface Water Quality	Changes to Surface Water Quality have the potential to affect biodiversity and biological function through direct exposure and indirect food chain influences and the cultural values of Indigenous groups, the public, non-compliance with regulations or permit conditions
Sediment Quality	Project activities may alter sediment quality. Potential changes in sediment particle size, chemistry, and distribution within the aquatic environment, may in turn, influence biodiversity and biological function in the aquatic environment (specifically for benthic invertebrates and fish). Such effects are of interest with respect to cultural values of Indigenous groups, the public, and other stakeholders.
Benthic Invertebrates	Project activities may result in changes to benthic invertebrates as a receptor through changes to surface water quality and sediment quality. Benthic invertebrates are of ecological importance for aquatic environments and therefore with respect to cultural values of Indigenous groups, the public, and other stakeholders.
Fish and Fish Habitat	Project activities may result in a change to fish and fish habitat thereby affecting the ecological function of the aquatic environment, cultural values of Indigenous peoples, Interested Parties and other

Valued Component	Rationale
	stakeholders. Assessment of Fish and Fish Habitat as a VC is consistent with regulatory requirements (e.g., *Fisheries Act* [Government of Canada 2019c]).
Fish Health	Project activities may result in a change to fish health (through chemical/radiological exposure) via changes to surface water quality and sediment quality. Changes to fish health may affect cultural values of Indigenous peoples and result in public concern non-compliance with regulatory requirements (e.g., *Fisheries Act* [Government of Canada 2019c]) or permit conditions.
Terrestrial Environment	
Terrain	Project activities may alter the topography and may affect the land use and economic activity in proximity to the Project and may also affect biological functions in proximity to the Project.
Organic Matter/Peat	Project activities may alter the availability of organic matter/peat, which may affect the land use, economic activity, and biological functions in proximity to the Project.
Soil Quantity	Project activities may alter soil quantities, as well as increase the potential for erosion and sediment transport; all of which may affect the land use, economic activity, and biological functions in proximity to the Project.
Soil Quality	Project activities may alter the soil quality, as well as increase the potential for erosion and sediment transport; all of which may affect the land use, economic activity, and biological functions in proximity to the Project.
Vegetation and Ecosystems	Project activities may affect vegetation communities and ecosystems, which may result in effects on ecosystem integrity, function, biodiversity and how the area in proximity to the Project is used by wildlife and land users.
Listed Plant Species	Project activities may affect listed plant species, which contribute to biodiversity and are of provincial and/or federal management concern.
Wetlands	Project activities may affect wetland habitats, which contribute to biodiversity, maintenance of hydrology, nutrient cycling, water quality, and carbon storage. Wetlands also provide habitat for listed plant species and wildlife. These effects may also result in non-compliance with regulatory requirements or permit conditions (e.g., Aquatic Habitat Protection Permit).
Ungulates	Project activities and infrastructure may affect ungulate populations resulting in non-compliance with permit conditions and requirements (e.g., *The Wildlife Act, 1998* [Government of Saskatchewan 2020]).
Furbearers	Project activities and infrastructure may affect local furbearer populations, including species at risk, resulting in non-compliance with permit conditions requirements (e.g., *Species at Risk Act* [SARA; Government of Canada 2022], *The Wildlife Act, 1998* [Government of Saskatchewan 2020]).

Valued Component	Rationale
Woodland Caribou	Project activities and infrastructure may affect woodland caribou populations, resulting in non-compliance with permit conditions requirements (e.g., SARA [Government of Canada 2022], *The Wildlife Act, 1998* [Government of Saskatchewan 2020]).
Raptors	Project activities and infrastructure may affect raptor populations (specifically disturbance and/or destruction of eggs, young, and adults) resulting in non-compliance with regulatory requirements (e.g., *Saskatchewan Activity Restriction Guidelines for Sensitive Species* [Government of Saskatchewan 2017], *Wildlife Act* [Saskatchewan]).
Migratory Breeding Birds	Project activities and infrastructure may affect migratory breeding bird populations (specifically disturbance and/or destruction of eggs, young, and adults) resulting in non-compliance with regulatory requirements (e.g., SARA [Government of Canada 2022], *Migratory Birds Convention Act, 1994* [Government of Canada 2017], *Saskatchewan Activity Restriction Guidelines for Sensitive Species* [Government of Saskatchewan 2017], *The Wildlife Act, 1998* [Government of Saskatchewan 2020]).
Bird Species at Risk	Project activities and infrastructure may affect bird species at risk (specifically disturbance and/or destruction of eggs, young, and adults) resulting in non-compliance with regulatory requirements (e.g., SARA [Government of Canada 2022], *Migratory Birds Convention Act, 1994* [Government of Canada 2017], *Saskatchewan Activity Restriction Guidelines for Sensitive Species* [Government of Saskatchewan 2017], *The Wildlife Act, 1998* [Government of Saskatchewan 2020]).
Human Environment	
Human and Worker Health	
Human Health	Project activities and by-products could affect the health and safety of local community members, and land users.
Worker Health and Safety	Project activities and by-products could affect the health and safety of Project employees and contractors.
Land and Resource Use	
Indigenous Land and Resource Use	Project activities may alter the relative abundance of moose, woodland caribou, waterbirds and waterfowl, and upland game birds, which are important for subsistence harvesting. Project activities may alter safe access and navigation to resource harvest areas and the availability of supporting infrastructure such as cabins and camping sites, which are important to the continuation of traditional land and resource. Project activities can affect traditional land and resource use aesthetics and the perceived suitability of resources and resource harvest areas.
Other Land and Resource Use	Project activities may alter the relative abundance and distribution of Walleye, Northern Pike, moose, and furbearers (particularly pine marten), which are important species for recreational and commercial fishing, recreational hunting, or commercial trapping. Project activities may alter safe access and navigation to resource harvest areas and the availability of supporting infrastructure such as cabins and camping sites, which are important to the continuation of other land and resource. Project activities may also alter the continued ability to participate in and

Valued Component	Rationale
	maintain access to recreational activities provided by parks and protected areas, lodge and outfitting services, and ecotourism. Project activities can affect other land and resource use aesthetics and the perceived suitability of resources and resource harvest areas.
Heritage Resources	Project activities may alter the number of archaeological resources.
Quality of Life	
Cultural Expression	Project activities may affect opportunities for knowledge transmission on the land. This includes effects on language and land-based activities (such as hunting and gathering, travel, habitation, ceremonies, and cultural camps) where knowledge transmission occurs. Project activities may affect harvesting country foods (i.e., traditional foods), which support social bonds within families and communities and maintain cultural identities and traditional food systems.
Community Well-being	Project activities may change population and demographics if in/out migration results from people seeking employment opportunities. Project activities may change income of local workers through participation in employment and/or contracting activities. Project activities may lead to a change in community cohesion through a change in income and participation in a worker rotation system.
Infrastructure and Services	Project activities may increase traffic. Project activities may affect demands on local infrastructure and services. Project activities may affect demands on emergency services.
Economics	
Economy	The Project may affect current income levels and/or revenues to the local and provincial economies. The Project may affect current employment, training, and educational opportunities. The Project may affect current business levels and opportunities that would affect local communities and potentially provincial market sectors.

5.3.2 Key Indicators and Measurable Parameters

To provide focus and analytical rigour to the EA, the effects assessment for each VC identifies relevant KIs and associated MPs, as applicable. These are defined as follows:

- **Key Indicator**: an important component or aspect of the VC that is expected to be affected (changed) as a result of the Project. The KIs may comprise subsets or a guild of the VC (e.g., Soil Quality VC – Chemical Soil Properties KI), certain aspects of the VC that may be affected by the Project and/or which have a particular importance (e.g., Raptor VC – Bald Eagle and Osprey KIs;

Indigenous Land and Resource Use VC – Resource Availability KI), and/or that can serve as indicators of potential effects on the VC.

- **Measurable Parameter**: a parameter or metric associated with the KI that can be used to detect and measure Project-related changes (e.g., amount of habitat altered, change in levels of contaminants of concern, or change in regional unemployment rates).

The VCs, KIs, and their associated MPs are identified and listed as outlined in Table 5.3-2 and form the basis for the subsequent VC-specific assessment.

Table 5.3-2: Valued Components, Key Indicators, and Measurable Parameters

Valued Component Category	Valued Component	Key Indicator	Measurable Parameter
Biophysical Environment			
Atmospheric and Acoustic	Air Quality	Levels of dust, combustion products, uranium, metals, and/or radionuclides	Change in concentrations and deposition rates of total suspended particulate (TSP), inhalable particulate matter (PM_{10}), respirable particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), uranium, metals, and radionuclides compared to the most appropriate air quality criteria.
	Noise	Noise levels	Change in sound pressure levels (Ldn, Ld, and Ln), measured in decibels, over ambient noise. Changes in % highly annoyed.
Geology and Groundwater	Geology	Surficial geology	Amounts of removed underlying surficial geological material through terrain destabilization and accelerated erosion.
	Groundwater Quality	Constituent concentrations in groundwater	Change in level of constituents of concern and water parameters within the surface waterbodies relative to baseline conditions.
	Groundwater Quantity	Water levels in local and regional aquifers	Percentage loss or change of groundwater volume.
Aquatic Environment	Surface Water Quantity	Surface water flow and/or levels	Percentage loss or change of surface water flow and/or level (e.g., change in water level [m], mean monthly discharge [m^3/s], 5th percentile monthly discharge [m^3/s]).
	Surface Water Quality	Change in surface water quality from baseline concentrations	Change in the concentration of constituents that are directly related to Project activities as measured as a mass of a chemical per unit volume in water (e.g., mg/L)
	Sediment Quality	Sediment quantity and physical quality (particle size) from baseline conditions	Change in the quantity of solids deposited on aquatic sediments directly related to the Project.
		Change in sediment quality (chemical) from baseline concentrations	Change in the concentration of constituents in aquatic sediments directly related to Project activities.
	Benthic Invertebrates	Change in available aquatic habitat from baseline conditions	Aerial extent (m^2 or ha) of overprinted aquatic habitat.

Valued Component Category	Valued Component	Key Indicator	Measurable Parameter
		Change in sediment quality (chemical) from baseline concentrations	Change in the concentration of constituents in aquatic sediments directly related to Project activities, which may affect benthic invertebrate communities.
		Change to water levels or flows from baseline conditions	Changes in water levels (m) or percent changes to flow conditions (%).
	Fish and Fish Habitat	Change to water levels or flows from baseline conditions	Changes in water levels (m) or percent changes to flow conditions (%).
		Change in available aquatic habitat from baseline conditions	Aerial extent (m^2 or ha) of overprinted aquatic habitat.
		Change in surface water quality from baseline conditions	Change in the concentration of constituents that are directly related to Project activities, measured as a mass of a chemical per unit volume in water (e.g., mg/L).
	Fish Health	Change in surface water quality from baseline conditions	Change in the concentration of constituents that are directly related to Project activities, measured as a mass of a chemical per unit volume in water (e.g., mg/L).
		Change in sediment quality from baseline conditions	Introduction of constituents into the sediments of waterbodies as a result of the Project that are of a magnitude to negatively affect aquatic biota associated with the waterbodies.
		Change in fish tissue constituents of potential concern (COPC) concentrations from baseline conditions	Change in the concentration of constituents that are directly related to Project activities, measured as a mass of a chemical per unit mass in fish tissue (e.g., mg/kg).
Terrestrial Environment	Terrain	Terrain morphology	Change in slope grade, aspect. Change in topographical contours and drainage pattern.
		Terrain stability	Change in the stability of landform attributes. Increase in erosion potential; acceleration of erosional processes.
	Soil Quantity	Soil quantity	Change (i.e., net loss) of soil volume.
	Soil Quality	Physical and chemical soil properties	Change (i.e., degradation) in soil physical properties (particle size/texture, structure, and aggregation). Change in chemical properties (essential and non-essential metals).
	Organic Matter/Peat	Organic matter/peat	Change (i.e., net loss) in percentage of area extent of organic matter as a result of Project activities.
	Vegetation and Ecosystems	Vegetation abundance	Change in areal extent of habitat types.
		Constituent concentrations in vegetation	Change in level of constituents of concern in plant tissue.

Valued Component Category	Valued Component	Key Indicator	Measurable Parameter
	Listed Plant Species	Listed Plant Species	Change in number of known listed plant occurrences.
	Wetlands	Wetlands	Change in areal extent of wetlands.
	Ungulates	Moose (*Alces alces*)	Amount of habitat (km^2) (not necessarily occupied) that may be altered or lost relative to its availability in the Regional Study Area (RSA). The number of moose mortalities directly or indirectly attributable to the Project.
	Furbearers	Wolverine (*Gulo gulo*)	Amount of habitat (km^2) (not necessarily occupied) that may be altered or lost relative to its availability in the RSA. The number of wolverine mortalities directly or indirectly attributable to the Project.
		Pine marten (*Martes americana*)	Amount of habitat (km^2) (not necessarily occupied) that may be altered or lost relative to its availability in the RSA. The number of pine marten mortalities directly or indirectly attributable to the Project.
		Mink (*Neovison vison*)	Amount of habitat (km^2) (not necessarily occupied) that may be altered or lost relative to its availability in the RSA. The number of mink mortalities directly or indirectly attributable to the Project.
		Muskrat (*Ondatra zibethicus*)	Amount of habitat (km^2) (not necessarily occupied) that may be altered or lost relative to its availability in the RSA. The number of muskrat mortalities directly or indirectly attributable to the Project.
	Woodland Caribou	Woodland caribou (*Rangifer tarandus caribou*)	Amount of habitat (km^2) (not necessarily occupied) that may be altered or lost relative to its availability in the RSA. The number of woodland caribou mortalities directly or indirectly attributable to the Project.
	Raptors	Bald Eagle (*Haliaeetus leucocephalus*)	Percentage of Bald Eagle habitat altered/lost directly or indirectly as a result of Project activities. The number of Bald Eagle mortalities directly or indirectly attributable to the Project.
		Osprey (*Pandion haliaetus*)	Percentage of Osprey habitat altered/lost directly or indirectly as a result of Project activities. The number of Osprey mortalities directly or indirectly attributable to the Project.

Valued Component Category	Valued Component	Key Indicator	Measurable Parameter
	Migratory Breeding Birds	Waterbirds and waterfowl	Percentage of habitat for waterbirds and waterfowl altered/lost directly or indirectly as a result of Project activities. The number of waterbirds and waterfowl mortalities directly or indirectly attributable to the Project.
		Upland game birds	Percentage of habitat for upland game birds altered/lost directly or indirectly as a result of Project activities. The number of upland game bird mortalities directly or indirectly attributable to the Project
		Migratory songbirds	Percentage of habitat for migratory songbirds altered/lost directly or indirectly as a result of Project activities. The number of songbird mortalities directly or indirectly attributable to the Project.
	Bird Species at Risk	Common Nighthawk (*Chordeiles minor*)	Percentage of habitat for Common Nighthawk altered/lost directly or indirectly as a result of Project activities. The number of Common Nighthawk mortalities directly or indirectly attributable to the Project.
		Short-eared Owl (*Asio flammeus*)	Percentage of habitat for Short-eared Owl altered/lost directly or indirectly as a result of Project activities. The number of Short-eared Owl mortalities directly or indirectly attributable to the Project.
		Yellow Rail (*Coturnicops noveboracensis*)	Percentage of habitat for Yellow Rail altered/lost directly or indirectly as a result of Project activities. The number of Yellow Rail mortalities directly or indirectly attributable to the Project.
		Rusty Blackbird (*Euphagus carolinus*)	Percentage of habitat for Rusty Blackbird altered/lost directly or indirectly as a result of Project activities. The number of rusty blackbird mortalities directly or indirectly attributable to the Project
		Olive-sided Flycatcher (*Contopus cooperi*)	Percentage of habitat for Olive-sided Flycatcher altered/lost directly or indirectly as a result of Project activities. The number of Olive-sided Flycatcher mortalities directly or indirectly attributable to the Project
Human Environment			
Human Health	Human Health	Public health	Evaluation of risk of exposure to COPC through use of hazard quotient, incremental lifetime cancer risk, or radiation dose.
	Worker Health and Safety	Worker health	Change in risk of exposure to COPC. Radiological exposure and dose.

Valued Component Category	Valued Component	Key Indicator	Measurable Parameter
Land and Resource Use	Indigenous Land and Resource Use	Resource availability for harvesting subsistence resources	Change in relative abundance and distribution of fish wildlife, fish, and plant species. Change in the suitability of wildlife, fish, and plants for human consumption.
		Land/waters available for traditional practices	Change in lands available to conduct traditional harvesting, such as lands and waters altered/lost as a result of Project activities. Change in opportunities for traditional land use, including access, navigation, and occupation sites
		Perceived suitability of land and resources therein	Change in aesthetics of the land/water use experience. Change in perceived suitability of land/water for resource use. Change in quality of resources for consumption.
	Other Land and Resource Use	Resource availability for commercial and recreational harvests	Change in relative abundance and distribution of fish species. Change in relative abundance and distribution of wildlife species. Change to the health of the resources. Change in continued opportunities for commercial and recreational resource use.
		Land/waters available to conduct commercial and recreational harvests	Change in the area and accessibility of areas for commercial or recreational uses, such as cabins, tourism, guided outfitting, protected areas, mining, and forestry that is altered/lost because of Project activities. Changes in availability/accessibility of waterways.
		Perceived suitability of lands and resources therein	Change in aesthetic experience (with consideration of traffic, noise, air quality, modification of the wilderness experience). Change in perceived suitability of resources for safe use.
	Heritage Resources	Archaeological sites	Change in the number of known archaeological resources directly or indirectly altered/lost as a result of Project activities.
Quality of Life	Cultural Expression	Knowledge transmission	Changes to cultural practices that support knowledge transmission. Changes in the location of cultural practices that support knowledge transmission
		Traditional diet	Changes in availability of country foods included in a traditional diet. Changes in the perceived suitability and safety of country foods in a traditional diet.
	Community Well-being	Population and demographics	Change in population and demographics.
		Income of local workers	Change in income of local workers.

Valued Component Category	Valued Component	Key Indicator	Measurable Parameter
		Community cohesion	Change in community cohesion as understood by community members through Key Person Interviews.
	Infrastructure and Services	Traffic	Change in traffic volumes and types and risk of accident.
		Community infrastructure and services	Change in access to and capacity of community infrastructure and services. Change in emergency services capacity.
Economics	Economy	Employment and training	The number of Project-related employment opportunities. The number of Project-related training, and educational opportunities. Proportion of Project-related employment opportunities offered and attained by residents in the Local Study Area (LSA). Proportion of Project-related training and educational opportunities offered and attained by residents in the LSA.
		Income	Total wages and salaries paid by Denison and direct contractors on the Project. Changes in income levels of residents in the LSA communities (personal and household).
		Traditional economy	The change in LSA residents participating in the traditional economy due to the Project.
		Business opportunities	The total expenditures of northern Saskatchewan businesses contracted by the Project and procurement agreements and policies in place with Indigenous and northern businesses.
		Government revenues	Changes to provincial royalties and resource surcharges due to the Project. Changes to federal and provincial corporate income tax due to the Project. Change to federal and provincial direct employment income tax due to the Project.

5.3.3 Spatial Boundaries

Spatial boundaries for the EA are defined for each VC, based on the extent of the anticipated Project-related effects (i.e., direct and indirect) on the VC. When determining the spatial boundaries, the following information was considered, as appropriate and available:

- IK, LK, and engagement;
- information on current land and resource use by Indigenous groups;

- other pertinent ecological, technical, social, and cultural considerations (e.g., watersheds, ecozones);
- input from federal and provincial regulators and the public; and
- professional expertise of Denison and the EIS third party consultants.

The study areas for this EA are identified for each VC according to the following definitions:

- **Project Area:** the area within which the Project and all components/activities are located (i.e., the Project footprint; the area of maximum physical disturbance). This area is not VC-specific, but consistent throughout the EA.
- **Local Study Area (LSA):** the area that surrounds the Project Area where both direct and indirect effects resulting from Project activities can be reasonably measured. The LSA is established to assess the potential, largely direct effects of the Project and represents the extent to which there is a reasonable potential for the Project or Project-related activities to interact with and potentially adversely effect the VC.
- **Regional Study Area (RSA):** the area that surrounds and includes the LSA, established to assess the potential, largely indirect effects of the Project in a regional context. The RSA is large enough to capture the extent of potential effects (i.e., zone of influence) on a VC and defines the area within which cumulative effects may occur (i.e., cumulative effects assessment [CEA] boundary).

The Project Area is presented in Figure 5.3-1. The VC-specific LSAs and RSAs are presented in their respective sections of the EIS.

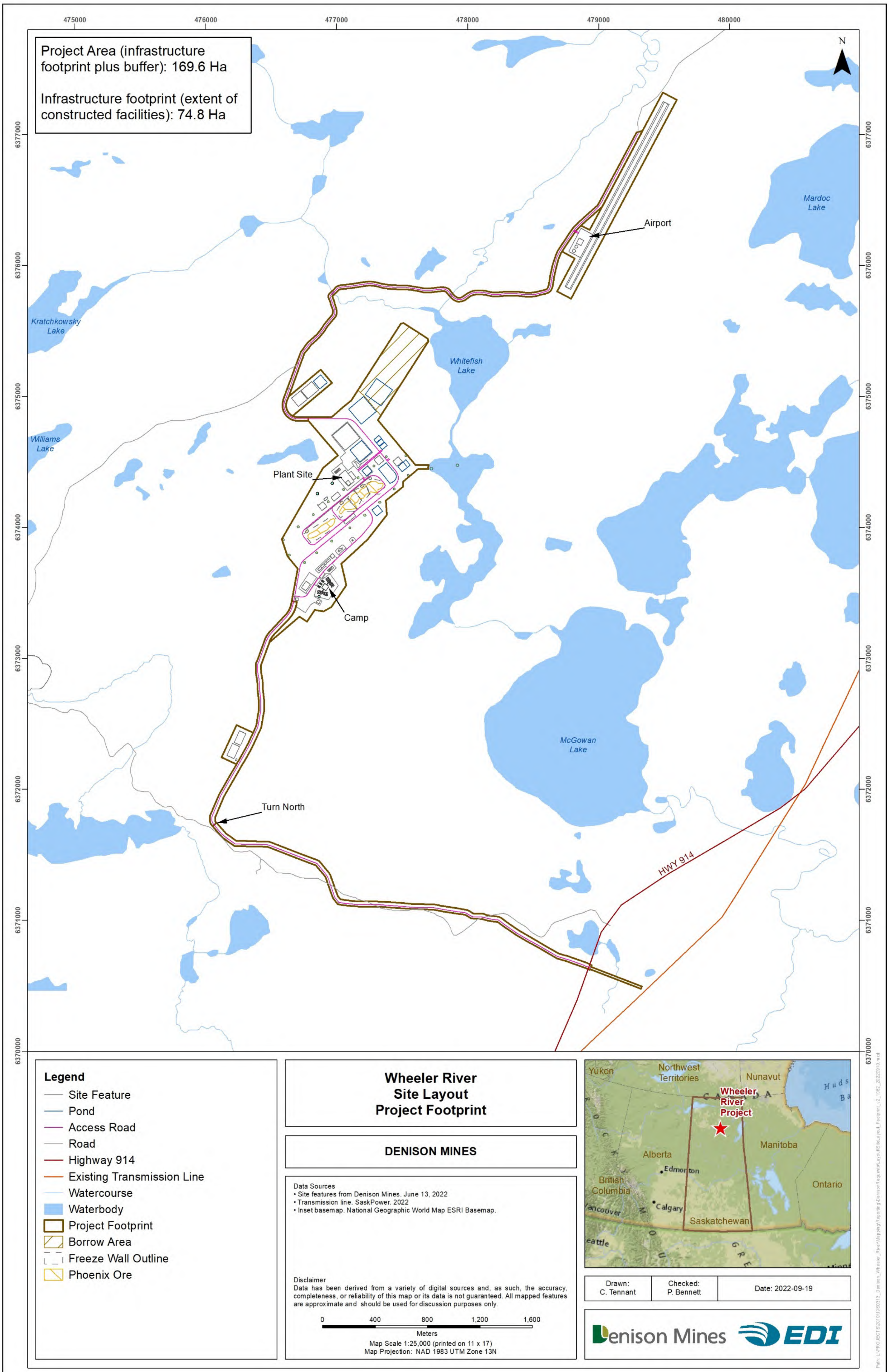

Figure 5.3-1: Project Area for the Wheeler River Project

5.3.4 Temporal Boundaries

The temporal boundaries for the EA represent the timeframes that the Project is expected to interact with and potentially affect the VCs, and as appropriate, reflect seasonal and annual variations or biophysical constraints related to a VC. Temporal boundaries are based on the different phases of the Project, Construction (including site preparation), Operation, Decommissioning, and Post-Decommissioning as described in Table 5.3-3.

Table 5.3-3: Temporal Boundaries for the Environmental Assessment

Phase and Year	Description of Activities	
Construction Year 1 to 3	• Development of access roads and air strip • Site preparation and earthworks; clearing, levelling, and grading of the Project Area • Power generation – generators • Installation of main substation and distribution of power around site • Wellfield and freeze hole drilling; ground freezing • Batch plant operation (concrete); crusher at borrow area • Development of surface infrastructure (camp, operations centre, plants, ponds, pads, and support facilities) • Waste management (composting, domestic and industrial landfill operation, recycling)	• Water management (including treatment and site runoff) • Groundwater supply • Surface water withdrawal • Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel) • On-site and off-site operation of vehicles and transport of materials • Air transportation for workers • Regulatory site inspections • Engagement – site visit from Interested Parties • Employment and expenditures
Operation Year 3 to 18	• Operation of the in situ recovery (ISR) wellfield • Wellfield and freeze wall drilling • Operation and expansion of freeze wall • Batch plant operation (grout and cement) crusher at borrow area • Expansion of pond and pads • Operation of the processing plant and production of uranium concentrate • Water withdrawal from groundwater or surface water body • Management of surface water (including seepage and site runoff) • Water treatment, both domestic and industrial • Water release to surface water body • Waste management (composting, domestic and industrial landfill operation, recycling)	• Hazardous waste management (temporary storage, handling, and off-site transportation) Storage and disposal of drill waste rock, process precipitates, and industrial wastewater treatment plant precipitates • On-site and off-site operation of vehicles and transport of materials • Power supply – primarily power from the grid, also generators and back-up generators • Package and transport of nuclear substances • Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel) • Air transportation for workers • Progressive decommissioning and reclamation • Regulatory site inspections • Engagement - site visit from Interested Parties • Employment and expenditures

Phase and Year	Description of Activities	
Decommissioning Year 18 to 23	• Site water management, treatment, and release • Mining horizon remediation and thawing of freeze wall • Process water treatment and release • Closure of ISR and freeze wells and related infrastructure • Decontamination of surface facilities and injection, recovery, and monitoring wells • Asset removal (including site power transmission lines and electrical infrastructure) • Demolition and disposal of non-salvageable surface infrastructure and materials	• Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area) • Power generation – generators • Waste management (composting and landfill operation) • Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal) • On-site and off-site operation of vehicles and transport of materials • Reclamation of disturbed areas • Regulatory site inspections • Engagement – site visit from Interested Parties • Employment and expenditures
Post-Decommissioning Year 23 to 38	• Environmental monitoring • Regulatory site inspections	• Engagement – site visit from Interested Parties • Employment and expenditures

5.4 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

At its broadest level, IK can be understood as the unique and collective knowledge of Indigenous peoples, which may include, but is not limited to the environmental, cultural, economic, political, and spiritual conditions of a community or region. The results of IK collection influence the assessment by guiding the development and refinement of primary data collection, providing context for interpretation of secondary data, and providing context for the baseline.

The category of LK for the Project applies only to the information provided by Bobby John, a member of the English River First Nation (ERFN) who previously resided is in the Project Area. Local knowledge is considered as specialized knowledge developed through long-term association, interaction, and cumulative experience. It is context-specific and unique. As the information is held by an individual, it cannot be validated and vetted through processes commonly applied in the collection of IK, which is considered as community-held and shared knowledge.

In this EIS, IK and LK are viewed as complementary and influential alongside western science to produce a full understanding of the potential effects of the Project, whether measurable or perceived. Both forms of information have been given full and fair consideration. Each VC-specific section in Parts II and III of the EIS contains a subsection that outlines the influence of IK, LK, and engagement on the assessment. Indigenous Knowledge and LK quotes and citations have been included to provide readers the information considered as the Project advanced throughout the effect assessment process.

Denison recognizes the importance of engaging with local and Indigenous communities, residents, businesses, organizations, land users and the various regulatory authorities, collectively referred to as Interested Parties. Since 2016, Denison has been engaging with these Interested Parties to support the development of positive relationships and a mutual commitment to collaboration. Broadly speaking, Denison has grouped Interested Parties into three categories:

- Indigenous (Communities/Organizations);
- general public; and
- regulatory agencies.

Specific guidance on inclusion of IK, LK, and engagement in the assessment is provided in Section 3 Indigenous and Local Knowledge and Section 4 Engagement. A summary table listing where IK, LK, and engagement have been considered is included, when applicable, as an appendix in each relevant EIS section.

5.5 Existing Environment

The existing environment section for each VC (and, where applicable, KI) establishes the current conditions and setting (i.e., considers past and current anthropogenic and natural disturbances) for each KI for the assessment of Project-related effects. The information is provided at an overview level for the RSA and in more detail for the LSA. The level of detail provided for each study area is sufficient to allow potential Project effects to be identified and understood.

Existing conditions are based on available information and are accompanied by supporting information including:

- federal, provincial, Indigenous, and local government jurisdictions, mandates, agreements, and interests of specific relevance to the VC/KI;
- an overview of the data sources, and desktop and baseline studies conducted for the Project, with reference to appendices as appropriate;
- a brief description of the quality and reliability of the baseline data and their applicability for the purpose used, including any uncertainty or gaps;
- natural and human caused trends that are presently affecting baseline conditions, including an explanation of if and how other projects and activities have or are currently affecting the VC/KI;
- available IK, LK, and results of engagement activities of specific relevance to the particular VC/KI, subject to any confidentiality constraints that may apply; and
- scientific and other information, such as published literature, databases, remote sensing imagery and data, monitoring programs, and previous EAs or associated technical reports.

5.6 Assessment of Project-related Effects

In this EA, each VC is evaluated consistently by first identifying potential interactions between the Project and each VC (and, where applicable KIs), then identifying and describing potential Project effects, and finally, assessing the changes due to the Project (i.e., considering residual effects after mitigation) and their significance for receptor VCs. In a next step, the results of the residual effects characterizations for all KIs for a VC are summarized (i.e., rolled-up) to determine the significance of those effects on the receptor VC. The significance is typically related to the sustainability or integrity of the KI/VC at the regional level.

All residual effects (independent of significance, or designation as intermediate or receptor VC) are further assessed in a CEA. The CEA considers whether residual adverse effects of the Project on a given VC will overlap spatially and/or temporally with the same residual adverse effects on the VC resulting from other past, present, and reasonably foreseeable projects or activities (see Section 5.9).

5.6.1 Potential Interactions Between the Project and Valued Components/Key Indicators

This subsection within each VC-specific section identifies which Project activity potentially interacts with which VC/KI. Interactions are determined by providing Project information to third party experts who use their knowledge and experience to conduct a qualitative ranking. Interactions between the Project and VC consider feedback through engagement with Communities of Interest. Potential interactions in the summary table are ranked as:

- **Primary Interaction** (✓): Project activity is expected to interact with the VC/KI, which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- **Other Interaction** (✓)**:** Project activity is expected to interact with the VC/KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- **No Interaction:** Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

Potential interactions between key Project activities and the VCs are summarized by Project phase in Table 5.6-1 and Table 5.6-2, with a check mark with grey highlight (✓) indicating a primary interaction and a check mark (✓) indicating an 'other' interaction. No check mark means no interaction is anticipated. Each VC-specific section contains its own summary table relating to VCs and KIs.

Table 5.6-1: Summary Interaction Matrix for Valued Components in the Biophysical Environment

Key Project Activities	Biophysical Environment Valued Components																							
	Atmospheric and Acoustic		Geology and Groundwater			Aquatic Environment						Terrestrial Environment												
	Air Quality	Noise	Geology	Groundwater Quality	Groundwater Quantity	Surface Water Quality	Surface Water Quantity	Sediment Quality	Benthic Invertebrates	Fish and Fish Habitat	Fish Health	Terrain	Organic Matter/Peat	Soil Quantity	Soil Quality	Vegetation and Ecosystems	Listed Plant Species	Wetlands	Ungulates	Furbearers	Woodland Caribou	Raptors	Migratory Breeding Birds	Bird Species at Risk
Construction Activities																								
Development of access roads and air strip	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Site preparation and earthworks; clearing, levelling, and grading of the Project Area	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Power generation - generators	✓	✓													✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Installation of main substation and distribution of power around site	✓	✓														✓	✓	✓	✓	✓	✓	✓	✓	✓
Wellfield and freeze hole drilling; ground freezing	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Batch plant operation (concrete); crusher at borrow area	✓	✓													✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Development of surface infrastructure (camp, operations centre, plants, ponds, pads, and support facilities)	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	✓	✓				✓		✓			✓			✓	✓	✓				✓		✓	✓	✓
Water management (including treatment and site runoff)				✓		✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Groundwater supply					✓	✓	✓	✓	✓	✓						✓	✓	✓						
Surface water withdrawal						✓	✓	✓	✓	✓	✓					✓	✓	✓		✓		✓	✓	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)																✓	✓	✓		✓		✓	✓	✓
On-site and off-site operation of vehicles and transport of materials	✓	✓													✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Air transportation for workers	✓	✓														✓	✓	✓	✓	✓	✓	✓	✓	✓
Regulatory site inspections																✓	✓	✓	✓	✓	✓	✓	✓	✓
Engagement – site visit from Interested Parties																✓	✓	✓	✓	✓	✓	✓	✓	✓
Operation Activities[1]																								
Operation of the ISR wellfield	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓			✓	✓	✓	✓	✓	✓
Wellfield and freeze wall drilling	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Key Project Activities	Biophysical Environment Valued Components																							
	Atmospheric and Acoustic		Geology and Groundwater			Aquatic Environment						Terrestrial Environment												
	Air Quality	Noise	Geology	Groundwater Quality	Groundwater Quantity	Surface Water Quality	Surface Water Quantity	Sediment Quality	Benthic Invertebrates	Fish and Fish Habitat	Fish Health	Terrain	Organic Matter/Peat	Soil Quantity	Soil Quality	Vegetation and Ecosystems	Listed Plant Species	Wetlands	Ungulates	Furbearers	Woodland Caribou	Raptors	Migratory Breeding Birds	Bird Species at Risk
Operation and expansion of freeze wall		✓	✓	✓	✓		✓	✓	✓							✓	✓	✓						
Batch plant operation (grout and cement); crusher in borrow area	✓	✓														✓	✓	✓				✓	✓	✓
Expansion of pond and pads	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Operation of the processing plant and production of uranium concentrate	✓	✓		✓		✓	✓	✓	✓	✓	✓				✓	✓			✓	✓	✓	✓	✓	✓
Water withdrawal from groundwater or surface water body					✓	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	✓
Management of surface water (including seepage and site run-off)				✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water treatment, both domestic and industrial				✓		✓	✓	✓	✓	✓	✓					✓			✓	✓	✓	✓	✓	✓
Water release to surface water body						✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	✓	✓		✓		✓	✓	✓	✓	✓	✓			✓	✓	✓				✓		✓	✓	✓
Hazardous waste management (temporary storage, handling, and off-site transportation)	✓	✓		✓		✓		✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates	✓	✓		✓		✓		✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
On-site and off-site operation of vehicles and transport of materials	✓	✓				✓		✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Power supply – primarily power from the grid, also generators and back-up generators	✓	✓													✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Package and transport of nuclear substances	✓	✓				✓					✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)																✓	✓	✓		✓			✓	✓
Air transportation for workers	✓	✓														✓	✓	✓	✓	✓	✓	✓	✓	✓
Progressive decommissioning and reclamation	✓	✓				✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	✓
Regulatory site inspections																✓	✓	✓	✓	✓	✓	✓	✓	✓
Engagement – site visit from Interested Parties																✓	✓	✓	✓	✓	✓	✓	✓	✓
Decommissioning Activities																								
Site water management, treatment, and release				✓	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	✓

Key Project Activities	Biophysical Environment Valued Components																							
	Atmospheric and Acoustic		Geology and Groundwater			Aquatic Environment						Terrestrial Environment												
	Air Quality	Noise	Geology	Groundwater Quality	Groundwater Quantity	Surface Water Quality	Surface Water Quantity	Sediment Quality	Benthic Invertebrates	Fish and Fish Habitat	Fish Health	Terrain	Organic Matter/Peat	Soil Quantity	Soil Quality	Vegetation and Ecosystems	Listed Plant Species	Wetlands	Ungulates	Furbearers	Woodland Caribou	Raptors	Migratory Breeding Birds	Bird Species at Risk
Mining horizon remediation and thawing of freeze wall	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓		✓			✓	✓
Process water treatment and release				✓	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	✓
Closure of ISR and freeze wells and related infrastructure	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Decontamination of surface facilities and injection, recovery, and monitoring wells	✓			✓		✓	✓	✓	✓	✓	✓					✓			✓	✓	✓	✓	✓	✓
Asset removal (including site power transmission lines and electrical infrastructure)	✓	✓						✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Demolition and disposal of non-salvageable surface infrastructure and materials	✓	✓		✓		✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Power generation – generators	✓	✓		✓											✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Waste management (composting and landfill operation)	✓	✓		✓		✓								✓	✓	✓				✓		✓	✓	✓
Decommissioning of landfills; hazardous materials management (temporary storage and removal off-site)	✓	✓				✓		✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
On-site and off-site operation of vehicles and transport of materials	✓	✓													✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Reclamation of disturbed areas	✓	✓		✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Regulatory site inspections																✓	✓	✓	✓	✓	✓	✓	✓	✓
Engagement – site visit from Interested Parties																✓	✓	✓	✓	✓	✓	✓	✓	✓
Post-Decommissioning Activities																								
Environmental monitoring				✓	✓	✓		✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	✓
Regulatory site inspections																✓	✓	✓	✓	✓	✓	✓	✓	✓
Engagement - Site visit from Interested Parties																✓	✓	✓	✓	✓	✓	✓	✓	✓

1 Operational activities include maintenance.

Table 5.6-2: Summary Interaction Matrix for Valued Components in the Human Environment

Key Project Activities	Human Environment Valued Components								
	Human Health		Land and Resource Use			Quality of Life			Economics
	Human Health	Worker Health and Safety	Indigenous Land and Resource Use	Other Land and Resource Use	Heritage Resources	Cultural Expression	Community Well-being	Infrastructure and Services	Economy
Construction Activities									
Development of access roads and air strip	✓	✓	✓	✓		✓		✓	
Site preparation and earthworks; clearing, levelling. and grading of the Project Area	✓	✓	✓	✓		✓		✓	
Power generation – generators	✓		✓	✓		✓			
Installation of main substation and distribution of power around site			✓	✓		✓			
Wellfield and freeze hole drilling	✓	✓	✓	✓		✓		✓	✓
Ground freezing	✓	✓	✓	✓		✓			✓
Batch plant operation (concrete); crusher at borrow area	✓	✓	✓	✓					✓
Development of surface infrastructure (camp, operations centre plants, ponds, pads, and support facilitates)	✓		✓	✓		✓		✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)			✓	✓		✓			
Water management (including treatment and site run-off)	✓	✓	✓	✓					
Groundwater supply			✓	✓					
Surface water withdrawal	✓	✓	✓	✓		✓			

Key Project Activities	Human Environment Valued Components								
	Human Health		Land and Resource Use			Quality of Life			Economics
	Human Health	Worker Health and Safety	Indigenous Land and Resource Use	Other Land and Resource Use	Heritage Resources	Cultural Expression	Community Well-being	Infrastructure and Services	Economy
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)			✓	✓		✓			
On-site and off-site operation of vehicles and transport of materials	✓	✓	✓	✓		✓		✓	
Air transportation for workers		✓	✓	✓		✓		✓	
Regulatory site inspections									
Engagement – site visit from Interested Parties									
Employment and expenditures[1]							✓	✓	✓
***Operation Activities*[2]**									
Operation of the ISR wellfield	✓	✓	✓	✓		✓		✓	
Wellfield and freeze wall drilling	✓	✓	✓	✓		✓		✓	
Operation and expansion of freeze wall			✓	✓					
Batch plant operation (grout and cement); crusher at borrow area	✓	✓	✓	✓		✓			
Expansion of pond and pads			✓	✓		✓		✓	
Operation of the processing plant and production of uranium concentrate	✓	✓	✓	✓		✓		✓	
Water withdrawal from groundwater or surface water body		✓	✓	✓		✓			
Management of surface water (including seepage and site run-off)	✓		✓	✓		✓			

Key Project Activities	Human Environment Valued Components								
	Human Health		Land and Resource Use			Quality of Life			Economics
	Human Health	Worker Health and Safety	Indigenous Land and Resource Use	Other Land and Resource Use	Heritage Resources	Cultural Expression	Community Well-being	Infrastructure and Services	Economy
Water treatment, both domestic and industrial	✓		✓	✓		✓			
Water release to surface water body	✓	✓	✓	✓		✓			
Waste management (composting, domestic and industrial landfill operation, recycling)	✓	✓	✓	✓		✓			
Hazardous waste management (temporary storage, handling, and landfill operation)	✓	✓	✓	✓		✓		✓	
Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates	✓	✓	✓	✓		✓		✓	
On-site and off-site operation of vehicles and transport of materials	✓	✓	✓	✓		✓		✓	
Power supply – primarily power from the grid, also generators and back-up generators	✓		✓	✓		✓			
Package and transport of nuclear substances	✓	✓	✓	✓		✓		✓	
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)			✓	✓		✓		✓	
Air transportation for workers		✓	✓	✓		✓		✓	
Progressive decommissioning and reclamation			✓	✓		✓			
Regulatory site inspections									
Engagement – site visit from Interested Parties									

Key Project Activities	Human Environment Valued Components								
	Human Health		Land and Resource Use			Quality of Life			Economics
	Human Health	Worker Health and Safety	Indigenous Land and Resource Use	Other Land and Resource Use	Heritage Resources	Cultural Expression	Community Well-being	Infrastructure and Services	Economy
Employment and expenditures[1]							✓	✓	✓
Decommissioning Activities									
Site water management, treatment, and release	✓	✓	✓	✓		✓			
Mining horizon remediation and thawing of freeze wall	✓	✓	✓	✓		✓		✓	
Process water treatment and release	✓		✓	✓		✓		✓	
Closure of ISR and freeze wells and related infrastructure			✓	✓		✓		✓	
Decontamination of surface facilities and injection, recovery, and monitoring wells			✓	✓		✓			
Asset removal (including site power transmission lines and electrical infrastructure)	✓	✓	✓	✓		✓		✓	
Demolition and disposal of non-salvageable surface infrastructure and materials	✓		✓	✓		✓		✓	
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	✓	✓	✓	✓		✓		✓	
Power generation – generators	✓		✓	✓		✓			
Waste management (composting, and landfill operation)			✓	✓		✓			
Decommissioning of landfills; hazardous materials management (temporary storage and removal off-site)	✓		✓	✓		✓		✓	

Key Project Activities	Human Environment Valued Components								
	Human Health		Land and Resource Use			Quality of Life			Economics
	Human Health	Worker Health and Safety	Indigenous Land and Resource Use	Other Land and Resource Use	Heritage Resources	Cultural Expression	Community Well-being	Infrastructure and Services	Economy
On-site and off-site operation of vehicles and transport of materials	✓	✓	✓	✓		✓		✓	
Reclamation of disturbed areas	✓	✓	✓	✓		✓		✓	
Regulatory site inspections									
Engagement – site visit from Interested Parties									
Employment and expenditures[1]							✓	✓	✓
Post-Decommissioning Activities									
Environmental monitoring			✓	✓		✓		✓	
Regulatory site inspections									
Engagement – site visit from Interested Parties									
Employment and expenditures[1]							✓	✓	✓

1 Project employment and expenditures are generated by most Project activities and components throughout the phases of the Project. Hence, Project employment and expenditures have been added into the table as a separate row for each Project phase instead of acknowledging these individually by component or activity.

2 Operational activities include maintenance.

5.6.2 Potential Project-related Effects

Based on the anticipated Project – VC/KI interactions, this section of each VC-specific assessment describes the potential Project-related effects (i.e., changes to the MPs that result from the Project), by Project phase. It provides an overview of what is known and understood about the potential effects of this type of Project and other similar projects on the VC/KI. This includes relevant information and findings from the literature; input from IK, LK, and engagement; reported monitoring results of other similar projects; and/or professional knowledge and experience. In short, this section presents what is known about whether and how the Project is expected to affect the VC/KI.

5.7 Mitigation Measures

Mitigation in this EA is defined as the elimination, reduction, or control of the adverse effects of the Project and includes restitution for any damage to the VC caused by such effects through replacement, reclamation, compensation, or any other means. Mitigation measures refer to Project-specific mitigation and can include, but are not limited to, engineering design features and responses, best management practices, management plans, emergency response programs, and training. The rationale for and effectiveness of the proposed mitigation measures are discussed, as appropriate, and evaluated. Available data, survey and study results, and detailed mitigation measures that demonstrate a particular emphasis on avoidance of effects are included here. From there, and with this base of general mitigation and optimization in place, the assessment identifies and proposes additional VC-specific mitigation measures as required and appropriate.

Following identification of potential effects for each VC/KI, a pragmatic and transparent approach was taken to describe mitigation measures to either avoid or minimize effects, including:

- project design options;
- best management practices;
- environment, health and safety management plans, programs, and procedures;
- employee training programs and procedures;
- emergency response programs and procedures; and
- compensation, where appropriate and discussed with Denison.

5.8 Residual Effects Evaluation

The residual effects evaluation in each VC-specific section describes the likely residual effects of the Project on the VC/KI. Residual effects are effects that remain after the implementation of all mitigation measures and management plans and are the expected consequences of the Project on the VC and, where applicable, KI. For each KI of the VC, each residual effect is assessed in the context of the Project activities that will occur within each Project phase. Each residual effect is then characterized based on the combined predicted residual effect for all Project phases.

5.8.1 Definitions for Residual Effects Characterization and Significance

5.8.1.1 Residual Effects Characteristics

Table 5.8-1 summarizes the criteria used for characterizing residual effects, although the specific definitions and ratings for some characteristics may be developed on a VC-specific basis and presented in each VC-specific section.

Table 5.8-1: Effect Characteristics Considered When Evaluating Residual Effects for each Valued Component/Key Indicator

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Negative effect or effect is not desirable. **Positive** – Beneficial effect or effect is desirable.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Low** – Minimal amount of change relative to the range of existing variation. **Moderate** – Moderate amount of change relative to the range of existing variation. **High** – High amount of change relative to the range of existing variation.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the VC LSA. **Regional** – Effect extends beyond the VC LSA into the VC RSA. **Beyond Regional** – Effect extends beyond VC RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions. **Partially Reversible** – A residual effect that partially diminishes to baseline conditions. **Irreversible** – A residual effect that will not diminish to baseline conditions.
Context	Receptor VC - The extent to which the VC or KI has been affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its	**Low** – VC/KI has high resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or a lack of historic and ongoing anthropogenic or natural disturbance. No listed species present. **Moderate** – VC/KI has moderate resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or an intermediate level of historic or ongoing anthropogenic or natural disturbance with the capacity to assimilate more change. Presence of listed species.

Residual Effect Characteristic	Definition	Rating
	ability to recover from that effect (i.e., resilience)	**High** – VC/KI has weak resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or a high level of historic or ongoing anthropogenic or natural disturbance. Presence of SARA-listed species.
	Intermediate VC- describes how the residual effect evaluation is carried forward to significance determination for receptor VCs.	
Likelihood	Likelihood that the residual effect will occur including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability that the residual effect will occur. **Unlikely** – A low probability that the residual effect will occur.

5.8.1.2 Significance and Confidence

5.8.1.2.1 Significance

Significant effects are those adverse effects that will cause a change in the VC/KI that will alter its status or integrity beyond an acceptable level. A residual effect that does not meet the aforementioned criteria is considered **not significant**. Significance definitions, based on this approach, are developed on a VC-specific basis, or on a KI-specific basis as applicable.

Significance is determined for receptor VCs that represent assessment endpoints (e.g., Fish Health; Ungulates, Furbearers, and Woodland Caribou). The results of the residual effects evaluation for intermediate VCs (i.e., Air Quality, Noise, Geology, Groundwater Quality, Groundwater Quantity, Surface Water Quantity, Surface Water Quality, and Sediment Quality) feed into receptor VCs and they do not have significance determinations of their own.

5.8.1.2.2 Confidence

In this EA, the precautionary approach to the evaluation of potential effects was adopted, recognizing areas of uncertainty and uses conservative assumptions and approaches within the assessment process. Areas of uncertainty in the process and in predictions for each VC are identified and discussed in each VC-specific section, or on a KI-specific basis as applicable.

Confidence predictions are defined as low, moderate, or high. Where a high degree of uncertainty regarding a residual adverse effect is evident, the confidence level may be low. A high level of confidence is assigned to predictions that have direct, site-specific quantitative data to support the predictions. Low or moderate degrees of uncertainty are manageable through monitoring and follow-up programs to confirm the absence, presence, and extent of residual adverse effects.

5.8.2 Residual Effects Evaluation

This subsection first provides an overview of the analytical methods used to conduct the EA for the VC/KI. It includes a general description of the information and methods that have been used to characterize the existing (baseline) conditions, as well as the manner that this information and the Project Description were used to predict the likely adverse effects of the Project on the VC (by KI and MP), using a combination of quantitative and qualitative methods, as appropriate.

The residual effects are described for each of the KIs by discussing how the Project is expected to change the MP, considering the mitigation measures discussed earlier in the VC-specific section. This discussion frames and informs the characterization of each residual effect (i.e., through change in the MP). Additional details are provided for each of the characteristics, augmenting the information related to the rationale provided for the ratings.

5.8.3 Summary of Project-related Residual Adverse Effects on the Valued Components

This part of each VC-specific section provides a summary of characterizations and significance of the residual effects on the KIs, to determine the significance of the resulting total effect on the receptor VC. The significance definition used for the residual effects on the KIs is also used for the prediction of significance of the effects on the receptor VC. Residual effects of the Project are summarized in Section 16 Assessment Summary and Conclusions. All residual effects, regardless of significance, are considered in the CEA (see Section 5.9).

5.9 Cumulative Effects

The CEA considers whether residual adverse effects of the Project on a given VC will overlap spatially and/or temporally with the same residual adverse effects on the VC resulting from other past, present, and reasonably foreseeable projects or activities. The CEA follows standard methodology as per provincial (e.g., *Guidelines for an Environmental Assessment* [Government of Saskatchewan 2022]) and federal guidance (e.g., *Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012* [Government of Canada 2019a]). The methodology for the CEA is discussed in subsequent subsections. Cumulative effects are presented within each VC-specific section of the EIS and are summarized within Section 16.

5.9.1 Cumulative Effects Assessment Process

For residual effects to be considered in the CEA for the Project, the following criteria had to be met:

- potential exists for a residual adverse effect of the Project on a VC;
- the residual adverse effect can be demonstrated to act cumulatively with the residual adverse effects from other projects or activities on the same VC;
- other projects or activities must have been, or are expected to be, carried out in the reasonably foreseeable future; and,
- the cumulative effect is likely to occur.

The approach for assessing cumulative effects considers both the current conditions (which include changes caused by past development, projects, and activities, and are, therefore, considered in the baseline condition of the VC) and the identified reasonably foreseeable future projects and/or activities. The steps of the CEA for each VC are:

1. Determine the spatial boundaries for the CEA, which is VC specific, and typically the RSA for the VC.
2. Determine the project inclusion list of all other past, present, and reasonably foreseeable projects and/or activities that are expected to have adverse residual effects that extend into the VC RSA.
3. Consider all Project-related residual effects that were identified during the effects assessment for each VC, regardless of significance.
4. Identify the potential for interaction (i.e., must overlap spatially and temporally) of the Project-related residual effects with those of other projects and activities identified in Step 2 above.
5. Identify and describe the cumulative effects, and if practical, identify technically and economically feasible mitigation measures (i.e., in addition to those already identified to mitigate potential Project effects) to avoid, reduce, or otherwise mitigate the predicted cumulative effects.
6. Qualitatively assess and evaluate (i.e., characterize) the cumulative effects with respect to the likely nature and degree of change from the existing (baseline) environment as a result of the Project's residual effects in combination with the residual effects of other relevant future projects and activities.
7. Determine the significance of the cumulative effect using characterization criteria as defined for the residual effects evaluation.

5.9.2 Identification of Present or Reasonably Foreseeable Projects and Activities

Projects and activities that are considered reasonably foreseeable and may be a source of residual effects that could interact with residual effects of the Project were identified through a literature review, database review (e.g., Saskatchewan – EA Projects), discussion with Indigenous groups, discussion with local communities and review by the EIS team and Denison. Projects and activities were included in the CEA based on the following criteria:

- projects or activities that have been built or conducted for which the residual effects overlap spatially and temporally with those of the Project and are expected to continue (i.e., they are certain); and
- projects that are either proposed (e.g., are in the publicly available review process) or have been approved to be built, but are not yet built, for which the residual effects overlap spatially and temporally with those of the Project (i.e., they are reasonably foreseeable).

A preliminary list of projects and activities for potential consideration in the VC-specific CEA for the Project are listed in Table 5.9-1. Their general locations and boundaries (where available) are shown in Figure 5.9-1. The inclusion list generally includes:

- exploration and mining activities;
- Indigenous and other land use activities;
- lodges/outfitters and tourist/recreational activities;
- infrastructure use and maintenance activities; and
- others, as appropriate.

A subset of these projects and activities were assessed for each VC, subject to their overlap with the residual Project effects on each VC within the cumulative effects study area, which is typically based on the RSA for each VC. The projects and activities expected to have residual effects that overlap with the residual effects of the Project for each VC are described in the respective VC-specific sections in Parts II and III of this EIS. Note that the projects and activities listed in Table 5.9-1 include those presented in the main Map Area of Figure 5.9-1, which does not include the entire RSA for the Human Environment (i.e., Land and Resource Use, Quality of Life, and Economics) that is illustrated in the side bar of Figure 5.9-1. However, relevant projects and activities associated with VCs for the Human Environment have been assessed in Section 11, Section 12, and Section 13 of Part III of the EIS.

Table 5.9-1: Projects and Activities for Consideration in the Cumulative Effects Assessment for the Valued Components

Description	Project/Land Use Type	Activity
Cameco Key Lake Operation	Existing Mines and Mills	Exploration and mining activities
Cameco McArthur River Operation	Existing Mines and Mills	Exploration and mining activities
Cameco Cigar Lake Mine	Existing Mines and Mills	Exploration and mining activities
Courtenay Lake	Campground/Recreation Site	Tourist/recreational activities
Geikie River	Campground/Recreation Site	Tourist/recreational activities
Wollaston Lake (Hidden Bay)	Campground/Recreation Site	Tourist/recreational activities
Cree Lake Winter Road	Completed Road	Infrastructure use and maintenance activities
Davies Creek Bridge	Completed Road	Infrastructure use and maintenance activities
Fox Lake Road	Completed Road	Infrastructure use and maintenance activities
Key Lake Road	Completed Road	Infrastructure use and maintenance activities
MacFarlane Lake Winter Road	Completed Road	Infrastructure use and maintenance activities
Thin Creek Bridge	Completed Road	Infrastructure use and maintenance activities
Waterbury Lake Local Access Road	Completed Road	Infrastructure use and maintenance activities
Highway 914 All Weather Road	Future Road	Infrastructure use and maintenance activities
Beaver Lodge Fly-Inn Co. Ltd.	Outfitter	Lodges/outfitters
Broken Arrow Lodge	Outfitter	Lodges/outfitters
Costigan Lake Lodge	Outfitter	Lodges/outfitters

Description	Project/Land Use Type	Activity
Cree Lake Lodge	Outfitter	Lodges/outfitters
Johnson River Camp	Outfitter	Lodges/outfitters
Mawdsley Lake Fishing Lodge	Outfitter	Lodges/outfitters
Plaisted Camps	Outfitter	Lodges/outfitters
Wheeler River Lodge	Outfitter	Lodges/outfitters
Wilderness Family Outfitters	Outfitter	Lodges/outfitters
Pink Lake	Ecological Reserve (provincially designated protected area[1])	Tourist/recreational activities
Treaty #8	Indigenous Land/Treaty	Indigenous and other land use activities
Treaty #10	Indigenous Land/Treaty	Indigenous and other land use activities
Cree Lake I.R	Indigenous Land/Treaty	Indigenous and other land use activities
English River First Nation Barkwell Bay Reserve Land	Indigenous Land/Treaty	Indigenous and other land use activities
English River Haultain Lake I.R.	Indigenous Land/Treaty	Indigenous and other land use activities

1 No new industrial activities are permitted; continued use for Indigenous and recreational land use activities.

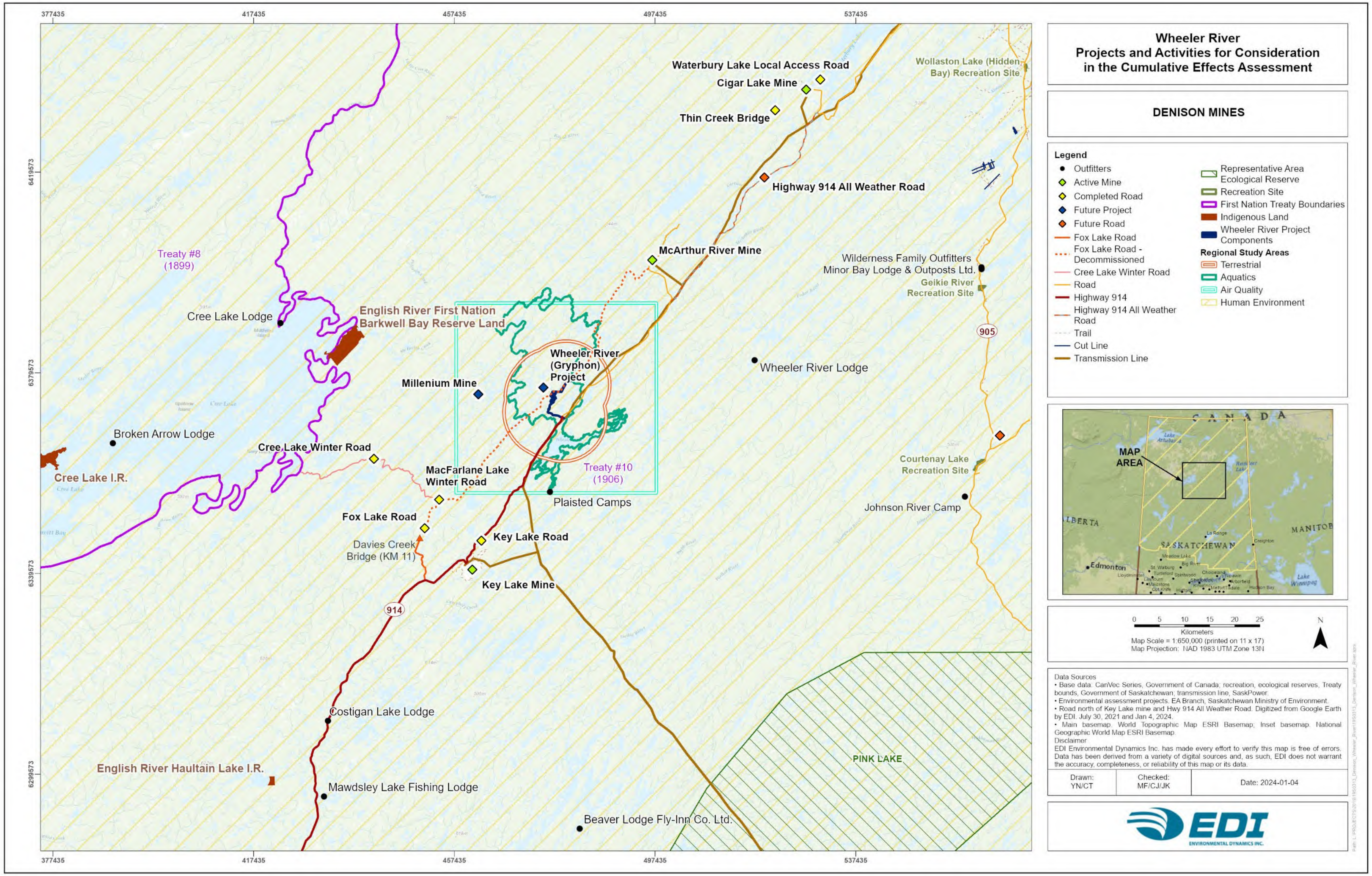

Figure 5.9-1: Projects and Activities for Consideration in the Cumulative Effects Assessment for the Valued Components

5.9.2.1 Description of Present or Reasonably Foreseeable Projects and Activities

According to the Canadian Environmental Assessment Agency's (CEAA's) Interim Technical Guidance (CEAA 2018), a future project (or physical activity) could be considered reasonably foreseeable based on the following criteria:

- The intent to proceed is officially announced by a proponent.
- The project or activity is under regulatory review (i.e., the application is in process).
- The submission for regulatory review is imminent.
- The project or activity is identified in a publicly available development plan that is approved or for which approval is anticipated (e.g., a wastewater treatment plant in a city's long term development plan).
- The physical activity supports—or is consistent with—the long-term economic or financial assumptions and engineering assumptions made for the project's planning purposes.
- A physical activity is required in order for the project to proceed (e.g., rail or port transportation facilities, or a transmission line).
- The economic feasibility of the project is contingent upon the future development.
- The completion of the project would facilitate or enable the future development.

Residual effects from the Project on a given VC have the potential to interact cumulatively with the residual effects from the present or reasonably foreseeable projects and/or activities on the same VC if they overlap spatially and temporally. The following provides a general description of the projects and/or activities presented in Table 5.9-1 and Figure 5.9-1 that have the potential to act cumulatively with the Project. These have been categorized by activity as well as by Project/land use type.

5.9.2.1.1 Exploration and Mining Activities

Historic anthropogenic disturbance such as seismic activity, drilling, and access creation in support of past exploration and mining activities, and future exploration activities have occurred within the Athabasca Basin since the 1940s when uranium was first discovered in the region. Uranium is the predominant ore most actively mined in this region because of the high-grade deposits that are present. The following provides a summary of the active operations that may be considered as part of the CEA.

Existing Mines and Mills

Cameco Key Lake Operation

The Key Lake site included two uranium ore bodies, Gaertner and Deilmann, discovered in 1975 and 1976. Mining was conducted between 1983 and 1997 and milling began in 1983. Since 2000, uranium ore is transported from the McArthur River Operation to Key Lake for milling. The mill is located approximately 570 kilometres north of Saskatoon, Saskatchewan. The Key Lake Operation is located 35 km southwest of the Project. The site is accessible by both aircraft and via Highway 914 (Cameco 2013). In 2018, sustained low uranium prices resulted in a decision to curtail production for the foreseeable future and place the operation into safe care and maintenance. On February 9, 2022, Cameco announced plans for the operation's gradual return to production.

Cameco McArthur River Operation

Cameco discovered the McArthur River ore body in 1988. Construction of the McArthur River Operation began in 1997, with mining beginning in 2000. The McArthur River Operation consists of an underground mine with underground production workings, an ore handling system, and surficial facilities. The ore is trucked to the Key Lake mill for processing and the tailings disposed of at the Deilmann pit tailings management facility. The McArthur River Operation is located 35 km northeast of the Project. The site is accessible by both aircraft and Highway 914. In 2018, sustained low uranium prices resulted in a decision to curtail production for the foreseeable future and place the operation into safe care and maintenance. On February 9, 2022, Cameco announced plans for the operation's gradual return to production.

Cigar Lake Mine

Commercial operation of Cameco's Cigar Lake Mine began in May 2015. Infrastructure at this mine includes an underground mine with ore processing and load out, surficial facilities, as well as a freezing plant and associated freeze pads. The ore from the mine is processed at the McClean Lake mill operated by Orano. The Cigar Lake Mine is located 85 km northeast of the Project.

5.9.2.1.2 Infrastructure Use and Maintenance Activities

Completed Roads

Existing infrastructure considered as part of the CEA include the Highway 914, as well as winter roads (e.g., Cree Lake Winter Road, Fox Lake Road, MacFarlane Lake Winter Road), mine access and haul roads (e.g., Key Lake Road), as well as exploration roads and trails (e.g., Waterbury Lake Local Access Road). It is anticipated that these will be continuously used during the lifetime of the Project and may require varying levels of maintenance. Maintenance activities may include vegetation management for safety and line-of-sight, road grading and gravelling, improvement of surface water management infrastructure (e.g., culvert replacement and recontouring of ditches and drainages), and other repairs.

Future Roads

Highway 914 Extension (All Weather Road)

Highway 914 is presently gated at the Key Lake Operation, which restricts public access to the northeast. The Ministry of Highways and Infrastructure proposes to extend Highway 914 by approximately 51 km (Stantec 2021). The extension is between a point on the existing road near the Cameco McArthur River Operation and Highway 905, approximately 8 km southeast of the

Cameco Cigar Lake mine site. This project also includes a 13.5 km bypass around the McArthur River mine surface lease. Development of the highway extension would provide a secondary route for vehicles travelling to and from the north (with the current access provided by Highway 905). The extension would also provide an efficient travel route for traffic to access mines and exploration sites operated by industry stakeholders in northern Saskatchewan. The EIS for the proposed extension was submitted to the Saskatchewan Environmental Assessment Branch in 2021 (Stantec 2021); construction of the extension has not started but this project was included in the CEA as being reasonably foreseeable.

5.9.2.1.3 Lodges/Outfitters and Tourist/Recreational Activities

Lodges and Outfitter Camps

The majority of hunting and/or fishing lodges and/or camps located near the Project in northern Saskatchewan are fly-in establishments only, whereas the Johnson River Camp, Mawdsley Lake Fishing Lodge, and Thompson's Resort are accessible by road. Some outfitters offer moose and/or bear hunting. Sport fish such as Northern Pike, Walleye, and Lake Trout are most commonly sought after by anglers at all locations.

Plaisted Camps and Wheeler River Lodge are located 15 km and 34 km, respectively, from the Project. Both outfitters are relatively small, with a main lodge for meals, and offering two to three smaller cabins as accommodation. The Plaisted Camp is a fishing only camp, whereas the Wheeler River Lodge offers fly-in fishing and guided bear hunting.

Campground and Recreational Sites

The Courtney Lake Recreational Site and Geikie River Recreational Site are located 85 km and 88 km, respectively, from the Project, with the Wollaston Lake (Hidden Bay) further away and north of the Geikie River site. These sites typically consist of day use areas, although Courtney Lake and Geikie River have amenities and facilities for overnight stays.

Ecological Reserves

The Pink Lake Representative Area Ecological Reserve is part of the Saskatchewan's Representative Areas Network that was launched in 1997 to conserve representative or unique examples of landscapes across Saskatchewan. The Pink Lake Ecological Reserve, located 75 km from the Project, is Saskatchewan's largest provincially-designated protected area of approximately 3,660 km^2. Although this ecological reserve is situated in relatively remote location, users may access the areas for recreational or other land use purposes.

5.9.2.1.4 *Indigenous and Other Land Use Activities*

The CEA has included consideration of numerous First Nations Reserves in proximity to the Project. Many of the closer reserve lands do not have permanent residences (e.g., ERFN Barkwell Bay). Refer to Section 5.9.3 for information on past, present, and predicted cumulative effects from ERFN and the Kineepik Métis Local #9 at Pinehouse.

5.9.2.2 Projects Deemed Not Reasonably Foreseeable

In addition to the projects listed in Table 5.9-1, two other mining projects located in proximity to the Project were also evaluated to see if they met the criteria to be considered reasonably foreseeable projects (as outlined in Section 5.9.2.1).

- **Cameco Millennium Mine:** Located approximately 15 km west of the Project, the Millennium Mine is a proposed underground uranium mine that is awaiting approval as part of a joint Federal-Provincial EA and approval process. Product from the Millennium mine will be transported to the Key Lake mill via a new haul road that will be constructed that will join with the McArthur River-Key Lake haul road. Construction was initially anticipated to begin in 2014; however, the timeline for project initiation has been pending corporate decision to proceed since 2012 (Cameco 2012). As part of the provincial-federal EA process and rigorous licensing process under the CNSC, a joint provincial-federal EIS was initiated in 2009 and the EIS was submitted in 2013. In December 2013, the Saskatchewan Minister of Environment provided Ministerial Approval for the project under Section 15(1)(a) of *The Environmental Assessment Act* (Government of Saskatchewan 2018). However, the federal part the EA and licensing was not completed. In May 2014, Cameco informed the CNSC that it did not wish to proceed with licensing of the Millennium Mine Project at that time, due to current economic conditions (https://www.ceaa-acee.gc.ca/050/evaluations/document/99381). If, at a later date, Cameco requests the CNSC to consider the application for a licence for the Millennium Mine, the EA will be re-opened and completed at that time.
- **Wheeler River (Gryphon) Project:** Future development of the Gryphon deposit is proposed as an underground mining operation, using a conventional long hole mining approach with processing of ore off site at the McClean Lake mill. Development of the Gryphon deposit as an underground mine was evaluated at the prefeasibility level in 2018, but has not advanced to feasibility study or EA. Denison has not announced an intent to proceed with the development of the Gryphon deposit.

Based on the information available, neither the Millennium mine nor the mining of the Gryphon deposit are reasonably foreseeable based on the CEAA's Interim Technical Guidance (CEAA 2018).

5.9.3 Lands Taken From an Indigenous Perspective

Cumulative effects assessment is important to Indigenous communities in general because incremental effects to the environment can weaken resource economies, affect important resources such as plants, fish, and wildlife, affect rights-based and cultural activities, and affect both the health of wildlife and humans (Indigenous Centre for Cumulative Effects 2021). Indigenous perspectives can be complementary to the CEA for the Project, and Denison acknowledges the important relationship of the Indigenous Communities of Interest to the lands and waters. The Indigenous Communities of Interest of ERFN and the Kineepik Métis Local #9 at Pinehouse (KML) have shared their Indigenous Knowledge on past, present, and predicted cumulative effects through the following sources:

- *Wheeler River Project – Summary of Health and Socio-Economic Study Results* (ERFN and SVS 2022a);
- *Wheeler River Project - Summary of Traditional Knowledge Study Results* (ERFN and SVS 2022b);
- *Kineepik Valued Ecosystem Components – KML Pre-statement for Denison EIS* (KML and NVP 2022); and
- *Response to the Environment Impact Assessment For the proposed Ministry of Highways 914 Extension Project* (KML and Limnos Environmental 2022).

These perspectives on cumulative effects have been summarized in Section 3.4.8 of Section 3. Denison and the Communities of Interest agreed on the high value of this contribution being part of the EIS.

5.9.4 Potential Cumulative Effects

For each VC, baseline conditions (as outlined in the EIS sections for the VC) represent past and present projects/activities including all associated disturbances. In addition to current disturbances, there is a likelihood of cumulative effects as a result of the residual Project effects (as identified in VC section of the EIS) overlapping with residual effects of a variety of reasonably foreseeable projects and activities in the VC-specific spatial boundaries for the CEA, typically the RSA.

For those projects that warranted additional consideration/analysis for a specific VC, the likely cumulative effects were described, and a qualitative assessment provided. All Project-related residual effects that were identified during the Project EA for each VC were considered and the potential for interaction of the Project-related residual effects with those residual effects of identified future projects and activities was described.

5.9.5 Additional Mitigation Measures

If applicable and appropriate, additional measures to mitigate the cumulative effects, in addition to Project-related mitigation measures outlined specifically for each VC, were described. Measures may include technically and economically feasible mitigation measures to avoid, reduce, or otherwise mitigate the predicted cumulative effects.

5.9.6 Cumulative Effects Characterization and Determination of Significance

Residual cumulative effects with respect to the likely nature and degree of change from the existing (baseline) environment, resulting from the Project's residual effects in combination with the residual effects of the identified future projects and activities, were qualitatively evaluated. The assessment was completed using the characterizations introduced in the residual effects assessment of Project effects on the VC (see Section 5.8.1) by Project Phase. In addition, significance and level of confidence of each cumulative effect were assessed using the characterization criteria as defined for the residual Project effects assessment (see Section 5.8.1).

5.9.7 Cumulative Effects Assessment Summary

A summary table of the overall results of the CEA is provided in Appendix 16-B of Section 16, including the additional mitigation measures to be implemented to eliminate, reduce, or control adverse cumulative effects that may occur due to interactions with other projects and activities as it relates to the VC.

5.9.8 Environmental Monitoring and Follow-up for Cumulative Effects

When applicable, VC-specific CEA sections contain a discussion of any proposed environmental monitoring and/or follow-up programs. Focusing on areas of identified uncertainty, the need for and scope of monitoring and follow-up programs as required were described to verify the accuracy of the cumulative effects predictions, and the value of proposed additional mitigation measures. Additional details on monitoring and follow-up are provided in Section 5.10.

5.9.9 Climate Change Considerations

Within the CEA of applicable VC-specific sections, a subsection has been included that provides a brief discussion on how climate change has been considered. Climate change has been included in the cumulative effects section because it is an external force that can influence the potential effects of the Project. For details on climate change in the context of the Project, please refer to Section 15 Effects of the Environment on the Project.

5.10 Monitoring and Follow-up

Each VC-specific section includes a discussion of any proposed monitoring and/or follow-up programs for each VC, by KI or MP as appropriate. Appendix 16-C of Section 16 provides a summary of monitoring and follow-up programs mentioned in the EIS.

For the purposes of this EIS, monitoring and follow-up are defined as follows:

- Monitoring programs are designed to meet regulatory requirements (e.g., permit or license conditions), and/or to demonstrate compliance with environmental commitments made in the EIS.
- Follow-up programs are those that are proposed to address any uncertainties identified during the EA process (e.g., to verify predictions made during the EA; determine the effectiveness of proposed and implemented mitigation measures) and to determine if and when to implement adaptive management measures.

Monitoring requirements will be directed by the provincial or federal regulators and as requested by Indigenous groups during the Project licensing process and will include requirements related to scheduling, sampling design, frequency, and reporting. Monitoring programs can include, as appropriate:

- objectives of the monitoring program and a schedule for collection of the monitoring data required to meet these objectives;
- sampling design, methodology, selection of the subjects and indicators to be monitored, and their selection criteria;
- frequency, duration, and geographic extent of monitoring, and justification for the extent;
- application of the principles of adaptive environmental management;
- reporting and response mechanisms, including criteria for initiating a response and procedures;
- approaches and methods for monitoring the cumulative effects of the Project with existing and future developments in the Project area;
- integration of monitoring results with other aspects of the Project including adjustments to operating procedures and refinement of mitigation measures;
- experience gained from previous and existing monitoring programs;
- advisory roles of independent experts, government agencies, communities, holders of IK and LK, and renewable resource users;
- procedures to assess the effectiveness of monitoring and follow-up programs, mitigation measures and recovery programs for areas disturbed by the Project; and
- information plans to describe the results of monitoring to Interested Parties.

Denison has committed to working with the regulators, Indigenous groups and other Interested Parties to finalize the details of many of the monitoring and follow-up programs outlined in this EIS. Additional information on this topic is included in each VC-specific section, when appropriate.

Denison continues to improve its approach based on experience gained in the construction and operation of various projects. If unforeseen adverse effects are identified during any of the monitoring or follow-up programs, Denison will, as per its ongoing adaptive management process, adjust the existing mitigation measures or, if necessary, develop new mitigation or other measures to address those effects. This could result in Denison refining or modifying the design and implementation of management plans, mitigation measures, and Project operations, with the final approach selected depending on the issue identified.

5.11 Valued Component Specific Summary

Each VC-specific section contains a final, brief summary written in plain language. This summary provides a high-level overview of the main points of the assessment, including potential residual and cumulative effects to the VC/KI from the Project and relevant mitigation, monitoring, and follow-up.

5.12 Accidents and Malfunctions Assessment

An assessment of potential accident and malfunction scenarios associated with the Project was undertaken and is detailed in Section 14 Accidents and Malfunctions of the EIS, as well as in the accidents and malfunctions Technical Supporting Document (see Appendix 14-A; Ecometrix 2022).

For the purpose of the assessment, accidents and malfunctions refer to events or conditions that are not part of any activity or normal operation of the Project as proposed by Denison. This is consistent with the definition of an accident as described in REGDOC-3.6 (CNSC 2022). The assessment was carried out in alignment with federal (CNSC 2020) and provincial (Government of Saskatchewan 2014a, 2014b) guidance, as well as recent EA practices in consideration of proposed uranium mining developments in the Athabasca Basin.

The objective of the assessment was to evaluate the potential effects to human health or the biophysical environment resulting from radiological and conventional accidents and malfunctions in consideration of proposed environmental protection measures. The assessment considered all Project phases focusing on the Project site, the Project site access road and specific off-site locations along the Project-related transportation route (i.e., provincial highway system) of interest to local Indigenous peoples.

The assessment of accidents and malfunctions employed a risk assessment approach to characterize the potential effects of non-routine events on human health and/or the biophysical environment. Residual effects (i.e., effects that cannot be mitigated) for accidents and malfunctions and transportation-related events were defined in terms of risk, which can be characterized based on the likelihood of the postulated event and the effect or severity of the potential effects on human health or the biophysical environment. The assessment involved initially identifying a comprehensive list of Project-specific hazard scenarios, which represent physical situations with the potential to harm human health or the biophysical environment. This initial list was then screened qualitatively based on likelihood and consequence to determine overall risk level using a risk matrix approach. Bounding scenarios were then selected from this initial list of hazard scenarios. The subsequent analysis focused on evaluating the hypothetical effects associated with each bounding scenario. A revised risk evaluation that considered the results of the detailed assessment was then completed for each bounding scenario.

5.13 Effects of the Environment on the Project

The environmental setting in which the Project is located can affect the design, construction, operation, and decommissioning of the Project. Section 15 provides information on the interaction of these environmental considerations with the Project. The potential effect on the Project is evaluated, activities sensitive to these potential effects are discussed, and the mitigation and contingency plans and designs are presented.

Several steps were taken to identify and evaluate potential effects of natural hazards on the Project:

- identifying and describing the existing environmental conditions relating to natural hazards that may affect the Project;
- describing the implications that a natural hazard may have on the performance and environmental consequences of the Project; and
- selecting appropriate mitigation measures to address reasonable risks through the adaptive management process.

A natural hazard is considered to have a potential effect on the Project if it could result in one or more of the following:

- modification to the Project design;
- harm to Project personnel or the public;
- substantial delay in construction (i.e., more than one season);
- interruption in the mining process (i.e., more than one week);
- damage to Project infrastructure;
- threat to public safety; and
- damage to infrastructure to the extent that repair is not economically or technically feasible.

Natural hazards that either affected Project design or have the potential to affect Project Construction, Operation, and Decommissioning include:

- seismic events (e.g., earthquakes);
- forest fires;
- extreme weather short-term events (i.e., major precipitation events and drought; atypically high or low temperatures; atypically high winds); and
- climate change (long-term changes).

Historical data and published literature were used to characterize the natural hazards that may affect the Project. Predictions were used to characterize potential changes associated with climate change.

Project design features and mitigation measures were described to inform how potential effects of the environment on the Project would be prevented, minimized, or managed. This approach demonstrates Denison's due diligence in identifying the potential risks from the environment to assist with the planning, design, construction, operation, monitoring, and eventual decommissioning of the Project to reduce overall adverse effects. As part of this process, the existing environmental setting and potential environmental conditions and scenarios that may collectively affect the Project were considered so that suitable and practical mitigation measures could be evaluated and implemented during the various phases of the Project.

5.14 Concordance Tables

Concordance tables linking the content of the EIS to specific regulatory requirements are provide in Appendix 1-A of Section 1.

5.15 References

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Denison Mines

Wheeler River Project

Final Environmental Impact Statement

November 2024

Powering
PEOPLE, PARTNERSHIPS AND PASSION.

Wheeler River Project

Final Environmental Impact Statement

Section 6 – Atmospheric and Acoustic Environment

November 2024

Denison Mines

Denison Mines Corp.

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Roadmap

This roadmap of the Wheeler River Project Environmental Impact Statement (EIS) has been provided to summarize the main document sections and appendices of the EIS.

Wheeler River Project
Environmental Impact Statement

Executive Summary

Part I: Introduction and Context	Part II: Biophysical Environmental Assessments	Part III: Human Environment Assessments	Part IV: Integrated Topics and Summary
Section 1: Project Introduction and Overview	Section 6: Atmospheric and Acoustic Environment	Section 10: Human Health	Section 14: Accidents and Malfunctions
Section 2: Project Description	Section 7: Geology and Groundwater	Section 11: Land and Resource Use	Section 15: Effects of the Environment on the Project
Section 3: Indigenous and Local Knowledge	Section 8: Aquatic Environment	Section 12: Quality of Life	Section 16: Assessment Summary and Conclusions
Section 4: Engagement	Section 9: Terrestrial Environment	Section 13: Economics	
Section 5: Approach and Methodology of the Assessment			

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Abbreviations, Acronyms and Units

Abbreviation / Acronym	Definition
AAQC	Ambient air quality criteria
AER	Alberta Energy Regulator
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
ARM	Ambient Ratio Method
CAAQS	Canadian Ambient Air Quality Standards
CCME	Canadian Council of Ministers of the Environment
CLMC	Cigar Lake Mining Corporation
CNSC	Canadian Nuclear Safety Commission
CO	Carbon monoxide
CO_2	Carbon dioxide
COPC	Constituent of potential concern
EA	Environmental assessment
ECCC	Environment and Climate Change Canada
EIS	Environmental Impact Statement
HA	Highly annoyed
ISR	In situ recovery
KI	Key indicator
Ldn	day-night level
LSA	Local Study Area
MECP	Ministry of Environment, Conservation and Parks (Ontario)
MP	Measurable parameter
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxide
$PM_{2.5}$	Respirable particulate matter
PM_{10}	Inhalable particulate matter
PSL	Permissible sound level
RCP	Representative concentration pathway
RSA	Regional Study Area
SAAQS	Saskatchewan Ambient Air Quality Standards
SO_2	Sulphur dioxide
TSP	Total suspended particulate
VC	Valued component
WRF-NMM	Weather Research Forecast Non-Hydrostatic Mesoscale Model

Units	Definition
°C	degrees Celsius
Bq/m^3	becquerels per cubic metre
d/y	days per year
dB	decibels
dBA	decibels A
ft	foot
h/y	hours per year
ha	hectare
kHz	kilohertz
km	kilometre
kW	kilowatt
m	metre
mg/cm^2/30-days	milligram per squared centimetre per 30 days
mm	millimetre
mSv	millisievert
MW	Megawatt
ppb	parts per billion
$\mu g/m^3$	microgram per cubic metre

Glossary

Term	Definition
A-weighted decibel (dBA), or A-weighting	"A-weighted decibels" are *decibels* that have been adjusted to approximate the relative sensitivity of the normal human ear to different frequencies (pitches) of sound. *Decibels* are direct measures of atmospheric pressure across a range of frequencies (low pitch to high pitch); however, the human hearing mechanism is not equally sensitive to all frequencies. Application of *A-weighting* reduces the contribution of sound at frequencies that humans are not particularly sensitive to (e.g., very low and very high pitches).
Ambient air	Ambient air is the natural state of the air at a particular time and place out of doors. Often used interchangeably with "outdoor air."
Ambient ratio method	The ambient ratio method is a method used to convert concentrations of nitrogen oxide (NOx) to nitrogen dioxide (NO_2). It uses an empirical NO_2/NOx ratio to estimate NO_2 concentrations.
AP-42	AP-42 is the United States Environmental Protection Agency's (US EPA) primary compilation of emission factors and supporting information for various air pollution source categories. It is collectively known as the "AP-42, Compilation of Air Pollutant Emission Factors".
CALMET	A diagnostic, three-dimensional meteorological model used in conjunction with CALPUFF.
CALPUFF	An advanced, three-dimensional, non-steady-state puff air quality dispersion model for assessing the transport of contaminants in the atmosphere.
Carbon monoxide (CO)	A colourless, odourless, tasteless, and flammable gas, produced by burning fuel, such as natural gas. It consists of one carbon atom and one oxygen atom.
Climate	The typical, long-term weather pattern of a geographical location or area (usually, 30 years).
Combustion	The act or instance of burning a fuel like natural gas to produce energy. For example, combustion is typically the process that powers automobile engines and power plant generators.
Concentration (Air)	With respect to air quality, it refers to the amount of a particular contaminant within a given volume of air. Typically, in units of micrograms per cubic meter ($\mu g/m^3$).
Constituent of potential concern	For air quality, a contaminant for which measurable concentrations in the atmosphere can be used to describe the condition or quality of the air.
Day-night level (L_{dn})	The "day-night sound level", or L_{dn}, is a 24-hour *energy equivalent sound level* in which the night-time sound levels (occurring between 22:00 and 07:00) have been adjusted by +10 dB, in order to account for people being generally more sensitive to sounds that occur at night.
Daytime sound level (Ld)	The "daytime sound level", or Ld, is the *energy equivalent sound level* calculated over the 15-hour period from 07:00 to 22:00.
Decibel (dB)	A "decibel" is used to describe the magnitude of *sound pressure levels* relative to the threshold of human hearing (20 µPa). A *sound pressure level* in decibels is defined as twenty times the (base 10) logarithm of the ratio of the sound pressure (P, in units of Pascals) to the reference pressure (Pr, being the threshold of human hearing, or 20 µPa). Expressed as an equation, $dB = 20\log(P/Pr)$.
Dispersion Model (Air)	A group of mathematical relationships used to simulate on a computer the transport, dispersion, transformation of contaminants emitted into the air.
Dustfall or Dust Deposition	The amount of dust particles or particulate matter in the air that falls to an area on the ground, primarily due to gravitational settling.

Term	Definition
Emission Factor	A mathematical relationship used to estimate of the release rate of a contaminant to the atmosphere by a given source.
Energy equivalent sound level	The "Energy equivalent sound level", or Leq, is the constant sound level which would result in exposure to the same total A-weighted energy as would the specified time-varying sound if the constant sound level persisted over an equal time interval.
Fugitive dust	Dust particles or particulate matter that are introduced into the air through open sources and not discharged through a confined air stream like an exhaust stack. Examples of fugitive dust sources include unpaved roads and stockpile wind erosion.
Gamma radiation	Penetrating electromagnetic radiation emitted from an atom's nucleus. Also called gamma rays.
High-Volume Air Sample (Hi-Vol)	An instrument used to measure the amount of particulate matter (TSP, PM_{10}, or $PM_{2.5}$) in ambient air.
Incremental concentration	The concentration of an air contaminant in the atmosphere above a baseline air concentration. Used to measure the contribution of a project to overall air quality.
Meteorology	The science of the atmosphere and its direct effects upon the Earth's surface. Meteorology is especially concerned with how atmospheric conditions affect the weather.
Night-time sound level (Ln)	The "night-time sound level", or Ln, is the *energy equivalent sound level* calculated over the 9-hour period from 22:00 to 07:00.
Nitrogen oxides (NOx)	A general term pertaining to compounds of nitric oxide (NO), nitrogen dioxide (NO_2) and other oxides of nitrogen. Nitrogen oxides are typically created during combustion processes and are major contributors to smog formation and acid deposition.
Nitrogen dioxide (NO_2)	A highly reactive gas having a characteristic reddish-brown colour and strong odour. The main anthropogenic (i.e., man-made) source of NO_2 is fossil fuel combustion. It consists of one nitrogen atom and two oxygen atoms.
Particulate matter of 10 microns or less (PM_{10})	Tiny subdivisions of solid particles suspended in the atmosphere, with diameters that are generally 10 micrometers or less. Also known as inhalable particulate matter.
Particulate matter of 2.5 microns or less ($PM_{2.5}$)	Tiny subdivisions of solid particles suspended in the atmosphere, with diameters that are generally 2.5 micrometers or less. Also known as respirable particulate matter.
Percent Highly Annoyed (%HA)	The "percent highly annoyed", or %HA, is a measure of the percentage of people in a community that are typically annoyed by sounds at given levels. The %HA value is calculated using the *day-night level*, using an equation that is based on a dose-response curve developed from socio-acoustic studies that related increasing community noise levels with an associated increasing percentage of the community that is reported to be 'highly annoyed' by the noise as it rises.
Permissible Sound Level (PSL)	The "Permissible sound level (PSL)" is a sound level limit adopted by the Alberta Energy Regulator (AER) for assessment of industrial noise. PSLs are defined for the daytime period (see "Daytime sound level (Ld)") and night-time period (see "Night-time sound level (Ln)") and are applicable at sensitive receptor locations. These are *energy equivalent sound levels* (see "Energy equivalent sound level (Leq)").
Radionuclide	A material with an unstable atomic nucleus that spontaneously decays or disintegrates, producing radiation. Nuclei are distinguished by their mass and atomic number.
Sound level	"Sound level" generally refers to an A-weighted *sound pressure level* (see "Sound pressure level" and "A-weighted decibel (dBA)").
Sound power level	"Sound power" is a measure of sound energy and is associated with a source of noise. Sound power quantifies the sound output produced by a source of noise (e.g., an engine), and is presented in units of decibels, using a standard reference power level of 10^{-12} Watts.

Term	Definition
Sound pressure level	“Sound pressure” is the instantaneous difference between the actual pressure and the barometric pressure at a given location (e.g., a dwelling). Sound pressure levels are typically expressed in *decibels*.
Sulphur dioxide (SO_2)	A strong smelling, colourless gas that is formed by the combustion of fossil fuels. SO_2 and other sulphur oxides also contribute to the problem of acid deposition. It consists of one sulphur atom and two oxygen atoms.
Total suspended particulate	Airborne particulate matter with an upper size limit of approximately 100 micrometers (µm) in diameter.
Weather Research Forecast Non-Hydrostatic Mesoscale Model (WRF-NMM)	WRF-NMM is a state-of-the-art numerical weather prediction model used for research and operational forecasting purposes.

6 Atmospheric and Acoustic Environment

Section 6 of the Environmental Impact Statement (EIS) for the Wheeler River Project (the Project) is focused on the Atmospheric and Acoustic Environment. The integrated biophysical and human environment assessment approach is illustrated in Figure 6-1. As a guide for EIS reviewers, Figure 6-2 provides a preview of the Valued Components (VC) associated with the assessments completed in this section of the EIS.

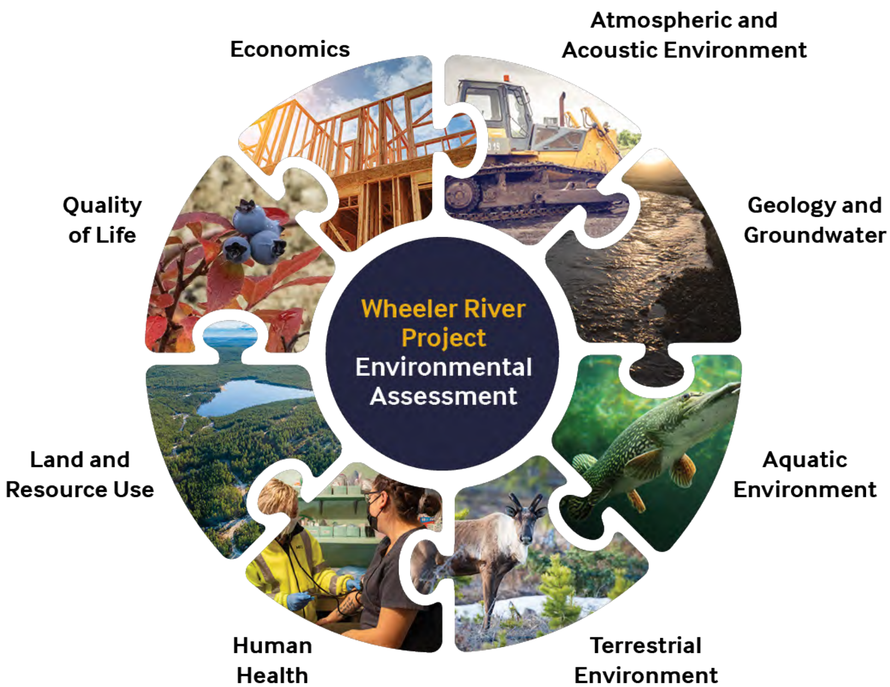

Figure 6-1: Biophysical and Human Environment Assessments for the Wheeler River Project Environmental Assessment

Figure 6-2: Atmospheric and Acoustic Environment - Valued Components

6.1 Air Quality

This section of the EIS addresses the potential for the Project to affect existing air quality in the vicinity of the Project Area. The Project will introduce new emissions sources to the area, which in turn will change the ambient air environment. Changes to the ambient air environment may affect Indigenous groups and the public. Existing air quality conditions in the Project Area have been established through field studies and a literature review, and predictions have been completed as part of this assessment using dispersion modelling to evaluate how the anticipated Project activities may change existing air quality conditions, and what the effect of these changes may be on people and the biophysical environment, such as soil and vegetation quality.

Air emission sources associated with the Project include unpaved road surfaces, site clearing and construction activities, fuel combustion (e.g., power generators, diesel-powered mobile equipment), wellfield and freeze hole drilling, operation of the in situ recovery (ISR) wellfield, operation of the ISR processing plant, and storage and disposal of drill waste rock and process precipitates. Potential effects related to air quality were identified using thresholds set by federal and provincial authorities pertaining to predicted concentrations in air of the identified constituents of potential concern (COPC). For instance, at the federal level, the Canadian Council of Ministers of the Environment (CCME) has developed the Canadian Ambient Air Quality Standards

(CAAQS), which have been adopted by Environment and Climate Change Canada (ECCC). Similarly, at the provincial level, the Government of Saskatchewan has developed a series of Saskatchewan Ambient Air Quality Standards (SAAQS) for application on industrial sites operating in the province.

This section of the EIS addresses potential Project-related effects on the Air Quality VC and is comprised of the following information:

- scope of the assessment;
- summary of existing conditions;
- identification and description of potential interactions between the Project and the Air Quality VC;
- identification and description of mitigation measures and monitoring activities to eliminate reduce, or control the potential adverse Project-related effects on the Air Quality VC;
- characterization of potential Project-related residual effects (i.e., after mitigation), including determination of significance and level of confidence in the predictions; and
- identification and characterization of cumulative effects.

Figure 6.1-1 is a graphic representation of the assessment process used in this EIS.

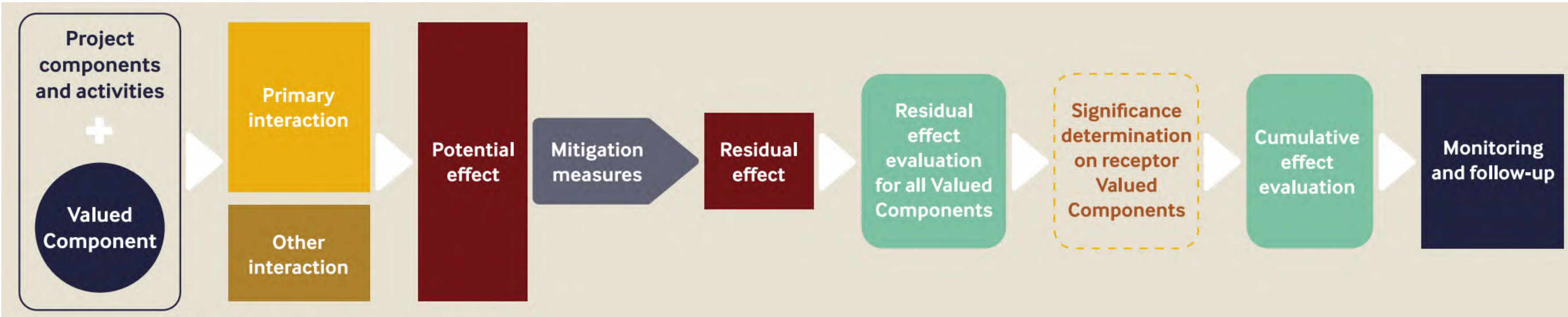

Figure 6.1-1: Environmental Assessment Process for the Wheeler River Project

6.1.1 Scope of the Assessment

6.1.1.1 Valued Component Selection

The process and rationale for the selection of VCs and establishment of Key Indicators (KIs) and associated measurable parameters (MPs) is described in Section 5 Approach and Methodology of the Assessment. Air Quality was selected as a VC based on the likelihood of Project-related activities to interact with and change the ambient air environment. Since changes to Air Quality could in turn lead to effects on other VCs selected for assessment Air Quality was identified as an intermediate VC (i.e., does not have an assessment endpoint). The significance of potential effects of Project-related changes to ambient air quality on the terrestrial environment, human health, and land use are discussed in Section 9 Terrestrial Environment, Section 10 Human Health, and Section 11 Land and Resource Use, respectively. Figure 6.1-2 is a graphic representation of the main linkages among the Air Quality VC and other VCs, illustrating the flow of assessment information from the Air Quality VC.

As stated in REGDOC-2.9.1 (CNSC 2016), Project-related emissions of radionuclide and non-radionuclide COPC to air pose a potential risk to human health and non-human biota receptors, and potential effects on ambient air quality should be assessed in the context of an EA. Indicators of effects on ambient air quality include air quality standards or criteria established by the CCME (CCME 2022) and the Government of Saskatchewan (Government of Saskatchewan 2014). The KIs and MPs derived to assist in the assessment of Air Quality are discussed in Section 6.1.1.2.

Due to the association of air quality with potential human health considerations, and the possibility of effects on the aquatic and terrestrial environments, Air Quality has been included as a VC in other EAs of similar scope that have been completed in the area. For example, the assessment of potential air quality effects associated with the Cameco Millennium Project are discussed in Annex L of the EIS document (Cameco 2013).

The Saskatchewan Ministry of Environment (SK MOE) has developed the *Saskatchewan Air Quality Modelling Guideline* (SK MOE 2012a) to assist proponents in conducting air dispersion modelling assessments in a consistent manner. The guideline defines the recommended approach for dispersion modelling assessments in Saskatchewan, including model selection, emission source characterization, and the determination of compliance criteria to apply. To assist in the quantification of emissions for this EIS, published emission factors and industry guidance documents were followed.

In addition to the regulatory requirement to include Air Quality as a VC in an EA, concerns relating to air quality were raised during engagement and consultation activities completed by Denison Mines Corp. (Denison). The concerns included the effects of the Project on Air Quality (19-EN-ERFN-140.27) and how the Project may affect the health of humans and wildlife (21-EN-ERFNSUR-456.21 and 21-EN-ERFNSUR-456.22). Significance determination is not completed on intermediate VCs, but integrated into the residual effect evaluation, residual effect characterization, and significance determination for related receptor VCs. As such, the discussion of Air Quality effects specific to the aquatic environment, terrestrial environment, and human health due to changes in Air Quality is part of the assessments included in Section 8, Section 9, and Section 10, respectively.

Figure 6.1-2: Integrated Assessment Approach - Key Connections between Air Quality and Other Valued Components

6.1.1.2 Key Indicators and Measurable Parameters

The KIs and associated MPs for the Air Quality VC are summarized in Table 6.1-1. The MPs are discussed further following the summary table.

Table 6.1-1: Key Indicators and Measurable Parameters for Air Quality

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Levels of dust, combustion products, uranium, metals, and/or radon.	• Project activities will introduce new sources of air emissions to the area. • The existing air quality environment is characterized by low ambient levels of dustfall, NO_2, SO_2, and radon, and therefore susceptible to the introduction of new industrial air sources. • Air quality may be reduced, resulting in effects on the terrestrial environment and human health. • Air quality has been historically addressed for other mining projects in northern Saskatchewan.	Change in concentrations and deposition rates of total suspended particulate (TSP), inhalable particulate matter (PM_{10}), respirable particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), uranium, metals, acrolein and radon compared to the most appropriate air quality criteria.

The COPC identified for the Air Quality VC include total suspended particulate matter (TSP), inhalable particulate matter (PM_{10}), respirable (fine) particulate matter ($PM_{2.5}$), carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), uranium, arsenic, cadmium, chromium, cobalt, copper, lead, molybdenum, nickel, selenium, vanadium, zinc, and radon gas. Acrolein emissions from diesel combustion were also evaluated using a quantitative screening analysis (detailed in Appendix 6-A) but were determined to be negligible and not considered a COPC. Emissions to air for each COPC were estimated and predictive modelling was used to estimate changes in COPC concentrations and deposition rates.

The primary source of emission factors that was used in the calculation of non-radiological COPC releases was the US EPA AP-42 database (US EPA 1995). Unpaved surfaces such as site roads are anticipated to be the main source of dust emissions from the Project, with a minor contribution from process emissions during Operation. Fuel combustion from mobile and stationary equipment is expected to be the main source of combustion gases from the Project, including CO, SO_2, and NO_2. The main sources of uranium and radon are related Operation and include the ISR processing plant and operation of the ISR wellfield, respectively. Emissions of radiological COPC were estimated using guidance from the United States Nuclear Regulatory Commission (US NRC 2003) and available engineering data for the Project. A detailed discussion of the methods applied to derive the emission rates for use in this assessment are provided in Appendix 6-A.

Except for radon, model predictions of COPC concentrations and depositions were added to background levels and compared to ambient air quality standards and criteria where available. The standards and criteria applied in this assessment are discussed in the following sections. Where federal and provincial criteria differed, the most stringent standards and criteria were adopted for the assessment of Project-related effects. The discussion of background levels is provided in Section 6.1.3.

6.1.1.2.1 Federal Assessment Criteria

The Project will be expected to demonstrate compliance with the CCME CAAQS (CCME 2022), which include the COPC of $PM_{2.5}$, SO_2, and NO_2. The CAAQS are presented in terms of the averaging period they are applicable to, and the values decrease in future years to reflect emission reduction targets. The CAAQS are presented in Table 6.1-2.

Table 6.1-2: Canadian Ambient Air Quality Standards

Constituents of Potential Concern	Averaging Time	Numerical Value		
		2015	2020	2025
Fine particulate matter ($PM_{2.5}$)	24-hour [1]	28 µg/m^3	27 µg/m^3	-
	Annual [2]	10 µg/m^3	8.8 µg/m^3	-
Sulphur dioxide (SO_2)	1-hour [3]	-	183.4 µg/m^3 (70 ppb)	170.3 µg/m^3 (65 ppb)
	Annual [4]	-	13.1 µg/m^3 (5 ppb)	10.5 µg/m^3 (4 ppb)
Nitrogen dioxide (NO_2)	1-hour [5]	-	112.8 µg/m^3 (60 ppb)	79 µg/m^3 (42 ppb)
	Annual [4]	-	32.0 µg/m^3 (17 ppb)	22.6 µg/m^3 (12 ppb)

Notes:

[1] 3-year average of the annual 98th percentile of the daily 24-hour average concentrations.

[2] 3-year average of the annual average of the daily 24-hour concentrations.

[3] 3-year average of the annual 99th percentile of the daily maximum 1-hour average concentrations.

[4] The average over a single year of all 1-hour average concentrations.

[5] 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentrations.

6.1.1.2.2 Provincial Assessment Criteria

On June 1, 2015, the Government of Saskatchewan enacted the *Saskatchewan Environmental Code* (the Code; Government of Saskatchewan 2014) under *The Environmental Management and Protection Act, 2010* (Government of Saskatchewan 2018). The Industrial Source (Air Quality) Chapter of the Code provided updated provincial ambient air quality standards for TSP, NO_2, SO_2, and CO, and added standards for PM_{10}, and $PM_{2.5}$. The SAAQS applied in this assessment are presented in Table 6.1-3.

Table 6.1-3: Saskatchewan Ambient Air Quality Standards

Constituents of Potential Concern	Average Concentration for Applicable Time Period (µg/m³)			
	1-hour	8-hour	24-hour	Annual
Particulate matter ($PM_{2.5}$)	-		28[1]	10
Particulate matter (PM_{10})	-	-	50	-
Total suspended particulates (TSP)	-	-	100	60[2]
Nitrogen dioxide (NO_2)	300 (159 ppb)	-	200 (106 ppb)	45[3] (24 ppb)
Sulphur dioxide (SO_2)	450 (172 ppb)	-	125 (48 ppb)	20[3] (8 ppb)
Carbon monoxide (CO)	15,000 (13,000 ppb)	6,000 (5,000 ppb)	-	-

Notes:

1 3-year average of the annual 98th percentile of the daily 24-hour average concentrations.

2 Geometric means.

3 Arithmetic means.

While there are no SAAQS for dust deposition (i.e., dustfall), the *Air Monitoring Guideline for Saskatchewan* (SK MOE 2012b) provides a guideline level of 2 mg/cm^2/30-days, which was applied in the assessment.

6.1.1.2.3 Other Guidelines and Standards

Saskatchewan does not currently have published air quality standards or criteria that apply to uranium or other metals. As a result, criteria for these COPC were adopted from the Ontario ambient air quality criteria (AAQC) list, which is maintained by the Ontario Ministry of Environment, Conservation and Parks (Ontario MECP 2020). Notably, the Ontario AAQC for metals are based on a variety of time-averaging periods (e.g., 24-hour, annual). These AAQC are summarized with the applicable averaging periods in Table 6.1-4.

Table 6.1-4: Ontario Ambient Air Quality Criteria for Metals

Constituents of Potential Concern	Ontario Ambient Air Quality Criteria (µg/m³)		
	24-hour	30-day	Annual
Arsenic (As)	0.3	-	-
Cadmium (Cd)	0.025	-	0.005
Chromium (Cr) [1]	0.5	-	-
Cobalt (Co)	0.1	-	-
Copper (Cu)	50	-	-
Lead (Pb)	0.5	0.2	-
Molybdenum (Mo)	120	-	-
Nickel (Ni) as PM_{10} [2]	0.1	-	0.02
Nickel (Ni) as SPM [3]	0.2	-	0.04
Selenium (Se)	10	-	-
Uranium (U) in PM_{10} [2]	0.15	-	0.03
Uranium (U) in SPM [3]	0.3	-	0.06
Vanadium (Vn)	2	-	-
Zinc (Zn)	120	-	-

Notes:

1 Ambient air quality criteria is for metallic, divalent, and trivalent forms of chromium compounds.

2 PM_{10} = inhalable particulate matter.

3 SPM = suspended particulate matter, an equivalent term to total suspended particulates (TSP).

Historically, the Radiation Protection Regulations (CNSC 2000) from the Canadian Nuclear Safety Commission (CNSC) recommended a guideline value of 60 Bq/m^3 for incremental average annual radon concentrations. This guideline was derived from an action level of 600 Bq/m^3 corresponding to a dose of 10 mSv per year inside of a dwelling (ICRP 1993). This value was divided by 10 to arrive at a concentration of 60 Bq/m^3 corresponding to an annual effective dose of 1 mSv per year for a member of the public. In 2009, the International Commission on Radiological Protection revised its Statement on Radon (ICRP 2009) and changed the action level from 600 Bq/m^3 to 300 Bq/m^3. Using the same logic, a radon guideline of 30 Bq/m^3 was derived, which is within the range of background radon concentrations reported by the CNSC (CNSC 2018) in northern Saskatchewan (<7.4 to 25 Bq/m^3) and does not allow for additional exposure pathways. As a result, background radon concentrations were used instead of 60 Bq/m^3 as an indicator of the magnitude of predicted radon concentrations from the Project.

6.1.1.2.4 *Summary of Assessment Criteria*

A summary of the criteria applied in the Air Quality assessment is provided in Table 6.1-5. While many of the COPC criteria in Table 6.1-5 are health-based, they are intended to evaluate the potential effects of the Project on Air Quality and are not necessarily intended to assess potential risks to the aquatic environment, terrestrial environment, or human health. Instead, predicted COPC concentrations and deposition rates derived from the air dispersion model were used by the assessors in Sections 8, 9, and 10 to determine the potential effects of air COPC on the aquatic, terrestrial, and human environments, considering all pathways of exposure. Furthermore, refined dose estimates were completed by the assessors of human health and worker health using predictions of radon from the air dispersion model (see Section 10).

For simplicity and to facilitate a conservative assessment, a single criterion and time-averaging period were selected for each COPC based on the most stringent criteria or standard presented in the preceding sections. As per the *Saskatchewan Air Quality Modelling Guideline* (SK MOE 2012a), the Project criteria applied to the maximum predicted value for each time-averaging period at receptors located outside of the Property Boundary, after allowing for the removal of meteorological anomalies[1].

It should be noted that the Ontario criteria for uranium in PM_{10} were conservatively selected as the Project criteria. At this time, the particle size information for the main source of uranium emissions (the ISR plant stacks) is not known; however, the literature suggests that the particle size distribution for yellowcake is 80% less than PM_{10} (US EPA 1980).

Emissions of nitrogen oxides (NO_x) from combustion sources are comprised of nitric oxide (NO) and small amounts of NO_2. Over time, NO is converted to NO_2 through a series of chemical reactions in the atmosphere. Since the CAAQS and SAAQS are based on NO_2, a conversion must be applied to the NO_x predictions to estimate the NO_2 content. For this assessment, the Ambient Ratio Method (ARM), as described in the *Saskatchewan Air Quality Modelling Guideline* (SK MOE 2012a), was applied. The ARM assumes a default NO_2/NO_x conversion ratio of 70%. The SK MOE considers this method to be conservative for the estimation of NO_2 emissions.

[1] As per the *Saskatchewan Air Quality Modelling Guideline* (SK MOE 2012a), predicted concentrations at ground level can be high due to extreme, rare, and transient meteorological conditions. Thus, the eight highest 1-hour predictions and the single highest 24-hour prediction at each receptor can be discarded according to this method.

Table 6.1-5: Criteria for the Assessment of Potential Air Quality Effects

Constituents of Potential Concern	Averaging Period	Criteria	Units	Jurisdiction
Total suspended particulates (TSP)	24-hour	100	µg/m³	Saskatchewan
	Annual	60	µg/m³	Saskatchewan
Particulate matter (PM_{10})	24-hour	50	µg/m³	Saskatchewan
Particulate matter ($PM_{2.5}$)	24-hour	27	µg/m³	Federal
	Annual	8.8	µg/m³	Federal
Dustfall	30-day	2	mg/cm²/30-days	Saskatchewan
Carbon monoxide (CO)	1-hour	15,000	µg/m³	Saskatchewan
	8-hour	6,000	µg/m³	Saskatchewan
Sulphur dioxide (SO_2)	1-hour	170	µg/m³	Federal
	24-hour	125	µg/m³	Saskatchewan
	Annual	10	µg/m³	Federal
Nitrogen dioxide (NO_2)	1-hour	79	µg/m³	Federal
	24-hour	200	µg/m³	Saskatchewan
	Annual	23	µg/m³	Federal
Arsenic (As)	24-hour	0.3	µg/m³	Ontario
Cadmium (Cd)	24-hour	0.025	µg/m³	Ontario
	Annual	0.005	µg/m³	Ontario
Cobalt (Co)	24-hour	0.1	µg/m³	Ontario
Chromium (Cr)	24-hour	0.5	µg/m³	Ontario
Copper (Cu)	24-hour	50	µg/m³	Ontario
Molybdenum (Mo)	24-hour	120	µg/m³	Ontario
Nickel (Ni)	24-hour	0.2	µg/m³	Ontario
	Annual	0.04	µg/m³	Ontario
Lead (Pb)	24-hour	0.5	µg/m³	Ontario
	30-day	0.2	µg/m³	Ontario
Selenium (Se)	24-hour	10	µg/m³	Ontario
Uranium (in PM_{10})	24-hour	0.15	µg/m³	Ontario
	Annual	0.03	µg/m³	Ontario
Vanadium (Vn)	24-hour	2	µg/m³	Ontario

6.1.1.3 Spatial and Temporal Boundaries

The areas used to assess the effects of the Project on the Air Quality VC are shown on Figure 6.1-3 and in the following bullets:

- **Project Area**: the area within which the Project and all components/activities will be located (i.e., the area of maximum physical disturbance).
- **Air Quality Property Boundary (Property Boundary)**: the area within which there will be limited to no public access, and the air quality effects criteria will apply in accordance with the *Saskatchewan Air Quality Modelling Guideline* (SK MOE 2012a).
- **Air Quality Local Study Area (LSA)**: the area surrounding the Project Area where direct and indirect Project-related effects will be reasonably measured. The Air Quality LSA was generally established to assess the potential, largely direct effects of the Project on Air Quality, and represents the extent within which there is a reasonable potential for the Project to interact with and potentially adversely effect the Air Quality VC.

  The LSA for the Air Quality VC was delineated in consideration of the locations of sensitive land uses of interest for the assessors of other VCs (e.g., Human Health), and professional experience regarding potential air quality effects from mining operations. The Air Quality LSA includes lands within 10 km of the Project Area.
- **Air Quality Regional Study Area (RSA)**: the area surrounding the Air Quality LSA. The Air Quality RSA was established to assess the potential, largely indirect effects of the Project on Air Quality in a regional context. The Air Quality RSA is large enough to capture the extent of potential effects (i.e., zone of influence) on the Air Quality VC and defines the area within which cumulative effects may occur (i.e., cumulative effects assessment boundary). The Air Quality RSA was established 10 km from the Air Quality LSA based on proximity to other nearby projects that may have COPC that overlap with, and thereby interact cumulatively with, the effects of the Project on Air Quality.

Temporal boundaries in the context of the Air Quality assessment have a two-fold meaning. The assessment accounted for (1) time periods when an effect is expected to occur in relation to specific Project phases and activities, and (2) time periods that the prediction of Air Quality effects are applicable to. The latter is largely driven by the MPs identified in Table 6.1-1 and subsequent air quality criteria presented in Table 6.1-5. The time periods over which air dispersion model predictions apply include 1-hour, 24-hour, 30-day, and annual averaging periods. In keeping with these requirements, the Project assessment scenarios for Air Quality were evaluated in two parts:

- a short-term emissions inventory was developed for each scenario to capture the maximum 1-hour and 24-hour operating conditions and production rates for the various Project activities; and

- a long-term or annual emissions inventory was developed for each scenario to reflect the average operating conditions and production rates for the various Project activities.

Air dispersion modelling requires meteorological data as an input, which is also timebound. In accordance with the *Saskatchewan Air Quality Modelling Guideline* (SK MOE 2012a), a minimum of one year of site-specific meteorological data is required for dispersion modelling. For the assessment, a one-year meteorological dataset was created in consultation with SK MOE for the year 2016 and used to run the air dispersion model (detailed information on this process is provided in Appendix 6-A). The maximum predicted air concentrations for each time-averaging period were then extracted from the modelling results and compared to the applicable air quality criteria.

Regarding the overall timeline of the Project and the associated phases and activities, these were established in accordance with the summary provided in Table 5.3-3 in Section 5. This assessment included an evaluation of the Construction, Operation, and Decommissioning phases of the Project. The Post-Decommissioning phase consists generally of environmental monitoring. A detailed discussion of the assessment scenarios and the associated sources and emissions is provided in Appendix 6-A.

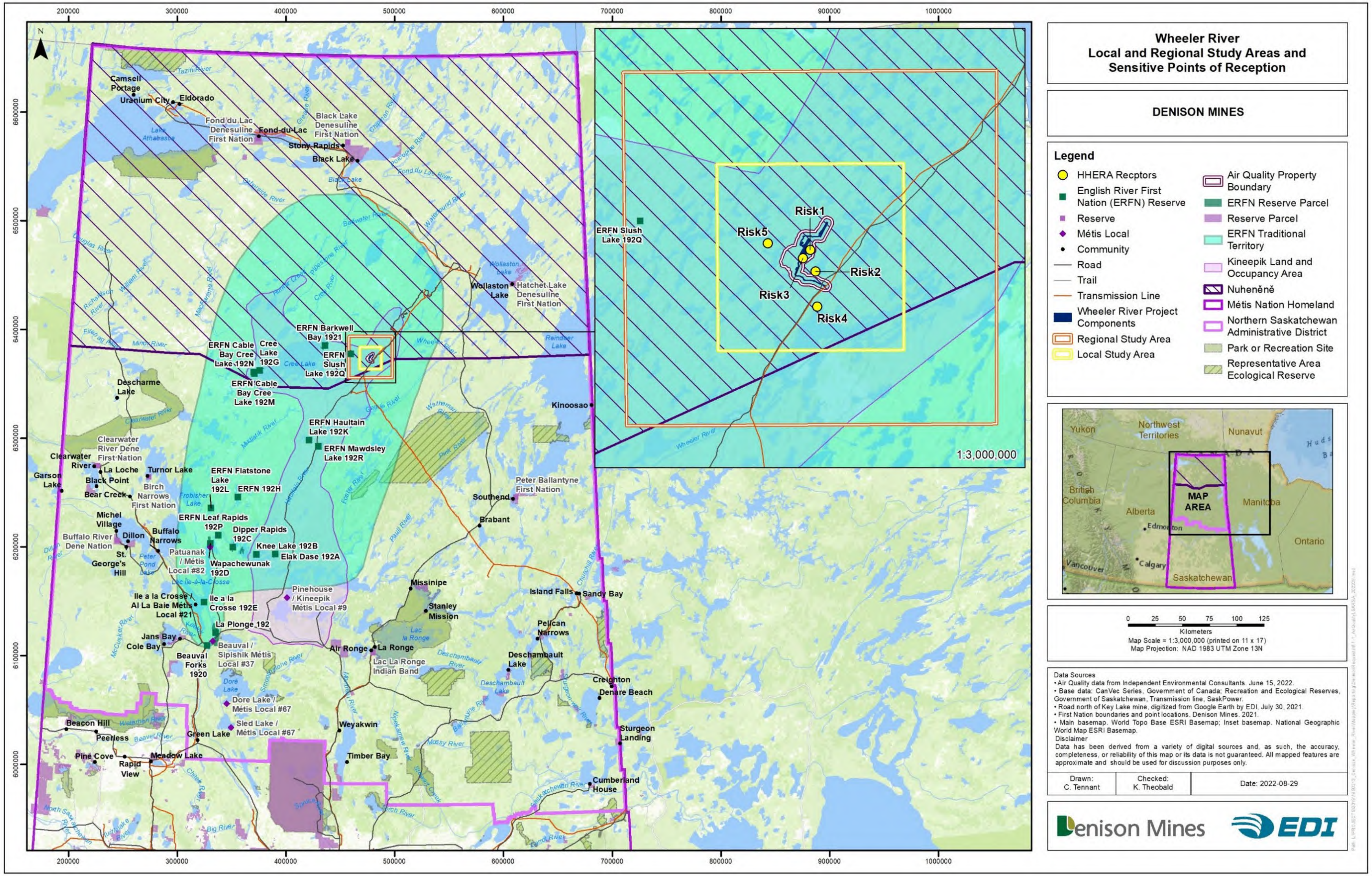

Figure 6.1-3: Local and Regional Study Areas and Sensitive Points of Reception for the Air Quality Valued Component

6.1.2 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

Lands within the study areas are currently being used, or have historically been used, for traditional purposes by the Indigenous communities that lay claim to the traditional territories that include the Project Area. These traditional uses include hunting, fishing, trapping, and harvesting of native plants for food and medicinal purposes. The process for selecting points of reception relating to air quality that represent these locations was primarily informed by local knowledge, as imparted to Denison in the form of traditional land use maps from the English River First Nation and Pinehouse Kineepik Métis, with permission to use this information in the EIS.

Denison has recorded and stored information regarding Indigenous Knowledge, Local Knowledge and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 21 EN-ERFNSUR-456.21). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment. Appendix 6-B provides a summary of unique identification numbers referenced within Section 6.1.

During engagement activities, concern was raised regarding the effects of the Project on the health of humans and wildlife (21-EN-ERFNSUR-456.21 and 21-EN-ERFNSUR-456.22). Specific points of reception for the Human Health and Ecological Risk Assessment (Appendix 10-A in Section 10) and the worker health assessment were included in the predictive modelling. A map depicting the location of sensitive receptor locations used in the model is provided in Figure 6.1-3.

6.1.3 Existing Environment

6.1.3.1 Climate

The Project Area is located within the Athabasca Plain ecoregion of the Boreal Shield ecozone, specifically in the cold and snowy forest zone of northern Saskatchewan. The climate of the Project area is typical of the continental sub-arctic region as characterized by extremely cold, dry winters and brief, cool and moist summers.

The nearest Environment and Climate Change Canada (ECCC) meteorological station to the Project site is located approximately 32 km away at Key Lake. Data from this station were used to characterize the existing climate conditions for the period 2011 to 2020. ECCC also provides 30-year climate normals for Key Lake, with the 1981-2010 dataset being the most recently available. The following sections provide a brief overview of existing climate conditions. Additional details about the existing climate are provided in the Climate Baseline and Greenhouse Gas Emissions Report in Appendix 6-C.

6.1.3.1.1 Temperature

The annual average temperature at Key Lake for the 2011 to 2020 period was -2.6° Celsius (C) and the daily average temperatures were less than or equal to 0°C between October and April. The coldest month on average was January, with a daily mean temperature of -21.1°C, while July was the warmest month with a daily mean temperature of 16.4°C. Temperature data for the 2011 to 2020 period is comparable to 30-year climate normals. The average annual temperature for the 1981 to 2010 period was -2.3°C, with the warmest daily temperatures in July (16.3°C) and the coldest in January (-22.3°C).

6.1.3.1.2 Precipitation

The average annual amount of total precipitation recorded at Key Lake for the period of 2011 to 2020 was 456 mm, which is comparable to the climate normals data, which has an average annual total precipitation value of 483 mm. For the 2011 to 2020 period, the greatest amount precipitation in a 24-hour period was 45.9 mm, which fell as rain on August 8^{th}, 2020. For the climate normals, the maximum 24-hour precipitation event was 72 mm, which fell as rain on July 12^{th}, 1998. The average number of days with measurable precipitation for the 2011 to 2020 period was 132 days, compared to 149 days for the climate normals period.

6.1.3.1.3 Wind

Hourly wind data for Key Lake were analysed for the 2011 to 2020 period to determine the frequencies of wind direction and average wind speed. The results are presented as wind roses in Appendix 6-C. The wind roses show that wind blows predominantly from the west (about 10% of the time), followed by south and east directions. The average wind speed is approximately 3.5 m/s. Wind data are not available for the climate normals period for comparison.

6.1.3.2 Air Quality

In accordance with the *Saskatchewan Air Quality Modelling Guideline* (SK MOE 2012a), modelled concentrations of COPC must be added to ambient background concentrations before being compared to applicable air quality criteria. "Background" is defined by the SK MOE in the guideline as the "*portion of the ambient concentration due to both natural and anthropogenic sources, which are other than the source(s) being evaluated*" (SK MOE 2012a). Baseline air quality measurements completed by Denison and regional data available from the SK MOE and neighbouring uranium mines in northern Saskatchewan were used to characterize baseline air quality for the Project.

As per Table 6.1-1, the only KI associated with the Air Quality VC pertains to levels of dust, combustion products, uranium, metals, and/or radionuclides. Existing air quality in the vicinity of the Project Area was characterized via a baseline monitoring program, which commenced in 2016. Due to the remote nature of the Project site and no access to power for monitoring equipment, baseline air quality was measured using passive approaches. The SK MOE approves of passive monitoring methods at remote sites where access to power is not possible (SK MOE 2012b). The baseline monitoring program included particulate matter (in the form of dustfall), NO_2, SO_2, radon, and external gamma. The baseline monitoring locations are shown in Figure 6.1-4. Additional details on monitoring program design, including detailed equipment descriptions, are provided in the *Baseline Air Quality Monitoring Report* in Appendix 6-D.

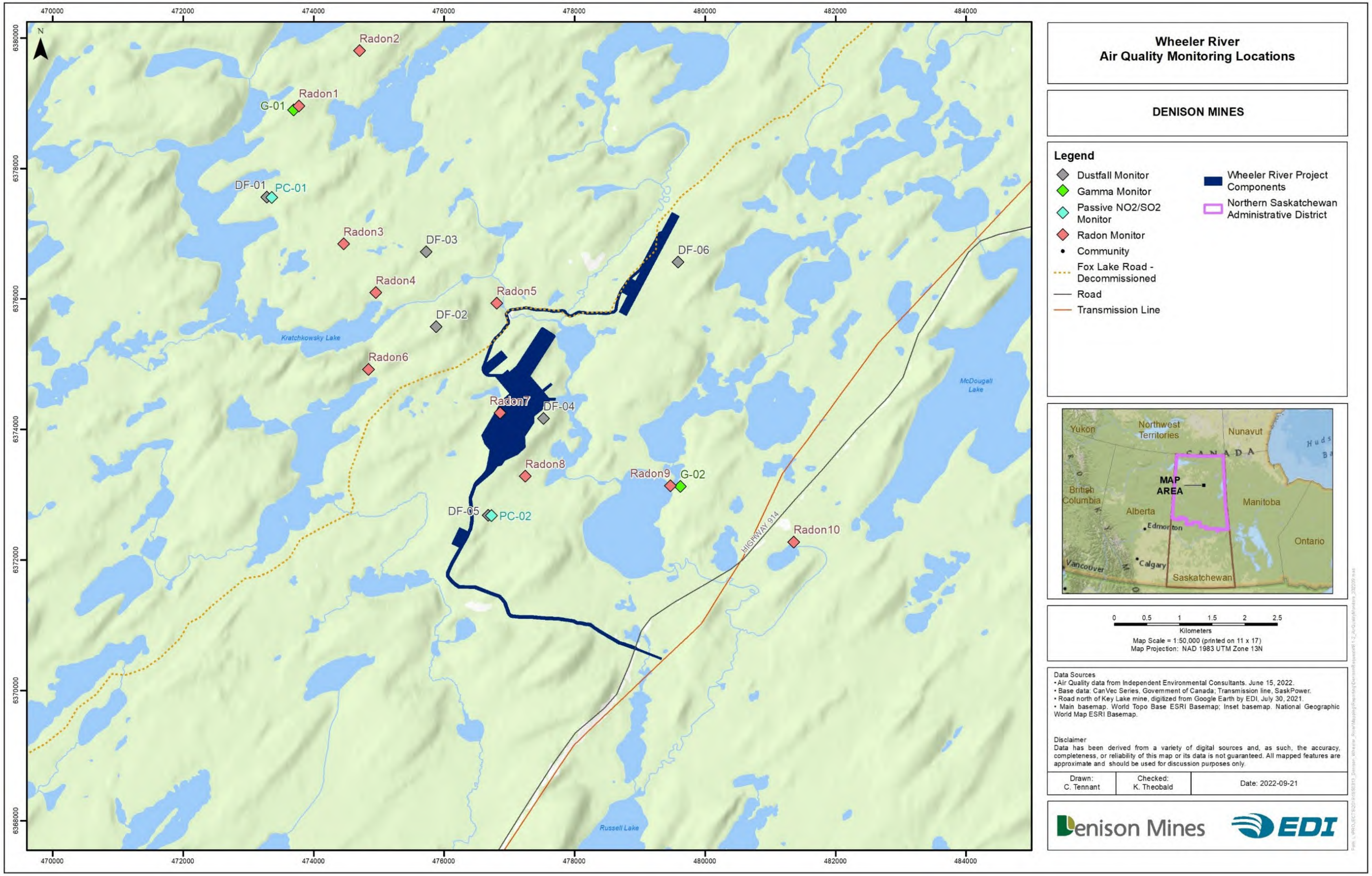

Figure 6.1-4: Air Quality Monitoring Locations

6.1.3.2.1 Particulate Matter

Particulate monitoring was included in the baseline monitoring program as settleable particulates (or dustfall), with measurements completed in accordance with ASTM Standard D1739:1998 (ASTM International 1998) and procedures from the British Columbia Environmental Lab Manual (BC MOE 2015). Dustfall monitoring commenced in 2018 and continued through 2021 for a total of nine campaigns, with samples being collected in duplicate at six locations (Figure 6.1-4).

As would be expected in a natural, undisturbed environment, the average and maximum levels of settleable particulates were well below the guideline of 2 mg/cm²/30-days from Table 6.1-5. The maximum dustfall amount from the various campaigns was 0.91 mg/cm²/30-days, which represents approximately 46% of the SK MOE guideline for settleable particulates. The average detectable dustfall across all locations and campaigns was 0.13 mg/cm³/30-days, or 6.5% of the guideline. A summary of the dustfall results is provided in Table 6.1-6.

Table 6.1-6: Summary of Total Dustfall Monitoring Results

Parameter	Unit	Monitoring Location					
		DF-01	DF-02	DF-03	DF-04	DF-05	DF-06
No. of samples	#	18	18	18	18	18	16
No. less than detection	#	9	7	10	5	6	5
Average detectable	mg/cm²/30-day	0.16	0.17	0.09	0.10	0.18	0.08
Maximum	mg/cm²/30-day	0.56	0.91	0.14	0.26	0.77	0.17
Minimum	mg/cm²/30-day	0.03	0.03	0.03	0.03	0.03	0.03
Average	mg/cm²/30-day	0.10	0.12	0.06	0.08	0.13	0.06

A metals analysis was completed on the dustfall samples collected during the September 2021 and October 2021 campaigns. Most of the metals included in the analysis were not present at detectable levels. The metals that were generally detectable in one or both campaigns included aluminum, barium, calcium, copper, iron, lead, magnesium, manganese, phosphorous, potassium, silicon, sodium, strontium, and uranium. A summary of the detectable metals included as air quality COPC, provided as a percentage by mass of fixed (i.e., insoluble) dustfall, is provided in Table 6.1-7.

Table 6.1-7: Detectable Metals as a Percentage of Fixed Dustfall

Constituents of Potential Concern	Average Composition (%)	Maximum Composition (%)
Arsenic (As)	0.0015	0.0015
Cadmium (Cd)	0.0006	0.0007
Chromium (Cr)	0.0012	0.0015
Cobalt (Co)	0.0057	0.0072
Copper (Cu)	0.0136	0.0359
Lead (Pb)	0.0013	0.0018
Molybdenum (Mo)	0.0058	0.0100
Nickel (Ni)	0.0057	0.0072
Selenium (Se)	0.0115	0.0145
Uranium (U)	0.0004	0.0012
Vanadium (Vn)	0.0115	0.0145
Zinc (Zn)	0.0420	0.0560

6.1.3.2.2 Nitrogen Dioxide and Sulphur Dioxide

Baseline concentrations of NO_2 and SO_2 were measured at two locations using passive samplers (Figure 6.1-4). The air concentrations represent the average concentration for the deployment period (typically around 30 days) and are not directly comparable to the criteria identified in Table 6.1-5. To facilitate a comparison of the measured levels to the criteria, a conservative approach to adjusting the averaging period from Section 9.1.1 of the *Saskatchewan Air Quality Modelling Guideline* (SK MOE 2012a) was applied to the data. It should be noted that the resulting concentrations still represent averages for the denoted period and should not be taken as maximum levels. The results in Table 6.1-8 (PC-01) and Table 6.1-9 (PC-02) show that average baseline levels of NO_2 and SO_2 are low and well below the applicable criteria, as would be expected for the remote location of the Project.

Table 6.1-8: Summary of Baseline Nitrogen Dioxide and Sulphur Dioxide Monitoring Results at PC-01

Parameter	Unit	Nitrogen Dioxide Concentration				Sulphur Dioxide Concentration			
		Period	Annual	24-hour	1-hour	Period	Annual	24-hour	1-hour
Measurement period	days	32	-	-	-	32	-	-	-
No. of samples	#	20	-	-	-	18	-	-	-
No. less than detection	#	18	-	-	-	10	-	-	-
Average detectable	µg/m³	0.28	0.15	0.76	1.8	0.33	0.17	0.88	2.1
Maximum detectable	µg/m³	0.38	0.19	0.99	2.4	0.52	0.27	1.4	3.4
Minimum	µg/m³	0.19	0.09	0.45	1.1	0.26	0.12	0.63	1.5
Weighted average	µg/m³	0.20	0.10	0.52	1.3	0.29	0.15	0.77	1.9

Table 6.1-9: Summary of Baseline Nitrogen Dioxide and Sulphur Dioxide Monitoring Results at PC-02

Parameter	Unit	Nitrogen Dioxide Concentration				Sulphur Dioxide Concentration			
		Period	Annual	24-hour	1-hour	Period	Annual	24-hour	1-hour
Measurement period	days	31.2	-	-	-	31.2	-	-	-
No. of samples	#	20	-	-	-	18	-	-	-
No. less than detection	#	18	-	-	-	17	-	-	-
Average detectable	µg/m³	0.28	0.13	0.67	1.6	0.52	0.27	1.4	3.5
Maximum detectable	µg/m³	0.38	0.17	0.90	2.2	0.79	0.39	2.1	5.0
Minimum	µg/m³	0.19	0.09	0.45	1.1	0.26	0.12	0.63	1.5
Weighted average	µg/m³	0.20	0.10	0.51	1.3	0.30	0.15	0.79	1.9

6.1.3.2.3 Radon

Monitoring of baseline radon levels, using alpha-track etch monitors, has been occurring at ten locations around the Project Area since 2016 (Figure 6.1-4). A statistical summary of the data collected at each location is provided in Table 6.1-10.

The maximum radon levels at the monitoring locations ranged from 9 Bq/m^3 at Radon 10 to 23 Bq/m^3 at Radon 6 and 7. Radon 6 and 7 are located towards the west side of the Project Area, between the Phoenix and Gryphon deposits, while Radon 10 is located furthest to the southeast of the Project Area, next to Highway 914. The *Regulatory Oversight Report for Uranium Mines and Mills in Canada* (CNSC 2018) states that the regional baseline in northern Saskatchewan is less than 7.4 Bq/m^3 to 25 Bq/m^3. All results from the baseline monitoring program are within this range.

Table 6.1-10: Summary of Baseline Radon Monitoring

Location	Number of Samples	Number Less Than Detection	Average Detectable (Bq/m^3)	Maximum Detectable (Bq/m^3)	Minimum (Bq/m^3)	Weighted Average (Bq/m^3)	Detectable Range (Bq/m^3)
Radon 1	26	17	4.8 ± 3.3	9 ± 3	< 3	5.0	0 to 13
Radon 2	26	17	4.7 ± 3.0	8 ± 3	< 3	4.8	0 to 11
Radon 3	32	17	4.6 ± 2.8	9 ± 3	< 2	4.6	0 to 12
Radon 4	31	17	3.9 ± 2.9	10 ± 3	< 3	4.4	0 to 13
Radon 5	30	13	5.1 ± 2.8	12 ± 4	< 3	5.2	0 to 15
Radon 6	32	18	5.9 ± 3.1	19 ± 4	< 3	5.1	0 to 23
Radon 7	32	18	6.2 ±3.1	19 ± 4	< 3	5.7	0 to 23
Radon 8	32	21	4.0 ± 3.2	5 ± 5	< 3	4.3	0 to 10
Radon 9	31	22	5.0 ± 3.1	9 ± 4	< 3	4.5	0 to 13
Radon 10	30	16	3.8 ± 2.8	6 ± 3	< 3	3.9	0 to 9

6.1.3.2.4 External Gamma

Long-term baseline gamma doses were assessed at two locations using Landauer InLight® optically stimulated luminescence dosimeters (Figure 6.1-4). Due to the nature of the dosimeters, sample collection involved several transit and deploy controls to calculate the final net gamma exposure results from the gross dose of the dosimeters deployed in the field. The adjustment from a gross dose to a net dose resulted in negative values in some instances. This indicates that the baseline gamma at the Project site is very low. The results of the baseline gamma monitoring are provided in Table 6.1-11.

Table 6.1-11: Summary of Baseline External Gamma Monitoring

Location ID	Start Date (YYYY-MM-DD)	End Date (YYYY-MM-DD)	Exposure Days	Exposure (mSv)	
				Gross	Net
G-01	2019-09-25	2019-11-14	50	0.252	0.008
	2020-07-25	2020-11-03	101	Destroyed in field by wildlife	
	2021-03-11	2021-06-08	89	0.469	-0.139
	2021-06-08	2021-09-21	105	0.31	-0.129
G-02	2019-09-26	2019-11-14	49	0.22	-0.024
	2020-07-24	2020-11-03	102	0.218	-0.098
	2021-02-17	2021-06-08	111	0.289	-0.06
	2021-06-08	2021-09-22	106	0.242	-0.197

6.1.3.2.5 Saskatchewan Ministry of Environment Regional Air Quality Data

The SK MOE has collected data from a series of monitoring stations that can be used to represent regional background air quality (SK MOE 2012a). Table 6.1-12 presents the available 1-hour, 24-hour, and annual regional background concentrations of PM_{10}, $PM_{2.5}$, CO, NO_2, and SO_2 for the northern air dispersion modelling zone. The SK MOE provides 99th and 90th percentiles of measured 1-hour or 24-hour concentrations; however, for refined assessments such as this one, the 90th percentile values should be considered. For COPC with annual standards, the 50th percentile should be used. Note that the SK MOE reports that the background concentrations of SO_2 are zero for all averaging periods.

No SK MOE regional background concentrations exist for TSP or annual PM_{10}. However, according to Brook et al. (1997), PM_{10} is on average close to 50% of TSP and $PM_{2.5}$ is approximately 50% of PM_{10}. Therefore, annual background concentrations for TSP and PM_{10} can be estimated by multiplying the SK MOE regional background concentration for annual $PM_{2.5}$ by four and two, respectively. Similarly, a background concentration for 24-hour TSP can be estimated by multiplying the SK MOE regional background concentration for 24-hour PM_{10} by two.

Table 6.1-12: Saskatchewan Ministry of Environment Regional Background Concentrations

Constituents of Potential Concern	Saskatchewan Ministry of Environment Regional Background (µg/m³)[1] (Northern Zone)			
	1-hour	8-hour	24-hour	Annual
Total suspended particulates (TSP)	-	-	46.2[2]	12.4[3]
Particulate matter (PM_{10})	-	-	23.1	6.2[3]
Particulate matter ($PM_{2.5}$)	-	-	6.5	3.1
Nitrogen dioxide (NO_2)	11.3	-	9.4	3.8
Sulphur dioxide (SO_2 [4])	0.0	-	0.0	0.0
Carbon monoxide (CO)	575	575	-	-

Notes:

1 From Table B-1 of the *Saskatchewan Air Quality Modelling Guideline* (SK MOE 2012a).

2 Calculated assuming 24-hour TSP = 2 x PM_{10}, as suggested by Brook et al. (1997).

3 Calculated assuming annual PM_{10} = 2 x $PM_{2.5}$ and TSP = 4 x $PM_{2.5}$, as suggested by Brook et al. (1997).

4 90th percentile regional background concentrations for SO_2 are reported as zero in the *Saskatchewan Air Quality Modelling Guideline* (SK MOE 2012a).

6.1.3.2.6 Reference Data from Other Operations

Cameco Corporation's Key Lake operation is located approximately 35 km south of the Project and monitors uranium, arsenic, and nickel using High Volume air samplers (Hi-Vols). Twenty-four-hour TSP samples are collected at five Hi-Vol stations located around the site on a one-in-six-day cycle, and a quarterly composite is used to analyze uranium, arsenic, and nickel (Cameco 2018). Since the camp Hi-Vol is approximately located upwind of the main operation, it was considered as a reference station for the purposes of characterizing baseline air quality. Data for the camp Hi-Vol are presented in Table 6.1-13.

Table 6.1-13: Key Lake Uranium, Arsenic, and Nickel Measurements at the Camp High Volume Air Samplers, 2009 to 2018

Constituents of Potential Concern	24-Hour Concentration (µg/m³)										
	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	Avg.
Uranium (U)	0.0005	0.0004	0.0005	0.0007	0.0002	0.0005	0.0006	0.0008	0.0006	0.0010	0.0006
Arsenic (As)	0.0005	0.0002	0.0005	0.0011	0.0012	0.0005	0.0005	0.0003	0.0011	0.0007	0.0007
Nickel (Ni)	0.0002	0.0003	0.0004	0.0005	0.0004	0.0003	0.0003	0.0005	0.0004	0.0002	0.0004

Prior to construction of the Cigar Lake Operation, the Cigar Lake Mining Corporation (CLMC) measured ambient concentrations of TSP and metals using Hi-Vols from 1989 to 2003 (Cameco 2004). Total suspended particulates were measured on a one-in-six-day cycle, and select metals (i.e., arsenic, nickel, lead, zine, copper, and selenium) and uranium were measured quarterly. The geometric means of this data set are presented in Table 6.1-14. The historic geometric mean for TSP was 8.8 µg/m³, which is lower than the regional background concentration of 12.4 µg/m³ estimated using SK MOE data. This suggests that the SK MOE regional background concentrations of particulate matter may be an overestimate of actual background concentrations. This is likely caused by the fact that the SK MOE regional background value is based on the La Loche monitoring station, which is located near anthropogenic sources, while the Project is in a remote area removed from anthropogenic sources.

Table 6.1-14: Baseline Air Quality Data for the 2004 Cigar Lake Environmental Assessment Study Report

Constituents of Potential Concern	Annual Geometric Mean[1] (µg/m³)	Constituents of Potential Concern	Annual Geometric Mean[1] (µg/m³)
Total suspended particulates (TSP)	8.8	Molybdenum (Mo)	nd[2]
Arsenic (As)	0.0005	Nickel (Ni)	0.0014
Cadmium (Cd)	nd	Selenium (Se)	0.000154
Cobalt (Co)	nd	Uranium (U)	0.0003
Chromium (Cr)	nd	Vanadium (Vn)	nd
Copper (Cu)	0.063	Zinc (Zn)	0.216
Lead (Pb)	0.0031	-	-

Notes:

1 Geometric means, as reported in Appendix A, Table A4.1 of 2004 Environmental Assessment Study Report (Cameco 2004).

2 nd = no data.

6.1.3.2.7 Adopted Background Concentrations

The background air quality data discussed in the previous sections were used to develop reasonable and conservative background concentrations for TSP, PM_{10}, $PM_{2.5}$, dustfall, CO, NO_2, SO_2, uranium, and metals, which are presented in Table 6.1-15.

The Saskatchewan Air Quality Modelling Guideline (SK MOE 2012a) requires that background concentration data be added to air model predictions using an accepted set of data. Following the SK MOE requirements, the regional SK MOE data presented in Table 6.1-12 were conservatively used to represent background concentrations of TSP, PM_{10}, $PM_{2.5}$, CO, SO_2, and NO_2. In the absence of SK MOE data, Key Lake data were selected to represent background concentrations of uranium, arsenic, and nickel. For copper, lead, selenium, and zinc, the Cigar Lake data in Table 6.1-14 were used.

For the remaining metals (i.e., cadmium, cobalt, chromium, molybdenum, and vanadium), the average compositions from recent dustfall data (Table 6.1-7) were conservatively applied to the background concentrations of TSP. For example, the 24-hour background concentration of cadmium is 0.0006% x 46.2 µg/m³, or 0.00028 µg/m³. Since the data set for dustfall was limited to two samples, Key Lake and Cigar Lake data were favoured over dustfall data.

For dustfall, the lowest arithmetic average of measured concentrations across all monitoring stations was used to represent background levels; therefore, the adopted background dustfall level is 0.06 mg/cm²/30-day.

As described in Section 6.1.3.2.5, the SK MOE regional data is considered conservative. While this data set has been adopted for the purposes of modelling and evaluating worst-case COPC concentrations in air, future measurement programs and air quality modelling for the Project will be evaluated using alternative data sets that are more recent and representative of baseline conditions in northern Saskatchewan (i.e., Buffalo Narrows monitoring station).

Table 6.1-15: Summary of Adopted Constituents of Potential Concern Background Concentrations

Constituents of Potential Concern	Period	Background Concentration (µg/m³)	Constituents of Potential Concern	Period	Background Concentration (µg/m³)
Total suspended particulates (TSP)	24-hour	46.2	Chromium (Cr)	24-hour[1]	5.54E-04
	Annual	12.4		Annual	1.49E-04
Particulate matter (PM_{10})	24-hour	23.1	Copper (Cu)	24-hour[1]	3.29E-01
Particulate matter ($PM_{2.5}$)	24-hour	6.5		Annual	6.30E-02
	Annual	3.1	Molybdenum (Mo)	24-hour[1]	2.68E-03
Dustfall	30-day	0.06 mg/cm²/30-day		Annual	7.19E-04
Carbon monoxide (CO)	1-hour	575	Nickel (Ni)	24-hour[1]	2.00E-03
	8-hour	575		Annual	4.00E-04
Sulphur dioxide (SO_2)	1-hour	0.0	Lead (Pb)	24-hour[1]	1.62E-02
	24-hour	0.0		30-day[1]	6.24E-03

Constituents of Potential Concern	Period	Background Concentration (µg/m³)	Constituents of Potential Concern	Period	Background Concentration (µg/m³)
	Annual	0.0		Annual	3.10E-03
Nitrogen dioxide (NO_2)	1-hour	11.3	Selenium (Se)	24-hour[1]	8.03E-04
	24-hour	9.4		Annual	1.54E-04
	Annual	3.8	Uranium (U)	24-hour[1]	3.00E-03
Arsenic (As)	24-hour[1]	3.00E-03		Annual	6.00E-04
	Annual	7.00E-04	Vanadium (Vn)	24-hour[1]	5.31E-03
Cadmium (Cd)	24-hour[1]	2.77E-04		Annual	1.43E-03
	Annual	7.44E-05	Zinc (Zn)	24-hour[1]	1.13
Cobalt (Co)	24-hour[1]	2.63E-03		Annual	0.22
	Annual	7.07E-04			

Notes:

1 Concentrations derived using the conversion methodology based on Section 9.1.1 of the *Saskatchewan Air Quality Modelling Guideline* (SK MOE 2012a)

6.1.4 Assessment of Project-Related Effects

6.1.4.1 Potential Interactions Between the Project and Valued Component / Key Indicators

Potential Project-related interactions with the Air Quality VC and its associated KI are summarized by Project phase in Table 6.1-16. Potential interactions in the summary table are ranked as:

- Primary Interaction (✓): Project activity is expected to interact with the VC/KI, which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- Other Interaction (✓): Project activity is expected to interact with the VC/KI. While the interaction is further considered in the effect assessment, it is not expected to be a primary contributor to potential adverse effects.
- No Interaction: Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and rationale is provided for not considering this potential interaction further.

The potential interactions identified in Table 6.1-16 are addressed further in the subsections following the table.

Table 6.1-16: Potential Project Interactions for Air Quality

Project Phase/Activity	Air Quality Levels of Dust, Combustion Products, Uranium, Metals, and/or Radionuclides
Construction Activities	
Development of access roads and air strip	✓
Site preparation and earthworks; clearing, levelling, and grading of the Project Area	✓
Power generation – generators	✓
Installation of main substation and distribution of power around site	✓
Wellfield and freeze hole drilling; ground freezing	✓
Batch plant operation (concrete); crusher at borrow area	✓
Development of surface infrastructure (camp, operations centre, plants, ponds, pads, and support facilities)	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	✓
Water management (including treatment and site runoff)	
Groundwater supply	
Surface water withdrawal	
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	
On-site and off-site operation of vehicles and transport of materials	✓
Air transportation for workers	✓
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Operation Activities	
Operation of the ISR wellfield	✓
Wellfield and freeze wall drilling	✓
Operation and expansion of freeze wall	
Batch plant operation (grout and cement); crusher in borrow area	✓
Expansion of pond and pads	✓
Operation of the processing plant and production of uranium concentrate	✓
Water withdrawal from groundwater or surface water body	
Management of surface water (including seepage and site runoff)	
Water treatment, both domestic and industrial	
Water release to surface water body	
Waste management (composting, domestic and industrial landfill operation, recycling)	✓
Hazardous waste management (temporary storage, handling, and off-site transportation)	✓
Storage and disposal of drill waste rock, process precipitates, and industrial wastewater treatment plant precipitates	✓
On-site and off-site operation of vehicles and transport of materials	✓

Project Phase/Activity	Air Quality
	Levels of Dust, Combustion Products, Uranium, Metals, and/or Radionuclides
Power supply – primarily power from the grid, also generators and back-up generators	✓
Package and transport of nuclear substances	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	
Air transportation for workers	✓
Progressive decommissioning and reclamation	✓
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Decommissioning Activities	
Site water management, treatment, and release	
Mining horizon remediation and thawing of freeze wall	✓
Process water treatment and release	
Closure of ISR and freeze wells and related infrastructure	✓
Decontamination of surface facilities and injection, recovery, and monitoring wells	✓
Asset removal (including site power transmission lines and electrical infrastructure)	✓
Demolition and disposal of non-salvageable surface infrastructure and materials	✓
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	✓
Generators	✓
Waste management (composting and landfill operation)	✓
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)	✓
On-site and off-site operation of vehicles and transport of materials	✓
Reclamation of disturbed areas	✓
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Post-Decommissioning Activities	
Environmental monitoring	
Regulatory site inspections	
Engagement – site visit from Interested Parties	

The information on activities associated with each phase of the Project shown in Table 6.1-16 was used to develop assessment scenarios for use in predictive modelling. The scenarios were developed based on the year with the maximum activity occurring in each phase. As noted previously, the Air Quality assessment included an evaluation of the Construction, Operation, and

Decommissioning phases of the Project. Post-Decommissioning consists generally of environmental monitoring.

The Construction scenario was based on the first year of construction as this involves the most equipment operating at the site, including construction of surface facilities, wellfield drill mobilizations, drilling of freeze holes and ISR wells, and development of the borrow area and landfills. Construction activities will be supported by a concrete batch plant and crusher, and power to the site during this stage will be provided by two (2) 1.1 MW generator sets and two (2) 450 kW generator sets. In addition, there will be regular truck trips to the site for delivering construction materials and site supplies (e.g., food, fuel).

The conservative Operation scenario was based on activities being completed in the late stages of Operation, with work being completed in Phase 5 of the deposit. Wellfield drilling would continue, and the ISR processing plant was assumed to be operating at maximum capacity. While the site will be powered from the provincial grid at this stage, the power generators were assumed to be operating under emergency conditions as a worst-case scenario, as the Air Quality assessment considers a maximum 1-hour and day (24-hour) of operations. Regular truck traffic will continue for provision of materials and supplies, and shipping of yellowcake will commence.

The Decommissioning scenario was based on remediation activities occurring at contaminated areas, including the ISR wellfield, pads, ponds, and process plant area. Power to the site during this stage will be provided by generator sets, and on- and off-site operation of vehicles and transport of materials will continue.

The specific emissions sources associated with each of the above activities that were included in the assessment of Project-related effects are summarized in Appendix 6-A. The discussion of sources therein also includes detailed information on the derivation of emission rates for use in predictive modelling.

6.1.4.2 Potential Project-Related Effects

The propagation of air emissions from Project activities associated with Construction, Operation, and Decommissioning was predicted using version 7 of the CALMET/CALPUFF modelling package (Exponent 2015). CALPUFF is an advanced three-dimensional (3D) dispersion model that can handle complex terrain and multiple emissions sources from facilities and activities located over large study areas. While the *Saskatchewan Air Quality Modelling Guideline* identifies that the **A**merican Meteorological Society/**E**nvironmental Protection Agency **R**egulatory **Mod**el (AERMOD) should be used for most assessments in Saskatchewan, Section 3.3 of the guideline does allow for the use of more sophisticated models, including CALPUFF, where justified (SK MOE 2012a). In consultation with the SK MOE, CALPUFF was selected for the Air Quality assessment primarily for its ability to model long range transport in the large RSA, along with its wet and dry removal processes and chemical transformation algorithms that are needed to generate inputs for the human health assessment. Consultations with the SK MOE regarding the use and setup of CALMET/CALPUFF began in December 2019 (Fudge 2019), with follow-up correspondences regarding CALMET in March 2020 (IEC 2020) and April/May 2021 (Fudge 2021a, b, IEC 2021). In August 2021, SK MOE staff also completed a review of the CALPUFF model input files (Fudge 2021c).

To overcome the limited meteorological record in the Project study areas, a prognostic meteorological data set was developed. Specifically, data outputs from the Weather Research Forecast Non-Hydrostatic Mesoscale Model were combined with surface observations from Key Lake Airport in CALMET to develop a one-year meteorological data set for the 2016 calendar year. Details of the CALMET modelling are provided in Appendix 6-A.

A scaled 3D representation of the Project and its surroundings were constructed in CALPUFF using digital terrain mapping and information on the planned building layouts and sources. The identified sources were parameterized in the CALPUFF model using either area sources, volume sources, or point sources, the details of which are provided in Appendix 6-A. Similarly, the identified sensitive points of reception were included in the model, as shown in Figure 6.1-3. In addition to the sensitive points of reception, a nested receptor grid was established for the study areas, meeting the minimum requirements of the *Saskatchewan Air Quality Modelling Guideline* (SK MOE 2012a).

Conservative air emission inventories were developed for each Project phase where Project-environment interactions are expected, including Construction, Operation, and Decommissioning (Table 6.1-16). Emission rates for the identified air sources were generally established using published emission factors and engineering calculations. The inputs for the calculations were derived from available information from the prefeasibility study (Denison 2018), other engineering studies, or test work for the Project. Where Project-specific information was not available, values based on recommended defaults or professional judgement were used. Additional details regarding the air emissions inventory and source configuration are provided in Appendix 6-A.

Using the CALMET data set, a CALPUFF model run was executed to determine the COPC concentrations and deposition rates at each receptor location associated with each modelled phase of the Project. Except for radon, the predictions were added to baseline air quality levels and compared to the available standards summarized in Table 6.1-5 at receptors located outside the Property Boundary. The predictions are also evaluated in the aquatic environment, terrestrial environment, and human health assessments in Section 8, Section 9, and Section 10, respectively.

There were no predicted exceedances of the criteria for dustfall, $PM_{2.5}$, CO, SO_2, arsenic, cadmium, chromium, cobalt, copper, lead, molybdenum, nickel, lead, selenium, vanadium, and zinc for any of the modelled Project phases. Similarly, the annual criteria for TSP, NO_2, cadmium, nickel, and uranium, and the 24-hour criteria for NO_2, were not exceeded for any of the modelled Project phases. In all modelled phases of the Project, annual average radon concentrations at receptors beyond the Property Boundary are expected to be indiscernible from background levels.

Concentrations of 24-hour TSP and PM_{10} were predicted to exceed the air quality criteria at receptors located outside of the Property Boundary in all modelled phases of the Project. The highest off-property (i.e., beyond the Property Boundary) concentrations of particulate matter were predicted during Construction at a receptor near Highway 914, with the highest overall concentrations at 313% of the TSP criterion of 100 $\mu g/m^3$ and 232% of the PM_{10} criterion of 50 $\mu g/m^3$.

For all modelled phases of the Project, 1-hour NO_2 concentrations were predicted to exceed the Project criterion of 79 $\mu g/m^3$ at off-property receptors, reflecting worst-case operations of the stand-by diesel generators. The maximum off-property concentrations of 1-hour NO_2 concentrations were similar between the modelled phases, having predictions that were 224% (Construction) and 225% (Operation and Decommissioning) of the criterion.

Twenty-four-hour uranium concentrations were predicted to exceed the criterion of 0.15 $\mu g/m^3$ at off-property receptors during Operation only, reflecting worst-case operations of ISR stacks. The highest 24-hour uranium concentration was predicted to be 148% of the criterion at the maximum off-property receptor.

6.1.4.2.1 Potential Effect 1: 24-hour Total Suspended Particulate Exceedances

Concentrations of 24-hour TSP were predicted to exceed the criterion of 100 $\mu g/m^3$ during Construction, Operation, and Decommissioning, up to a maximum of 313% of the criterion during Construction. An analysis of exceedances showed that 24-hour TSP concentrations exceed the criterion 28% of the time during Construction, 21% of the time during Operation, and 0.5% of the time during Decommissioning at the maximum off-property receptor. The analysis also showed that exceedances do not extend beyond 200 m from the Property Boundary in any of the modelled Project phases. Exceedances are attributable to fugitive dust from general construction activities (e.g., earthworks) and unpaved road dust during Construction and Operation. The 24-hour TSP exceedance plots are presented in Figure 50, 52 and 54 of Appendix 6-A.

6.1.4.2.2 Potential Effect 2: 24-hour Particulate Matter (PM_{10}) Exceedances

Concentrations of 24-hour PM_{10} were predicted to exceed the criterion of 50 $\mu g/m^3$ at off-property receptors during Construction and Operation, up to a maximum of 232% of the criterion during Construction. An analysis of exceedances showed that 24-hour PM_{10} concentrations exceed the criterion 17% of the time during Construction and 12% of the time during Operation at the maximum off-property receptor, which occurs on the Property Boundary. The analysis also showed that exceedances do not extend beyond 300 m from the Property Boundary in any of the modelled Project phases. Exceedances are attributable to fugitive dust from general construction activities (e.g., earthworks) and unpaved road dust during Construction and Operation. The 24-hour PM_{10} exceedance plots are presented in Figure 51 and 53 of Appendix 6-A.

6.1.4.2.3 Potential Effect 3: 1-hour Nitrogen Dioxide Exceedances

Concentrations of 1-hour NO_2 were predicted to exceed the criterion of 79 µg/m³ at off-property receptors during Construction, Operation, and Decommissioning, up to a maximum of 225% of the criterion during Operation and Decommissioning. An analysis of exceedances showed that 1-hour NO_2 concentrations exceed the criterion less than 1% of the time during any of the modelled Project phases at the maximum off-property receptor, which occurs on the Property Boundary. The analysis also showed that exceedances do not extend beyond 1 km from the Property Boundary in any of the modelled Project phases. Exceedances are attributable to the use of diesel generators. The standby diesel generators were included in the Operation and Decommissioning modelling as a worst-case scenario; however, the standard operating condition of the site will be to operate using power from the provincial grid during these Project phases. The 1-hour NO_2 exceedance plots are presented in Figure 55 and 56 of Appendix 6-A.

6.1.4.2.4 Potential Effect 4: 24-hour Uranium Exceedances

Concentrations of 24-hour uranium were predicted to exceed the criterion of 0.15 µg/m³ at off-property receptors during Operation only, up to a maximum of 148% of the criterion. An analysis of exceedances showed that 24-hour uranium concentrations exceed the criterion less than 0.5% of the time at the maximum off-property receptor, which occurs on the Property Boundary. The analysis also showed that exceedances do not extend beyond 400 m from the Property Boundary. Exceedances are attributable to uranium emissions from the ISR plant stacks during Operation. The 24-hour uranium concentration and exceedance plots are presented in Figure 32 and 57 of Appendix 6-A.

6.1.5 Mitigation Measures

Strategies to reduce the likelihood and magnitude of the predicted Project-related effects on the Air Quality VC include emission controls and utilizing planning measures to counter the conditions that contribute to the predicted effects. Some mitigation measures have been incorporated into the Project plans and carried through the Air Quality assessment. These mitigation measures include the following:

- applying water at least twice per day to unpaved roads and surfaces;
- limiting equipment and vehicle speeds along the access road and site roads to <40 km/h;
- equipping the dryer, calciner, and hygiene exhausts with scrubber systems;
- making sure the dryer, calciner, and hygiene exhaust stacks are at least two times the building height to eliminate building downwash effects; and
- collecting and venting radon gas from wellfield operations (including test phases) through a radon surge tank equipped with a vertical stack at least 15 feet (4.5 m) above grade.

The success of these measures was estimated via modelling, and the results are discussed in the following section.

Additional mitigation measures beyond those incorporated in the predictive modelling include:

- creating and implementing an Environmental Management System (EMS) to address air quality monitoring, including the application of water or chemical dust suppressants to control fugitive dust, in addition to other operational strategies to assist in dust control;
- planning vehicle and equipment routes to minimize travel distances, where possible; and
- employing standard operating procedures and completing regular inspections of equipment machinery to make sure it is in good working order.

6.1.6 Residual Effects Evaluation

After application of the proposed mitigation measures in the predictive model, exceedances of the air quality criteria remain at receptors located beyond the Property Boundary. The residual effects are summarized in Table 6.1-17. Characterization of the residual effects are discussed in the Section 6.1.6.1.

Table 6.1-17: Summary of Residual Effects for the Air Quality Valued Component

Constituents of Potential Concern	Averaging Period	Criteria	Construction			Operation			Decommissioning		
			Max. Off-Property Conc.	% Of Criteria	Exceed.	Max. Off-Property Conc.	% Of Criteria	Exceed.	Max. Off-Property Conc.	% Of Criteria	Exceed.
Total suspended particulates (TSP)	24-hour	100 µg/m³	313.3 µg/m³	313%	104 d/y	281.2 µg/m³	281%	80 d/y	114.8 µg/m³	115%	2 d/y
Particulate matter (PM_{10})	24-hour	50 µg/m³	116.2 µg/m³	232%	61 d/y	103.8 µg/m³	208%	42 d/y	n/a	n/a	n/a
Nitrogen dioxide (NO_2)	1-hour	79 µg/m³	176.5 µg/m³	223%	28 h/y	177.7 µg/m³	225%	28 h/y	177.7 µg/m³	225%	25 h/y
Uranium (U)	24-hour	0.15 µg/m³	n/a	n/a	n/a	0.22 µg/m³	148%	3 d/y	n/a	n/a	n/a

Notes:

d/y – days per year; h/y – hours per year; n/a – not applicable; Max. = maximum; Conc. = concentration

6.1.6.1 Residual Effects Characterization

General definitions of the residual effects characteristics are provided in Table 5.8-1 in Section 5. Residual effects characteristics specific to Air Quality are defined in Table 6.1-18.

Table 6.1-18: Air Quality – Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Negative effect or effect is not desirable. **Positive** – Beneficial effect or effect is desirable.
Magnitude	The magnitude of predicted COPC concentrations relative to air quality criteria.	**Low** – Less than 125% of the air quality criteria. **Moderate** – Between 125% and 150% of the air quality criteria. **High** – More than 150% of the air quality criteria.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Air Quality Property Boundary and the Project Area. **Local** – Effect is limited to the Air Quality LSA. **Regional** – Effect extends beyond the Air Quality LSA into the Air Quality RSA. **Beyond Regional** – Effect extends beyond the Air Quality RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs less than 10% of the time. **Sporadic** – Effect occurs between 10% and 50% of the time. **Frequent** – Effect occurs more than 50% of the time. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions. **Partially Reversible** – A residual effect that partially diminishes to baseline conditions. **Irreversible** – A residual effect that will not diminish to baseline conditions.
Context	Since Air Quality is an intermediate VC, the context is best defined in the significance determination of the receptor VCs including various VCs in the Terrestrial Environment, Indigenous Land and Resource Use, and Other Land and Resources Use assessments.	
Likelihood	Likelihood that the residual effect will occur, including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability that the residual effect will occur. **Unlikely** – A low probability that the residual effect will occur.

The residual effects criteria defined in Table 6.1-18 have been applied to the scenarios with residual effects that were identified in Table 6.1-17, and include the following:

- Construction, Operation, and Decommissioning – exceedances of the 24-hour TSP criterion (Table 6.1-19, Table 6.1-20, and Table 6.1-21);
- Construction and Operation – exceedances of the 24-hour PM_{10} criterion (Table 6.1-22 and Table 6.1-23);
- Construction, Operation, and Decommissioning – exceedances of the 1-hour NO_2 criterion (Table 6.1-24, Table 6.1-25, and Table 6.1-26); and
- Operation – exceedances of the 24-hour uranium criterion (Table 6.1-27).

Table 6.1-19: Air Quality – Summary of the Characteristics Ratings for Residual Effect 1 (Construction, 24-hour TSP Exceedances)

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Increased air quality concentrations are considered an undesirable effect.
Magnitude	High	The predicted concentration is more than 150% of the air quality criterion.
Geographic Extent	Local	The receptors are in the Air Quality LSA.
Duration	Short-term	The increase is related to Construction.
Frequency	Sporadic	The frequency of exceedances is between 10% and 50%.
Reversibility	Fully Reversible	Air quality concentrations are expected to return to baseline levels as construction activities cease.
Context	Context is described for receptor VCs	
Likelihood	Likely	There is a moderate to high probability that the residual effect will occur.

Table 6.1-20: Air Quality – Summary of the Characteristics Ratings for Residual Effect 2 (Operation, 24-hour TSP Exceedances)

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Increased air quality concentrations are considered an undesirable effect.
Magnitude	High	The predicted concentration is more than 150% of the air quality criterion.
Geographic Extent	Local	The receptors are in the Air Quality LSA.
Duration	Medium-term	The increase is related to Operation.
Frequency	Sporadic	The frequency of exceedances is between 10% and 50%.
Reversibility	Fully Reversible	Air quality concentrations are expected to return to baseline as sources cease to operate.
Context	Context is described for receptor VCs	
Likelihood	Unlikely	There are limited sources of fugitive dust during Operation. The primary source of dust (i.e., unpaved roads) can be effectively managed through operational controls.

Table 6.1-21: Air Quality – Summary of the Characteristics Ratings for Residual Effect 3 (Decommissioning, 24-hour TSP Exceedances)

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Increased air quality concentrations are considered an undesirable effect.
Magnitude	Low	The predicted concentration is between 100% and 125% of the air quality criterion.
Geographic Extent	Local	The receptors are in the Air Quality LSA.
Duration	Medium-term	The increase is related to Decommissioning.
Frequency	Infrequent	The frequency of exceedances is less than 10%.
Reversibility	Fully Reversible	Air quality concentrations are expected to return to baseline as sources cease to operate.
Context	Context is described for receptor VCs	
Likelihood	Likely	There is a moderate probability that the residual effect will occur.

Table 6.1-22: Air Quality – Summary of the Characteristics Ratings for Residual Effect 4 (Construction, 24-hour PM_{10} Exceedances)

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Increased air quality concentrations are considered an undesirable effect.
Magnitude	High	The predicted concentration is more than 150% of the air quality criterion.
Geographic Extent	Local	The receptors are in the Air Quality LSA.
Duration	Short-term	The increase is related to Construction.
Frequency	Sporadic	The frequency of exceedances is between 10% and 50%.
Reversibility	Fully Reversible	Air quality concentrations are expected to return to baseline as construction activities cease.
Context	Context is described for receptor VCs	
Likelihood	Likely	There is a moderate to high probability that the residual effect will occur.

Table 6.1-23: Air Quality – Summary of the Characteristics Ratings for Residual Effect 5 (Operation, 24-hour PM_{10} Exceedances)

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Increased air quality concentrations are considered an undesirable effect.
Magnitude	High	The predicted concentration is more than 150% of the air quality criterion.
Geographic Extent	Local	The receptors are in the Air Quality LSA.
Duration	Medium-term	The increase is related to Operation.
Frequency	Sporadic	The frequency of exceedances is between 10% and 50%.
Reversibility	Fully Reversible	Air quality concentrations are expected to return to baseline as sources cease to operate.
Context	Context is described for receptor VCs	
Likelihood	Unlikely	There are limited sources of fugitive dust during Operation. The primary source of dust (i.e., unpaved roads) can be effectively managed through operational controls.

Table 6.1-24: Air Quality – Summary of the Characteristics Ratings for Residual Effect 6 (Construction, 1-hour NO_2 Exceedances)

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Increased air quality concentrations are considered an undesirable effect.
Magnitude	High	The predicted concentration is more than 150% of the air quality criterion.
Geographic Extent	Local	The receptors are in the Air Quality LSA.
Duration	Short-term	The increase is related to Construction.
Frequency	Infrequent	The frequency of exceedances is less than 10%.
Reversibility	Fully Reversible	Air quality concentrations are expected to return to baseline as construction activities cease.
Context	Context is described for receptor VCs	
Likelihood	Unlikely	The NO_x to NO_2 conversion method applied is conservative for a 1-hour averaging period.

Table 6.1-25: Air Quality – Summary of the Characteristics Ratings for Residual Effect 7 (Operation, 1-hour NO_2 Exceedances)

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Increased air quality concentrations are considered an undesirable effect.
Magnitude	High	The predicted concentration is more than 150% of the air quality criterion.
Geographic Extent	Local	The receptors are in the Air Quality LSA.
Duration	Medium-term	The increase is related to Operation.
Frequency	Infrequent	The frequency of exceedances is less than 10%.
Reversibility	Fully Reversible	Air quality concentrations are expected to return to baseline as sources cease to operate.
Context	Context is described for receptor VCs	
Likelihood	Unlikely	The NO_x to NO_2 conversion method applied is conservative for a 1-hour averaging period. The effect is associated with use of the generators, which will only be used in an emergency scenario.

Table 6.1-26: Air Quality – Summary of the Characteristics Ratings for Residual Effect 8 (Decommissioning, 1-hour NO_2 Exceedances)

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Increased air quality concentrations are considered an undesirable effect.
Magnitude	High	The predicted concentration is more than 150% of the air quality criterion.
Geographic Extent	Local	The receptors are in the Air Quality LSA.
Duration	Medium-term	The increase is related to Decommissioning.
Frequency	Infrequent	The frequency of exceedances is less than 10%.
Reversibility	Fully Reversible	Air quality concentrations are expected to return to baseline as decommissioning activities cease.
Context	Context is described for receptor VCs	
Likelihood	Unlikely	The NO_x to NO_2 conversion method applied is conservative for a 1-hour averaging period.

Table 6.1-27: Air Quality – Summary of the Characteristics Ratings for Residual Effect 9 (Operation, 24-hour Uranium Exceedances)

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Increased air quality concentrations are considered an undesirable effect.
Magnitude	Moderate	The predicted concentration is between 125% and 150% of the air quality criterion.
Geographic Extent	Local	The receptors are in the Air Quality LSA.
Duration	Medium-term	The increase is related to Operation.
Frequency	Infrequent	The frequency of exceedances is less than 10%.
Reversibility	Fully Reversible	Air quality concentrations are expected to return to baseline as sources cease to operate.
Context	Context is described for receptor VCs	
Likelihood	Likely	There is a moderate probability that the residual effect will occur.

6.1.6.2 Significance and Confidence

6.1.6.2.1 Significance

Significance is determined for receptor VCs that represent assessment endpoints for Air Quality (e.g., Vegetation and Ecosystems, Human Health, Indigenous Land and Resource Use, and Other Land and Resource Use). Since Air Quality feeds into these other assessment endpoints, the results of the residual effects characterizations for Air Quality do not have significance determinations of their own. See Sections 9, 10, and 11.

6.1.6.2.2 Confidence

To have confidence that the predictions completed in support of the Air Quality assessment will bound the actual observed conditions upon Project commencement, a series of conservative assumptions were implemented at each stage of the assessment. It should be noted that air dispersion models are generally considered accurate to within a factor of two. This would indicate that if all emissions sources were characterized accurately, and the model conditions reflected actual conditions (e.g., meteorology, source parameterization), then the model predictions would be within ± 2 of a measured level at the point of prediction. To have confidence in the bounding of the predictions for this assessment, the air emissions and configuration of modelled sources were set with conservatism. The assumptions to facilitate a conservative assessment are summarized in the following bullets:

- The assessment scenarios considered all activities occurring concurrently at their individual maximum rates of production.
- Where Project-specific variables were not known (e.g., material silt content), the upper range of suggested defaults from emissions quantification guidance were used.
- If a range of values were provided for Project-specific variables (e.g., stack emission estimates), the maximum value was used.
- The dimensions and initial dispersion parameters (i.e., sigma values) for area and volume sources were limited where source-specific information was not readily available.
- Conservative regional background concentrations from the *Saskatchewan Air Quality Modelling Guideline* (SK MOE 2012a) and based on the La Loche monitoring station were used for particulate matter, NO_2, SO_2, and CO. The La Loche monitoring station is located near anthropogenic sources, while the Project is in a remote area removed from anthropogenic sources.
- The ARM, a methodology recognized as conservative (SK MOE 2012a), was used to convert NO_x to NO_2 concentrations.
- A single criterion was selected for each air quality COPC and time-averaging period based on the most stringent criteria or standard presented in Section 6.1.1.2.

- A gap analysis memo/model inputs summary was prepared for review by Denison prior to modelling, to make sure that the source list was reflective of current Project plans and that the modelling reflected the worst-case operating scenario for each phase.

Details regarding the air emissions calculations, as well as the detailed model configuration, are provided in Appendix 6-A.

6.1.6.3 Summary of Project-Related Residual Adverse Effects on Air Quality

Residual effects were predicted at receptors located beyond the Property Boundary for 24-hour concentrations of TSP, PM_{10}, and uranium, and 1-hour concentrations of NO_2. The effects during Construction were short-term (less than three years), while the effects during Operation and Decommissioning were medium-term. Twenty-four-hour TSP and PM_{10} exceedances during Construction and Operation were sporadic; however, the residual effects during Operation were considered unlikely. During Decommissioning, 24-hour TSP exceedances were infrequent. Exceedances of the 24-hour uranium criterion during Operation and the 1-hour NO_2 criterion during Construction, Operation, and Decommissioning were also infrequent. In general, in all Project phases, the residual effects were limited in geographic extent and mostly infrequent.

6.1.7 Cumulative Effects

The Project site will be accessed from Highway 914 by a proposed access road. Highway 914 is approximately 3.4 km (direct) from the developed Project site, or approximately 5 km by the proposed access road. The Cameco McArthur River Operation and Key Lake sites are currently in Care and Maintenance mode; therefore, there is currently no truck traffic between the sites on Highway 914. When these sites were to become operational again, there is potential for a cumulative effect at sensitive locations near the highway. Based on data from the Millennium EIS (Cameco 2013), which are summarized in a Traffic Volumes Memorandum prepared by Denison (Appendix 2-B in Section 2 Project Description), the average daily traffic between Key Lake and the Project site is expected to increase by 23% during Construction and 30% during Operation due to the Project. A 5-km portion of Highway 914 from the access road and south towards Key Lake was included in the air dispersion model and emissions from traffic associated with the Project were considered (see Appendix 6-A). While traffic associated with Cameo Operations was not modelled, conservative regional background concentrations from the *Saskatchewan Air Quality Modelling Guideline* (SK MOE 2012a) and the La Loche monitoring station were used for particulate matter, NO_2, SO_2, and CO (see Section 6.1.3.2.5 and Appendix 6-A). The La Loche monitoring station is located near anthropogenic sources, while the Project is in a remote area removed from anthropogenic sources. Accordingly, emissions to air from traffic associated with Cameco's operations are captured by the regional background concentrations used in the air dispersion model and are considered in the assessment of Project-related effects discussed in Section 6.1.4.

6.1.7.1 Climate Change Considerations

Changes to the climate during the lifetime of the Project have the potential to affect meteorological parameters that govern dispersion, and therefore, ambient concentrations and deposition rates of COPC. As discussed in Section 15.5.2, future climate conditions over the life of the Project will include warmer, snowier winters, and longer, hotter summers. There is also an increased trend in total and extreme precipitation events, although there is uncertainty with projected precipitation and whether it could affect the Project.

Increased precipitation may decrease suspended particulate matter (and its adsorbed constituents) in ambient air via two pathways: 1) increased precipitation could wash out or remove suspended particulate from the air; and 2) increased precipitation could suppress emissions of fugitive dust from unpaved surfaces and storage areas. An increase in temperature would reduce the difference between in-stack temperature and ambient air temperature, leading to a decrease in buoyant flux and dispersion from point sources like the ISR plant stacks. However, the initial dispersion for most of the stacks at the Project is driven by momentum flux (i.e., the flow rate) and is unlikely to be sensitive to an increase in ambient air temperature. An increase in ambient temperature during the summer months without an increase in precipitation could also lead to drier conditions and increased emissions of fugitive dust. However, this type of condition could be effectively managed through air quality monitoring (Section 6.1.8 and Section 16).

6.1.8 Monitoring and Follow-up

To confirm the residual effects of the Project on Air Quality and demonstrate compliance with provincial ambient air quality standards, an adaptive air quality management program will be implemented. The air quality management program will contain various plans which will be finalized during permitting and licensing. The plans within the air quality management program will incorporate mitigation measures and monitoring requirements directed by provincial and federal regulators and by Indigenous groups and other Interested Parties as requested.

The air quality management plan will outline operational procedures and controls used to control fugitive emissions of particulate matter from unpaved roads, open areas, and material stockpiles and will also address community complaints and response procedures. An air quality monitoring plan will be designed to evaluate the effectiveness of these measures.

The air quality monitoring plan will detail the monitoring objectives, sampling design, methods and quality assurance and control requirements. The air quality monitoring plan will be an extension of the ongoing baseline monitoring program for the Project and will include the following:

- TSP;
- dustfall;
- uranium, select metals, and radionuclides in TSP and/or dustfall;
- passive NO_2; and

- radon.

The air quality monitoring plan will also define sampling requirements and methods for the processing plant stacks.

6.1.9 Air Quality Summary

Air Quality was selected as a VC because of the likelihood of Project-related activities to emit COPC and change ambient air quality. Air Quality is also important to human and ecological health and was raised as a concern during the engagement and consultation process. Indicators of Air Quality include levels of particulate matter (including adsorbed radionuclide and non-radionuclide constituents), combustion products, and radon compared to provincial and federal air quality criteria. Predicted COPC levels are also evaluated by the assessors of the aquatic environment, terrestrial environment, and human health.

The Air Quality assessment is spatially bound by the Project Area, the Project Boundary, the Air Quality LSA, and the Air Quality RSA. The Project Area is the area of maximum physical disturbance, while the Project Boundary is the boundary at which the air quality criteria apply. The Air Quality LSA is where direct Project effects can be expected and is within 10 km of the Project Area. The Air Quality RSA is where indirect or cumulative effects may potentially occur and extends 10 km from the Air Quality LSA. The assessment considered the Construction, Operation, and Decommissioning phases of the Project, where Project-environment interactions are expected.

The existing environment is typical of a remote northern setting with the baseline monitoring program measuring low levels of dust, NO_2, and SO_2. Baseline levels of radon are also low and within the regional baseline for northern Saskatchewan, which is less than 7.4 Bq/m^3 to 25 Bq/m^3 (CNSC 2018).

For each Project phase, emissions of COPC were estimated using industry-standard methodologies, such as published emission factors. Constituents of potential concern concentrations were predicted using the CALPUFF model and compared to criteria derived from provincial and federal standards, including from the SK MOE and the CCME. In the absence of provincial and federal standards, criteria from the Ontario Ministry of Environment, Conservation and Parks were used.

Residual effects were predicted at receptors located beyond the Property Boundary for 24-hour concentrations of TSP, PM_{10}, and uranium, and 1-hour concentrations of NO_2 during at least one Project phase. Overall, predicted residual effects were limited in geographic extent and mostly infrequent. Twenty-four-hour TSP and PM_{10} exceedances during Construction and Operation were sporadic; however, the residual effects during Construction were short-term and unlikely for Operation. During Decommissioning, 24-hour TSP exceedances were infrequent. Exceedances of the 24-hour uranium criterion during Operation and the 1-hour NO_2 criterion during all three phases were also infrequent.

To confirm the residual effects of the Project on Air Quality and demonstrate compliance with provincial ambient air quality standards, an adaptive air quality management program will be implemented during permitting and licensing. The EMS will evaluate the effectiveness of the air quality monitoring.

6.1.10 References

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6.2 Noise

This subsection addresses the potential for the Project to affect the existing sound environment in the vicinity of the Project. The Project Area is currently characterized by low ambient sound levels that are primarily attributable to sounds of nature, as would be expected for a remote location. The Project will introduce new sound sources into this environment, which will change the nature of the environment through the introduction of anthropogenic sounds associated with industrial activity, resulting in a localized increase in sound levels.

Noise sources associated with the Project include site clearing activities, construction of facilities, use of power generators, diesel-powered mobile equipment, drilling in the wellfield, on-site traffic and air traffic, chilling equipment associated with the freeze plant, and various equipment associated with the ISR process (e.g., pumps). Potential effects related to noise occur when sound levels are audible above background conditions at noise-sensitive locations or increase by a noticeable amount. Health Canada provides guidance for the assessment of noise during EAs, which includes recommended criteria for use in assessing the significance of the predicted sound levels and sound level increases at noise-sensitive locations (Health Canada 2017). Health Canada uses annoyance with sound as an indicator for potential effects on human health.

This section of the EIS addresses potential Project-related effects on the Noise VC and is comprised of the following information:

- scope of the assessment;
- summary of existing conditions;
- identification and description of potential interactions between the Project and the Noise VC;
- identification and description of mitigation measures and monitoring activities to eliminate, reduce, or control the potential adverse Project-related effects on the Noise VC;
- characterization of potential Project-related residual effects (i.e., after mitigation), including determination of significance and level of confidence in the predictions; and
- identification and characterization of cumulative effects.

Figure 6.2-1 is a graphic representation of the assessment process used in this EIS.

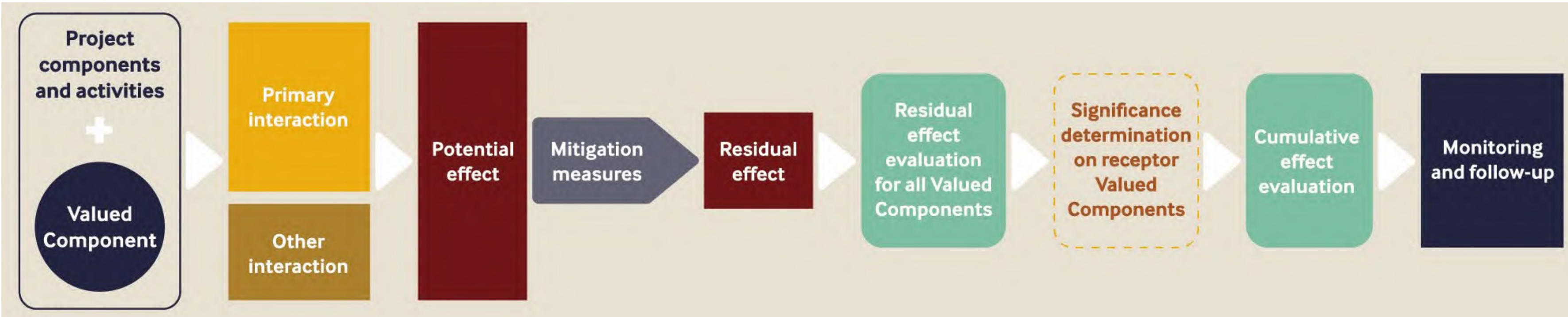

Figure 6.2-1: Environmental Assessment Process Used in This Environmental Impact Statement

6.2.1 Scope of the Assessment

6.2.1.1 Valued Component Selection

The process and rationale for the selection of VCs and establishment of KIs and associated MPs is described in Section 5. Noise was selected as a VC in general based on the likelihood of Project-related activities to interact with and change the existing sound environment. Any change to the existing sound environment in the vicinity of the Project has the potential to affect Indigenous groups and the public in terms of creating nuisance noise that may affect human health, and to change animal behaviours as related to hunting activity. The potential effects of Project-related changes to noise levels on the Ungulates, Furbearers, and Woodland Caribou VC are discussed in Section 9.3. The discussion in this section is focused on potential effects on humans. Figure 6.2-2 is a graphic representation of the main linkages among the Noise VC and other VCs, illustrating the flow of assessment information from the Noise VC.

Health Canada identifies that project-related changes to environmental noise carry a potential risk to human health (Health Canada 2017), and therefore recommends that noise be assessed in the context of an EA. According to Health Canada, indicators of effects on human health due to noise exposure include sleep disturbance and prolonged periods of high annoyance, which may in turn lead to health effects associated with cardiovascular health, mental health, and accidents (Health Canada 2017). The KIs and MPs derived from the Health Canada guidelines to assist in the assessment of Noise are discussed in Section 6.2.1.2.

Due to the association of noise with potential human health considerations, and the possibility of changes to noise levels influencing terrestrial wildlife behaviour (and the nature of use of traditional hunting grounds by Indigenous groups), Noise has been included as a VC in other EAs of similar scope that have been completed in the area. For example, the assessment of potential noise effects associated with the Cameco Millennium Project are discussed in Annex L of the EIS document (Cameco 2013).

While Saskatchewan does not currently have provincial guidance related to the assessment of potential noise effects associated with industry, other Canadian provinces, such as Ontario and Alberta, do maintain provincial noise assessment guidelines, which tend to pertain to environmental noise effects rather than health-specific effects (i.e., keeping the noise contribution of individual facilities below absolute thresholds that are based on the project setting). Based on professional experience, the SK MOE has considered the *Alberta Directive 038* (AER 2013) as a suitable stand in for provincial guidance. The Alberta Energy Regulator (AER) Directive involves establishing a permissible sound level (PSL) specific to the nearest identified sensitive receptor locations to the facility, and then using predictive modelling to evaluate whether the project under assessment is below the PSL. The PSL and project contributions are discussed as KIs and MPs in Section 6.2.1.2.

In addition to the scientific and regulatory rationale, and historic precedent for including Noise as a VC in other nearby projects of similar scope, concerns related to noise were also raised during engagement and consultation activities completed by Denison. The concerns included the audibility of Project-related noise at leased properties (20-LK-LEASE-328.10) and how noise may affect animal populations (21-EN-ERFN-447-45). As noted previously, significance determination is not completed on intermediate VCs, but integrated into the residual effect evaluation, residual effect characterization, and significance determination for related receptor VCs. The significance determination of Noise effects specific to the Ungulate, Furbearer, and Woodland Caribou VCs due to changes in noise level is part of the terrestrial environment assessment (Section 9.3).

Figure 6.2-2: Integrated Assessment Approach - Key Connections between Noise and Other Valued Components

6.2.1.2 Key Indicators and Measurable Parameters

The KIs and associated MPs for the Noise VC are summarized in Table 6.2-1. The MPs are further discussed in the following sub-sections.

Table 6.2-1: Key Indicators and Measurable Parameters for Noise

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Noise Levels	• Project activities will introduce new sources of noise to the area. • The existing sound environment is characterized by very low ambient sound levels and is therefore sensitive to the introduction of new industrial noise sources. • The difference between the ambient noise levels with and without the Project, as well as the predicted noise levels with the Project operating, can be used to evaluate the potential response of those exposed. • Change in noise levels has historically been addressed for other mining projects in northern Saskatchewan.	MP 1: Total day-night level (Ldn). MP 2: Change in percentage of persons highly annoyed (%HA). MP 3: Daytime sound level (Ld). MP 4: Nighttime sound level (Ln). MP 5: Change in Ld and Ln.

6.2.1.2.1 Federal Guidance

The assessment of noise effects in support of EAs for projects designated under the *Canadian Environmental Assessment Act, 2012* (Government of Canada 2019) are to be completed in accordance with the Health Canada publication *Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise* (Health Canada 2017). Health Canada's preferred methodology for the assessment of noise effects has been developed for the assessment of human health endpoints—the methodology is not intended for application to occupational exposure, or to the assessment of wildlife or ecosystems.

The Health Canada assessment approach is premised on community reaction to noise being a potential indicator of adverse health, and one of the most common community reactions is annoyance. The use of annoyance as an indicator of health effects relies on annoyance levels being correlated with sound levels. To achieve this, Health Canada relies on the results of socio-acoustic studies, which have demonstrated a link between increasing community noise levels and an associated increasing percentage of the community that is reported to be 'highly annoyed' by the noise as it rises. These studies have resulted in a dose-response curve that relates sound levels to 'percentage highly annoyed' (i.e., percentage of persons that are typically annoyed by sounds at the corresponding levels). This dose-response curve is the basis for the assessment of effects under the Health Canada approach.

The sound level metric that is applied in the assessment approach preferred by Health Canada is the 'day-night level' or Ldn (Health Canada 2017). This is a normalized sound level in which the sounds that occur during nighttime hours (22:00 to 07:00) are penalized by +10 dBA. This nighttime penalty is to account for people generally being more sensitive to sounds that occur at night; therefore, nighttime sounds are artificially raised. The Ldn that exists in a community before a project is implemented is determined through monitoring, modelling, and the dose-response relationship, which corresponds with an indication of the 'percentage of persons highly annoyed' by sounds at that level (or %HA). The future sound level with a project in place and operating is then estimated through modelling, and this contribution is added to the baseline sound level that previously existed in the community. This future Ldn also corresponds to a %HA value. Health Canada stipulates that a project should not cause the future sound level in a community to exceed an Ldn of 75 dBA (MP 1), and the %HA in a community should not increase from baseline conditions by more than 6.5% (MP 2).

Based on the aforementioned information, there are two Health Canada criteria for noise effect assessments: an absolute criterion (Ldn not to exceed 75 dBA) and a relative criterion (increase in %HA less than 6.5%). Both criteria are to be met for a project to be considered compliant. If either criteria are not met, then the effects of the project are considered severe and noise mitigation measures must be investigated. Furthermore, in quiet, rural areas where there is anticipated to be higher sensitivity to noise, Health Canada recommends that the baseline and predicted future Ldn sound levels be adjusted by +10 dBA prior to calculating the %HA values (and change in %HA), as this produces a greater change in %HA than would otherwise have occurred (Health Canada 2017).

6.2.1.2.2 Provincial Guidance

As mentioned previously, provincial guidance from Alberta was used as surrogate provincial criteria since there is currently no provincial environmental noise guidance for Saskatchewan. The AER Directive (AER 2013) outlines a comprehensive methodology for assessing sound levels from industrial facilities, including establishing sound level criteria and outlining requirements for quantitative predictions through calculations or detailed modelling. It should be noted that the AER Directive is not applicable to construction activities; however, it does include recommendations consider when planning construction. While the AER Directive is not strictly applicable to construction, the criteria have been applied in this assessment due to construction being a multi-year project.

The procedure outlined in the AER Directive involves the evaluation of daytime (07:00 to 22:00) and nighttime (22:00 to 07:00) periods. The daytime and nighttime sound levels considered in the AER Directive are measured or predicted sound pressure levels that were used to describe the baseline and future conditions with the Project in place. The procedure begins with the development of PSLs for the daytime and nighttime periods, which are the criteria by which the Project is assessed. The PSLs consider a basic sound level (provided in the AER Directive based on the project setting), a series of adjustments related to the specifics of the operation (e.g., duration, schedule), and the measured conditions at the site, if available. The PSLs for this assessment were established at 40 dBA for daytime hours and 36 dBA for nighttime hours.

The AER Directive requires acoustic modelling be completed to predict the sound effects of a project under conservative operating conditions. Minimum acceptable modelling parameters are outlined in Section 3.5.1 of the AER Directive and include requirements to account for geometric spreading of sound, barrier effects, atmospheric absorption, ground attenuation, and wind speed/direction. Source parameters must account for location, sound output, and intermittency, where applicable. Modelling is to be based on accepted international standards, such as International Organization for Standardization (ISO) 9613-2 (ISO 1996). The model adopted for this Project, as discussed in Section 6.2.4, is Cadna-A from DataKustik GmbH (DataKustik 2020), which meets all the preceding requirements.

Regarding Construction, the recommendations in the AER Directive include limiting construction activity to daytime hours (07:00 to 22:00), scheduling significant noise-causing activities and notifying residents of the schedule, making use of mufflers for combustion equipment, and using on-site buildings to shield construction noise from nearby residences.

6.2.1.2.3 Change in Subjective Loudness

It should be noted that, while the sound levels may comply with various criteria discussed in the preceding sections, given the Project setting and low ambient sound levels, the increase in sound level due to the Project may still be noticeable and potentially objectionable. As such, additional criteria have been adopted for the assessment for use in characterizing the degree to which the Ld and Ln may change from baseline conditions. These are summarized in Table 6.2-2.

Table 6.2-2: Criteria for the Assessment of Residual Noise Effects

Sound Level Increment	Change in Subjective Loudness	Effects Rating
Up to 3 dBA	Not perceptible	Marginal to none
3 to 5 dBA	Perceptible	Low
5 to 10 dBA	Almost twice as loud	Moderate
Greater than 10 dBA	More than twice as loud	High

An increase in sound level of less than 3 dBA is not typically perceptible to the human ear (Cowan 1994); therefore, an exceedance of less than 3 dBA is considered to be a marginal effect. Sound level increases greater than 3 dBA up to 5 dBA are perceptible but generally not considered to be intrusive; therefore, a low effect rating is assigned. In general, every 10 dBA increase in sound level results in a doubling of the perceived loudness (Cowan 1994). In other words, if the sound level in an environment were to increase by 10 dBA, the environment would seem twice as loud as before to a listener in that environment. An increase in sound level of 20 dBA would result in the environment seeming four times as loud as before. Increases in sound level above 5 dBA are associated with higher potential for complaints and are therefore assigned a moderate (increment above 5 dBA) or high (increment above 10 dBA) effect rating.

6.2.1.3 Spatial and Temporal Boundaries

The areas used to assess the effects of the Project on the Noise VC are shown on Figure 6.2-3 and described in the following bullets.

- **Project Area**: the area within which the Project and all components/activities are located (i.e., the area of maximum physical disturbance). The Project Area is considered to be a conservative estimate of the area of direct disturbance effects on the Noise VC in this assessment.
- **Noise LSA**: the area that surrounds the Project Area where both direct and indirect effects resulting from Project activities can be reasonably measured. The Noise LSA is generally established to assess the potential, largely direct effects of the Project, and represents the extent to which there is a reasonable potential for the Project or Project-related activities to interact with and potentially adversely affect the Noise VC.

  The LSA for the Noise VC was set in consideration of the nearest sensitive land uses and professional experience regarding noise propagation from mining operations. At typical mining operations, noise returns to ambient levels at 3 to 5 km from the site. As there are sensitive receptors beyond this distance in this assessment, the Noise LSA was extended to include the lands within 10 km of the Project Area for a more fulsome assessment.
- **Noise RSA**: the area that surrounds the Noise LSA, established to assess the potential, largely indirect effects of the Project in a regional context. The Noise RSA defines the area within which cumulative effects may occur. As noise is not typically considered a regional issue, the Noise RSA has been established simply as the area outside of the Noise LSA for the purposes of identifying proximity to other northern projects.

Temporal boundaries in the context of the Noise assessment have a two-fold meaning. The assessment accounted for temporal boundaries in terms of when an effect is expected to occur in relation to specific Project phases and activities, and also in terms of the time periods that the prediction of noise effects are applicable to. The latter is largely driven by the MPs that have been identified in Table 6.2-1 and subsequent discussion. The Health Canada assessment approach focuses on activities being completed within a 24-hour period, while the assessment of the Ld and Ln necessitate the consideration of a daytime (15-hour) and nighttime (9-hour) period. Regarding the overall timeline of the Project and the associated phases and activities, these were established in accordance with the summary that has been provided in Table 5.3-3 in Section 5.

6.2.2 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

Denison has recorded and stored information regarding Indigenous Knowledge, Local Knowledge, and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 20-LK-LEASE-328.10). Appendix 6-B provides a summary of unique identification numbers referenced within Section 6.2.

During engagement activities, concern was raised regarding audibility of noise at leased properties (20-LK-LEASE-328.10). There are several lease areas in the vicinity of the Project site, and it has been assumed that each of these contain cabins for purposes of this assessment. As such, these locations have been included as points of reception in the model if they are located within the Noise LSA. A map depicting the location of sensitive receptor locations used in this assessment is provided in Figure 6.2-4. A brief description of the sensitive noise receptors is also provided in Table 6.2-3.

Table 6.2-3: Sensitive Noise Receptors

ID	Description
300601	Leased property – recreational lease, assumed to contain a rustic cabin
301493	Leased property – recreational lease, assumed to contain a rustic cabin
302424	Leased property – recreational lease, assumed to contain a rustic cabin
302586	Leased property – recreational lease, known to contain a rustic cabin
302955	Leased property – recreational lease, assumed to contain a rustic cabin
303010	Leased property – recreational lease, assumed to contain a rustic cabin
303069	Leased property – recreational lease, assumed to contain a rustic cabin
303109	Leased property – recreational lease, assumed to contain a rustic cabin
303238	Leased property – recreational lease, assumed to contain a rustic cabin
602377	Leased property – traditional land use lease, known to include a rustic cabin
Risk1	Risk – ecological receptor on-site
Risk2	Risk - human: seasonal resident at McGowan Lake (leased property #300601). This receptor is at the same location as the recreational fisher/hunter in the Human Health Risk Assessment (EIS Section 10)
Risk3	Risk - human: camp worker
Risk4	Risk - human: seasonal resident at Russell Lake. This receptor is at the same location as fisher/trapper, recreational fisher/hunter and seasonal resident in the Human Health Risk Assessment (EIS Section 10)
Risk5	Risk - reference receptor location

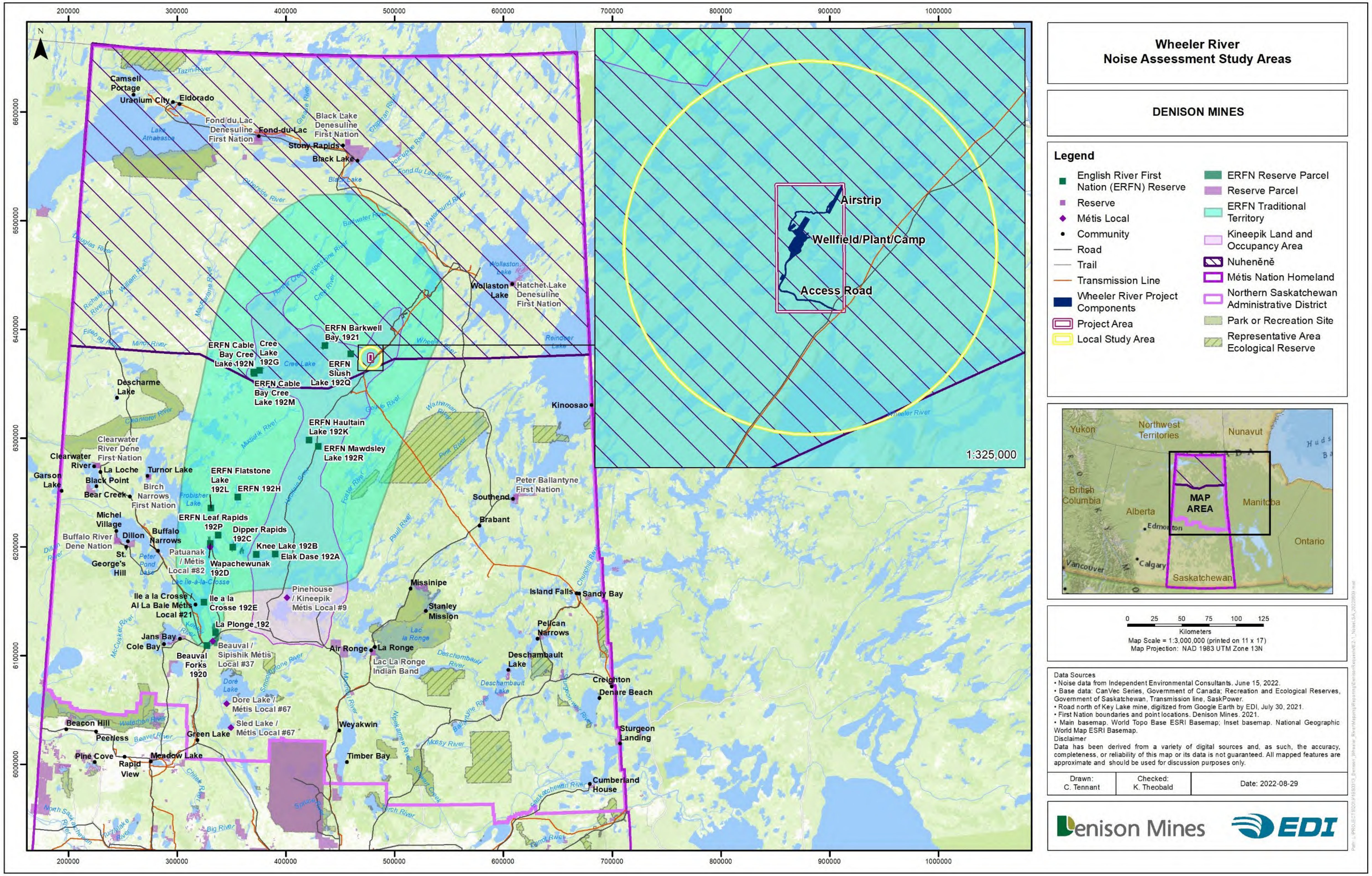

Figure 6.2-3: Noise Assessment Study Areas

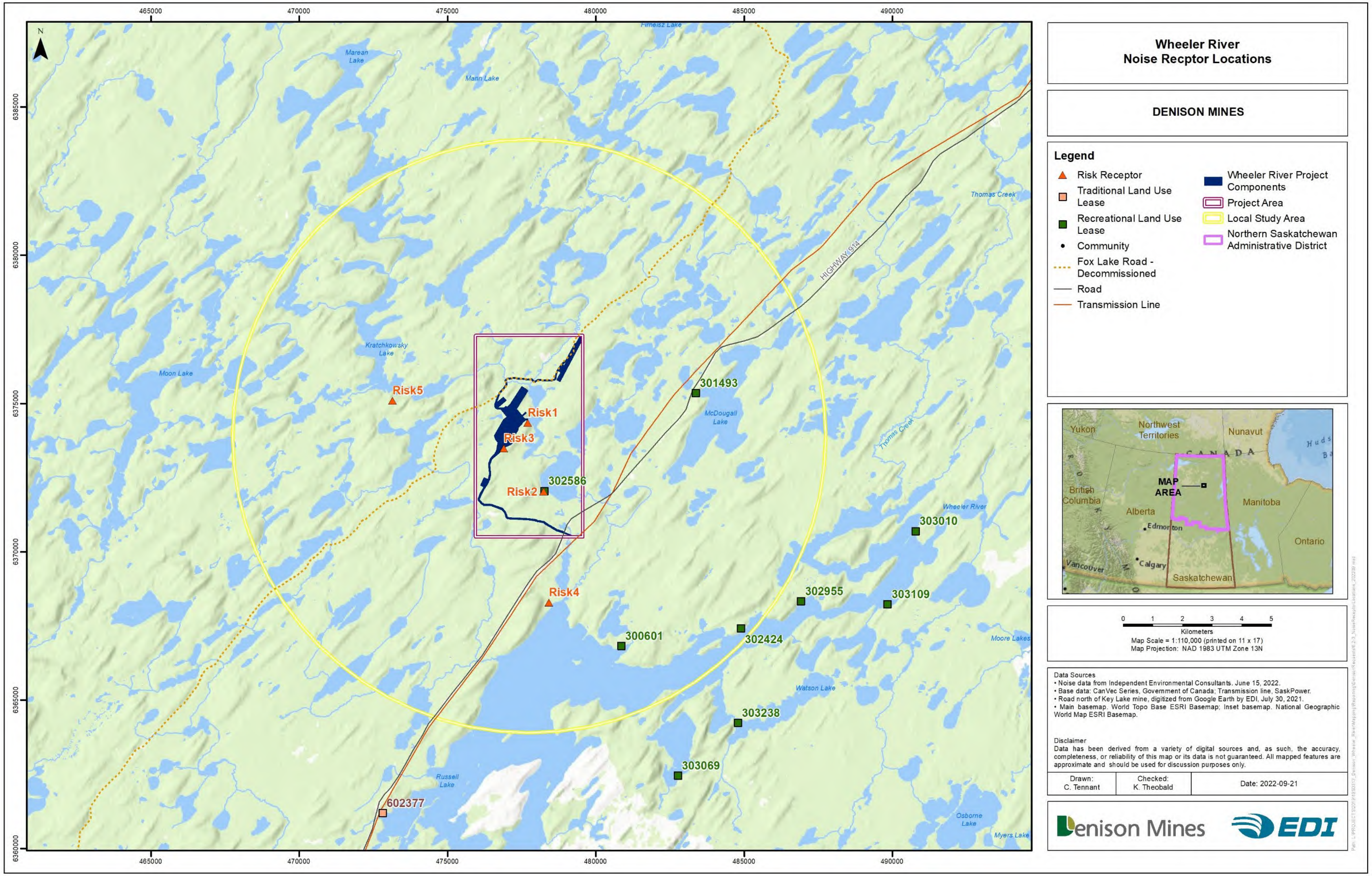

Figure 6.2-4: Sensitive Noise Receptors

6.2.3 Existing Environment

6.2.3.1 Baseline Noise Measurement Program

As per Table 6.2-1, the only KI associated with the Noise VC pertains to noise levels (i.e., sound pressure levels), which are considered both as absolute levels and in relation to existing levels in the assessment of effects. The existing sound environment in the vicinity of the Project Area was characterized via a noise measurement program, which was completed in May 2021. In accordance with Health Canada guidance, the measurement program was designed based on ISO Standard 1996-2:2007 (ISO 2007).

Per ISO requirements, the baseline measurement program was completed using a Class 1 sound level meter system (inclusive of calibrator), outfitted with a wind shield, and with all components calibrated to a traceable national standard (e.g., National Institute of Standards and Technology) within one year of use in the program. The sound level measurement system used in the program was a Larson Davis SoundExpert® LxT outfitted with environmental protection, including a wind screen, bird spikes, and desiccant chamber to control humidity in the pre-amplifier. The calibration device was a Class 1 Larson Davis CAL200, and calibration checks took place before and after the measurement program at 1 kHz (114 dB).

The program was completed over approximately one week (from May 5 to 13, 2021). In accordance with industry best practices and instrument manufacturer recommendations, the hourly meteorological conditions that occurred over the course of the measurement program were summarized with the measurement data, and any measurement data associated with unrepresentative conditions (e.g., precipitation, high gusting winds) were removed from the data set prior to summarization. The meteorological boundary conditions applied in the assessment are summarized in Table 6.2-4. Meteorological data for the noise measurement period were collected from the ECCC station located at the Key Lake site, approximately 32 km from the Project site, as an on-site meteorological station has not yet been established for the Project site. The parameters from Table 6.2-4 were summarized for the monitoring period and time synched with the noise measurement data. Measurement data corresponding with any hours for which one or more of the meteorological parameters was outside of the associated boundary condition were flagged and removed from the data set. The resulting data set was then carried forward to the analysis of the background sound conditions. Out of the approximately 187 hours of measurement data, only 14 hours (or 7.5%) of the data were discarded as a result of being outside of the established acceptable meteorological boundary conditions.

Table 6.2-4: Meteorological Boundary Conditions for Noise Monitoring

Parameter	Lower Limit	Upper Limit
Temperature[1]	-10°C	+39°C
Relative Humidity [1]	25%	90%
Precipitation[2]	Any amount of precipitation is unacceptable	
Wind Speed[2]	N/A	20 km/h

Notes:

1 Instrument manufacturer (Larson Davis) operating parameters (Larson Davis 2020).

2 Industry best practices.

Baseline sound level monitoring was completed at two locations, as shown on Figure 6.2-5. The sound level meters used in the baseline program at the Project site were in open outdoor spaces with no reflecting surfaces and were considered to be free-field measurements. The microphones were mounted on tripods (approximately 1.5 m above ground) to limit the influence of ground reflections. The locations of ongoing Denison exploration work were taken into consideration during planning, and monitoring locations were selected to be as far from these operations as possible while still being accessible by site personnel. It should be noted that there has been no hauling of ore from Cameco McArthur River to Key Lake along Highway 914 since 2017; therefore, baseline sound levels do not include traffic along Highway 914.

Sound levels were measured on a continuous 15-minute interval over the full measurement period (May 5 to 13, 2021) to provide an opportunity to flag and review any anomalous data within each 1-hour period (e.g., potential presence of wildlife). These sound levels were then summed to hourly levels for comparison to the meteorological data, unrepresentative data were removed as described above, and data were summed to Ld and Ln values for each day of measurement. These values were then used to calculate an Ldn for each day.

Upon return to collect the sound level meters, it was found that the measurements at NO-01 had been interrupted by a wildlife encounter. The tripod was found on its side and the bird spikes were bent and windscreen damaged. Upon inspection of the data, it appeared that the wildlife encounter occurred early in the program, on May 5 at approximately 20:45. As such, the full dataset from NO-01 was disregarded in the analysis. The validated sound levels measured at NO-02 are summarized in Table 6.2-5.

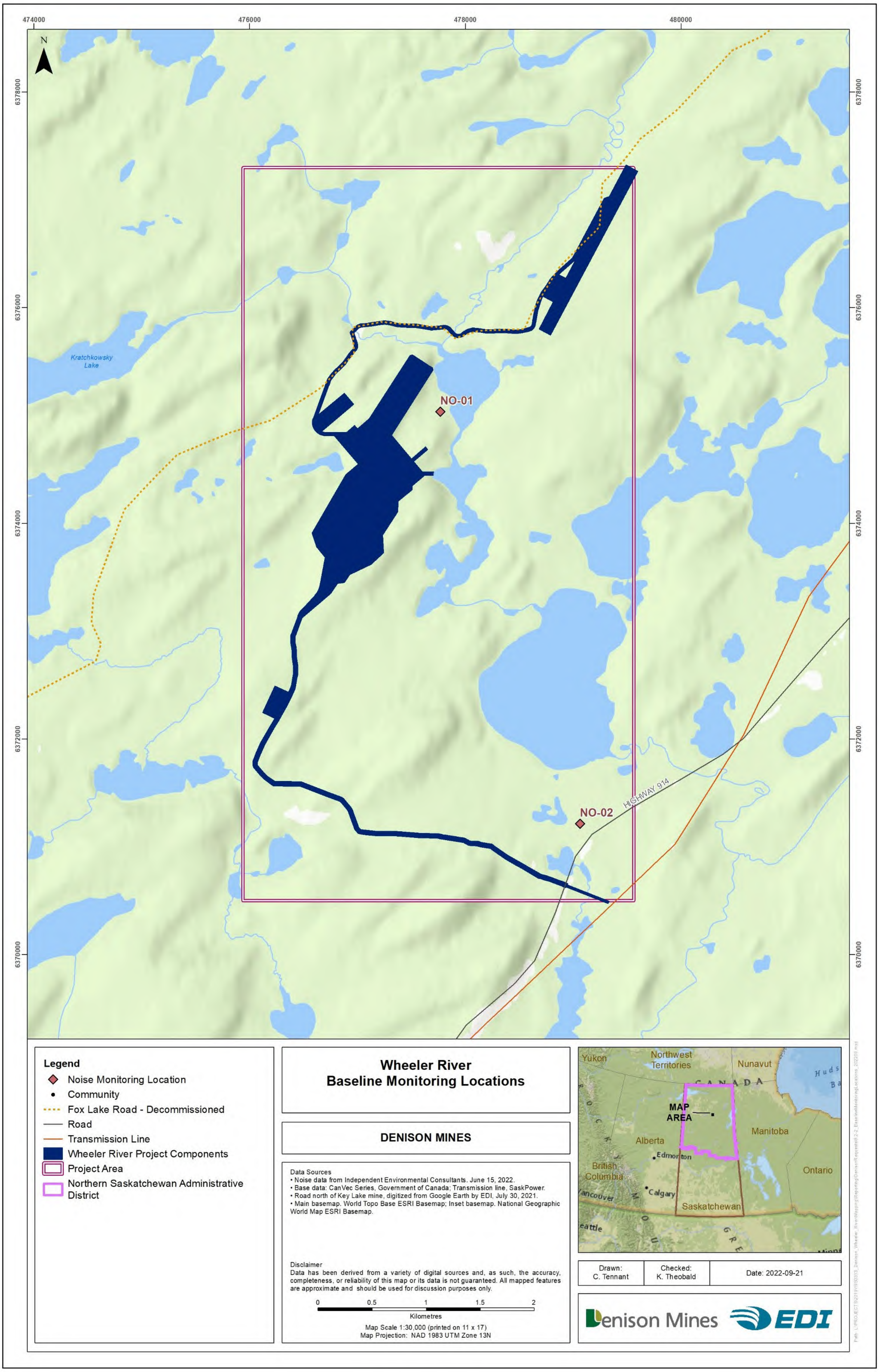

Figure 6.2-5: Baseline Monitoring Locations for Noise

Table 6.2-5: Ambient Noise Measurement Data (NO-02)

Date	Ld (15-hour, dBA)	Ln (9-hour, dBA)	Ldn (24-hour, dBA)
05-May-21	30.9	29.7	34.8
06-May-21	30.3	32.2	38.4
07-May-21	32.7	30.2	37.1
08-May-21	31.4	30.7	37.2
09-May-21	29.6	36.5	42.4
10-May-21	28.2	29.9	36.1
11-May-21	32.5	31.7	38.2
12-May-21	29.8	29.8	36.2
Average	**30.7**	**31.3**	**37.6**

6.2.3.2 Baseline Measurement Program Results as Sound Level Criteria

Both the federal and provincial guidelines adopted for this assessment (Section 6.2.1.2) consider the actual baseline conditions as a factor in the development of the applicable criteria. The Health Canada assessment approach uses the Ldn to calculate a corresponding baseline %HA for use in the assessment. An Ldn of 37.6 dBA corresponds with a %HA of 0.43%. If the baseline Ldn is increased by 10 dBA to account for the heightened expectation of quiet in a remote area, per Health Canada guidelines (Health Canada 2017), the resulting value of 47.6 dBA corresponds with a %HA value of 1.6%.

In terms of the provincial guidance, the AER Directive identifies that the starting points for determining sound level criteria in a remote area are 50 dBA during daytime and 40 dBA during nighttime (basic sound levels). These may be adjusted based on ambient monitoring data, and the results in Table 6.2-5 indicate that background sound levels during the daytime and nighttime were each approximately 31 dBA (actual sound levels). The adjustments were calculated based on the difference between the basic sound levels and actual sound levels. The differences of 19 dBA (day) and 9 dBA (night) result in adjustments of -10 dBA (day) and -4 dBA (night), indicating that the final criteria (or PSL) are 40 dBA (day) and 36 dBA (night).

6.2.4 Assessment of Project-Related Effects

6.2.4.1 Potential Interactions Between the Project and Valued Component / Key Indicators

Potential Project-related interactions with the Noise VC and its associated KI are summarized by Project phase in Table 6.2-6, with a grey highlighted check mark (✔) indicating a primary interaction, and a check mark (✓) indicating another interaction. Potential interactions in the summary table are ranked as:

- **Primary Interaction** (✓): Project activity is expected to interact with the VC/KI, which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- **Other Interaction (✓):** Project activity is expected to interact with the VC/KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- **No Interaction:** Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

The potential interactions identified in Table 6.2-6 are addressed further following the table.

Table 6.2-6: Potential Project Interactions for Noise

Project Phase/Activity	Noise
	Noise Levels
Construction Activities	
Development of access roads and air strip	✓
Site preparation and earthworks; clearing, levelling, and grading of the Project Area	✓
Power generation – generators	✓ (primary)
Installation of main substation and distribution of power around site	
Wellfield and freeze hole drilling; ground freezing	✓ (primary)
Batch plant operation (concrete); crusher at borrow area	✓ (primary)
Development of surface infrastructure (camp, operations centre, plants, ponds, pads, and support facilities)	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	
Water management (including treatment and site runoff)	
Groundwater supply	
Surface water withdrawal	
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	
On-site and off-site operation of vehicles and transport of materials	✓
Air transportation for workers	✓
Regulatory site inspections	
Engagement – site visit from Interested Parties	

Project Phase/Activity	Noise
	Noise Levels
Operation Activities	
Operation of the ISR wellfield	✓
Wellfield and freeze wall drilling	✓
Operation and expansion of freeze wall	✓
Batch plant operation (grout and cement); crusher in borrow area	✓
Expansion of pond and pads	
Operation of the processing plant and production of uranium concentrate	
Water withdrawal from groundwater or surface water body	
Management of surface water (including seepage and site runoff)	
Water treatment, both domestic and industrial	
Water release to surface water body	
Waste management (composting, domestic and industrial landfill operation, recycling)	
Hazardous waste management (temporary storage, handling, and off-site transportation)	
Storage and disposal of drill waste rock, process precipitates, and industrial wastewater treatment plant precipitates	✓
On-site and off-site operation of vehicles and transport of materials	✓
Power supply – primarily power from the grid, also generators and back-up generators	✓
Package and transport of nuclear substances	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	
Air transportation for workers	✓
Progressive decommissioning and reclamation	
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Decommissioning Activities	
Site water management, treatment, and release	
Mining horizon remediation and thawing of freeze wall	
Process water treatment and release	
Closure of ISR and freeze wells and related infrastructure	
Decontamination of surface facilities and injection, recovery, and monitoring wells	
Asset removal (including site power transmission lines and electrical infrastructure)	✓
Demolition and disposal of non-salvageable surface infrastructure and materials	✓

Project Phase/Activity	Noise
	Noise Levels
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	
Generators	✓
Waste management (composting and landfill operation)	
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)	
On-site and off-site operation of vehicles and transport of materials	✓
Reclamation of disturbed areas	
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Post-Decommissioning Activities	
Environmental monitoring	
Regulatory site inspections	
Engagement – Site visit from Interested Parties	

It should be noted that the assessment of noise effects included only Construction and Operation activities as Decommissioning and Post-Decommissioning activities would be effectively bounded by these phases in terms of the potential to cause an effect.

The information on activities associated with each phase of the Project shown in Table 6.2-6 was used to develop assessment scenarios for use in predictive modelling. The scenarios were developed based on the year with the maximum activity occurring in each phase.

The Construction scenario was based on the first year of construction as this involves the most equipment operating at the site, including construction of surface facilities, wellfield drill mobilizations, drilling of freeze holes and ISR wells, and partial operation of the freeze plant. Construction activities will be supported by a concrete batch plant and crusher, and power to the site during this stage will be provided by two (2) 1.1 MW generator sets and two (2) 450 kW generator sets. In addition, there will be regular truck trips to the site for delivering construction materials and site supplies (e.g., food, fuel). This scenario also included air traffic for personnel changes.

The Operation scenario was based on activities being completed in the late stages of Operation, with work being completed in Phase 5 of the deposit. Well drilling would continue, and the freeze plant was assumed to be operating at maximum capacity. While the site will be powered from the provincial grid at this stage, the power generators were assumed to be operating under emergency conditions as a worst-case scenario. Regular truck traffic will continue for provision of wellfield materials, process supplies, food, and fuel, and shipping of yellowcake material will commence. This scenario also included air traffic for personnel changes.

The specific noise sources associated with each of the above activities that were included in the assessment of noise effects are summarized in Appendix 6-E. The discussion of sources therein also includes detailed information on the derivation of source sound power levels for use in predictive modelling.

6.2.4.2 Potential Project-Related Effects

The propagation of sound from the Project associated with Construction and Operation was predicted using the software package Cadna-A from DataKustik GmbH (DataKustik 2020), which is based on the industry standard calculation method described in ISO Standard 9613-2 (ISO 1996). Air traffic was also assessed within the same Cadna-A model using a module for Cadna-A (DataKustik 2013) that implements the Integrated Noise Model developed by the Federal Aviation Administration in the United States. Sound power levels for the identified sources were generally established using manufacturer specifications, historic measurement data from similar sites, or engineering calculation methods referenced from scientific literature. The inputs for the calculations were derived from available manufacturer specifications and the operating parameters outlined on the equipment lists supporting the prefeasibility study (Denison 2018). Details regarding source characterization are provided in Appendix 6-E.

A scaled 3D representation of the facility and its surroundings was constructed in the model using digital terrain mapping and information on the planned building, road, and airstrip layouts. The model space was then populated with the identified noise sources and the associated sound power levels. Sensitive points of reception within the Noise LSA, including locations of interest to the Human Health and Ecological Risk Assessment and the aforementioned leased properties, were plotted at the provided coordinates as shown in Figure 6.2-4. The model was then run to calculate sound levels associated with each source active in each Project phase at each of the identified points of reception, and these were compared to the baseline levels discussed in Section 6.2.3 and/or the sound level limits summarized in Section 6.2.1.2. Additional details regarding the model configuration are provided in Appendix 6-E.

6.2.4.2.1 Potential Effect 1: Ldn and Increase in %HA

The first potential effect relates to the parameters associated with the Health Canada guidelines. There were found to be no predicted exceedances of the Health Canada limits for either of the modelled scenarios (Construction or Operation). The maximum predicted total Ldn was 42.3 dBA during Construction (Figure 8 in Appendix 6-E) and 40.4 dBA during Operation (Figure 10 in Appendix 6-E), which are well below the criterion of 75 dBA. Both were predicted at the property identified as 302586/Risk2, which is a seasonal cabin where recreational activities such as fishing may occur for a few weeks each summer located southeast of the Project Area at the south end of

McGowan Lake (Figure 6.2-4). When adjusted by +10 dBA and converted to %HA, and then compared to the adjusted baseline %HA, the predicted change in %HA at this location was +1.3% and +0.7% for Construction and Operation, respectively. These are each below the criterion of +6.5%. Contour plots depicting the %Ha are presented in Figures 9 and 11 in Appendix 6-E.

6.2.4.2.2 Potential Effect 2: Daytime and Nighttime Sound Levels

The second potential effect is associated with the provincial guideline under which daytime and nighttime sound levels were assessed and compared to the PSLs discussed in Section 6.2.1.2 and established based on the baseline conditions discussed in Section 6.2.3.2.

The daytime sound levels were not predicted to exceed the PSL of 40 dBA at any of the identified receptors in either scenario. The maximum predicted daytime sound levels were predicted at the property identified as 302586/Risk2 and were 35.8 dBA during Construction and 34.1 dBA during Operation. The increase in sound level at this location was found to be primarily attributable to drilling activity in the wellfield, concrete batching, and movement of trucks on the access road.

The nighttime sound levels were not predicted to exceed the PSL of 36 dBA at any of the identified receptors during Construction or Operation. As with the daytime sound levels, the maximum predicted nighttime sound levels were predicted at the property identified as 302586/Risk2. The predictions at this location were 35.9 dBA and 34.0 dBA for Construction and Operation, respectively. Detailed contour plots are presented in Figures 12-15 in Appendix 6-E.

As these are not impulse or tonal sources, no adjustments were made to the source sound levels. The crusher was modelled at its maximum sound output, while the diesel-powered equipment (e.g., dozers, drill rigs) were adjusted for partial operation over the respective daytime and nighttime periods. To account for potential issues resulting from equipment operating at maximum levels (as opposed to daytime and nighttime averages), the models were run with the partial operation adjustments removed, for comparison to the Health Canada recommended criteria value of 45 dBA Lmax at night. The predictions at the nearest human receptors did not exceed 45 dBA Lmax for either Construction or Operation.

6.2.4.2.3 Potential Effect 3: Change in Ld and Ln

In terms of incremental increases in sound level over the baseline conditions, it was found that the maximum increase was during Construction in the daytime hours at location 302586/Risk2 and was in the order of +5.1 dBA. In relation to the criteria in Table 6.2-2, an increase of greater than 5 dBA is considered a moderate effect. The nighttime increase of +4.6 dBA during Construction is considered a *Low* effect in accordance with Table 6.2-2. The increase in sound levels at this location was primarily due to construction activity in the wellfield, concrete batching and associated activity, and truck movements along the access road from Highway 914. During Operation, the maximum increase in sound level was predicted at 302586/Risk2 in the order of +3.4 dBA during the day and

+2.7 dBA during the night. These are associated with low and marginal effect ratings in accordance with Table 6.2-2. The increase in sound at this location is primarily due to wellfield activity, truck movements on the access road from Highway 914, and the operation of the two emergency generators (included as a worst-case scenario, not part of the standard operating condition). Detailed contour plots are presented in Figures 12-15 in Appendix 6-E.

6.2.5 Mitigation Measures

Strategies to reduce the likelihood and magnitude of the predicted effects include source elimination and utilizing planning measures to counter the conditions that contributed to the predicted effects. Mitigation measures to be applied during both Construction and Operation include:

- not using the concrete batching plant and crusher during nighttime hours, where possible;
- locating the concrete batching operation as far away from sensitive locations as possible;
- directing the generator discharge openings away from sensitive locations;
- making use of available on-site obstructions to control sound exposure at sensitive areas (i.e., locate sources behind buildings); and
- collecting sound level measurements from the identified sources once they are operating and determining whether the actual effect is lower than that which was modelled.

6.2.6 Residual Effects Evaluation

The results of the assessment of potential effects indicated that there were no predicted exceedances of the federal or provincial noise criteria (first and second potential effects). The increases in sound level (third potential effect) result in a moderate effect at one receptor during Construction in the daytime hours, which based on Table 6.2-2 may be perceptible and potentially objectionable. As a conservative measure, this has been carried forward as a residual effect. Characterization of the residual effects are discussed in the following section.

6.2.6.1 Residual Effects Characterization

General definitions of the residual effects characteristics are provided in Table 5.8-1 in Section 5. Residual effects characteristics specific to the Noise VC are defined in Table 6.2-7.

Table 6.2-7: Noise – Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Negative effect or effect is not desirable. **Positive** – Beneficial effect or effect is desirable.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Low** – Minimal amount of change relative to the range of existing variation. **Moderate** – Moderate amount of change relative to the range of existing variation. **High** – High amount of change relative to the range of existing variation.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the Noise LSA. **Regional** – Effect extends beyond the Noise LSA into the Noise RSA. **Beyond Regional** – Effect extends beyond the Noise RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions. **Partially Reversible** – A residual effect that partially diminishes to baseline conditions. **Irreversible** – A residual effect that will not diminish to baseline conditions.
Context	Since Noise is an intermediate VC, the context is best defined in the significance determination of the receptor VCs including various VCs in the Terrestrial Environment, Indigenous Land and Resource Use, and Other Land and Resources Use assessments.	
Likelihood	Likelihood that the residual effect will occur, including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability that the residual effect will occur. **Unlikely** – A low probability that the residual effect will occur.

The residual effects criteria defined in Table 6.2-7 have been applied to the change in sound level during daytime Construction hours, which was the only scenario with a residual effect. An assessment of the residual effect is summarized in Table 6.2-8.

Table 6.2-8: Noise – Summary of the Characteristics Ratings for Residual Effect 1 (Construction, Daytime Increase over Baseline)

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Increased noise is considered an undesirable effect.
Magnitude	Moderate	The predicted increase is greater than 5 dBA but less than 10 dBA.
Geographic Extent	Local	The receptor is located in the Noise LSA.
Duration	Short-term	The increase of greater than 5 dBA is only related to Construction.
Frequency	Frequent	The increase during the daytime is related to sources that operate continuously (drilling, generators, concrete batching, truck movements).
Reversibility	Fully Reversible	Sound levels are expected to return to baseline as sources cease to operate.
Context	Context is described for receptor VCs	
Likelihood	Likely	Sound levels are associated with equipment that is likely to operate on a continuous basis.

6.2.6.2 Significance and Confidence

6.2.6.2.1 Significance

As discussed in Section 5.8.1.2.1, significance is determined for VCs that represent assessment endpoints (e.g., Ungulates, Furbearers, Woodland Caribou, Indigenous Land and Resource Use, Other Land and Resource Use). Since the results of the Noise assessment feed into these other assessment endpoints, the results of the residual effects characterization for Noise do not have significance determinations of their own. See Sections 9 and 11.

6.2.6.2.2 Confidence

To have confidence that the predictions completed in support of this assessment will bound the actual observed conditions upon Project commencement, a series of conservative assumptions were implemented at each stage of the assessment. It should be noted that the ISO 9613-2 method that the predictive model implemented for sound propagation indicates that the estimated accuracy of the predictions is ±3 dB (ISO 1996). This would indicate that if all sources were characterized accurately, and the model conditions reflected actual conditions (e.g., meteorology, reflective parameters), then the model predictions would be within 3 dB of a measured level at the point of prediction. To have confidence in the bounding of the predictions for this assessment, the source sound level inputs and model configuration were set with conservatism. The assumptions to facilitate a conservative assessment are summarized in the following bullets:

- Sound power levels for mechanical equipment were calculated from literature based on the rated power for each source in the equipment list developed for the prefeasibility study (Denison 2018). To remain conservative, the rated powers for sources such as pumps and motors were doubled.
- Sound power levels for mobile construction equipment were calculated from literature using the maximum rated power for the associated expected manufacturer model.
- Generators were modelled at the maximum rated power levels, whereas they are actually likely to operate at partial load.
- The assessment scenarios account for all associated equipment running simultaneously and continuously (except for inherently intermittent sources such as vehicle trips).
- A gap analysis memo/model inputs summary was prepared for review by Denison prior to modelling, to make sure that the source list was reflective of current Project plans and that the modelling reflected the worst-case operating scenario for each phase.
- Modelling was completed using the temperature and relative humidity settings that resulted in the highest predicted sound levels. As per the model defaults, all receptors were treated as being downwind regardless of actual location relative to Project activities.

Details regarding the source sound levels and calculations, as well as the detailed model configuration, are provided in Appendix 6-E.

6.2.6.3 Summary of Project-Related Residual Adverse Effects on Noise

Residual effects were predicted at one location (i.e., the cabin at 302586/Risk2). The effect was limited to daytime hours during Construction, where daytime sound levels were predicted to increase by +5.1 dBA, resulting in a moderate effect. It should be noted that the federal and provincial criteria were not exceeded at this receptor location, nor at any other receptor location included in the assessment. Effects during Construction were predicted to be short-term (less than three years). The mitigation measures discussed in Section 6.2.5 are expected to assist in reducing the likelihood of this effect occurring.

6.2.7 Cumulative Effects

The Project Area will be accessed from Highway 914 by a proposed access road. Highway 914 is approximately 3.4 km (direct) from the developed Project site, or approximately 5 km by the proposed access road. The Cameco McArthur River Operation and Key Lake sites are currently in Care and Maintenance mode; therefore, there is currently no truck traffic between the sites on Highway 914. When these sites are to become operational again, there is potential for a cumulative effect at sensitive locations near the highway. Based on traffic volumes documented as part of the Millennium Project EA and summarized in a memo prepared by Denison (Denison 2022), the estimated daily truck traffic on Highway 914 when McArthur River and Key Lake are operating is approximately 58 trucks per day. A model was prepared that estimated the contributing sound levels of this amount of traffic on Highway 914 at each of the sensitive receptors included in the assessment. At location 302586/Risk2 (where the maximum effect of the Project was predicted), the predicted Ldn due to truck traffic was 18.3 dBA, which would not change the predicted sound levels when added on a logarithmic basis and therefore not change the assessment results based on the Health Canada guidelines. Similarly, the predicted daytime and nighttime levels at 302586/Risk2 due to anticipated Cameco truck traffic were each 11.9 dBA, which would also not change the predicted sound levels when added on a logarithmic basis, and therefore not change the assessment results based on the provincial guidance.

There are two leased properties that are closer to Highway 914 than 302586/Risk2: 301493 (125 m) and 602377 (240 m). The contributions from the Project at these locations were well below background (i.e., not expected to change the background noise levels). The increases in sound level at these locations (or any of the other locations included in the assessment) due to the addition of Cameco traffic to the model did not result in any exceedances of the federal or provincial guidelines, and incremental increases remain in the marginal to low range.

6.2.7.1 Climate Change Considerations

The generation of noise is not generally considered to be a factor that inherently or directly influences climate change. That said, climatological factors may influence the propagation of noise, and may also change the nature of operations. For instance, if temperatures warm, then cooling equipment (and electricity generation required to run it) may run longer and under greater loads, resulting in greater sound levels over longer periods. In terms of propagation, meteorological conditions such as temperature and relative humidity may influence the propagation of sound. The modelling was completed using a combination that generally results in the most conservative predictions (low temperature and high humidity). Temperature inversions are another climate-related occurrence that may affect noise propagation as temperature inversions act to refract sound waves that would otherwise disperse in the atmosphere back to the ground, resulting in further propagation. If climate change were to increase the frequency of temperature inversions, then sound levels from Operation would be expected to travel further; however, it should be noted that the modelling for this assessment accounts for moderate temperature inversions in the predictions and further assumes all receptors are downwind. Lastly, it should also be noted that sources of noise are often associated with sources of air emissions, which may then affect climate change depending on the releases. Climate change considerations related to Air Quality are discussed in Section 6.1.7.1.

6.2.8 Monitoring and Follow-up

An EMS will be implemented and include noise management and monitoring plans to confirm that the Project is compliant with the federal and provincial guidelines that have been adopted for this assessment during both Construction and Operation. Noise monitoring will be similar in nature to baseline monitoring that was completed in support of this assessment and will be completed twice per year to capture seasonal variability. The monitoring program will incorporate requirements directed by provincial and federal regulators and will seek and include input from Indigenous groups and other Interested Parties as requested.

The monitoring program will be developed in accordance with the following outline, provided as required by the EIS Guidelines. Prior to the commencement of the first routine noise monitoring campaign during Construction, Indigenous Groups and other Interested Parties will be notified of the monitoring schedule and planned locations. Initially, the proposed locations will be the same locations as were used in the baseline program for direct comparison of the data to the baseline conditions. These locations may be revised or expanded upon to include other locations based on feedback received. At the same time, Indigenous Groups and other Interested Parties will also be notified of how noise complaints may be registered. If a noise complaint is received, the associated monitoring would then take place at the location of the complainant.

Upon receiving a noise complaint, the responsible Denison environmental staff will implement a complaints response and resolution process, documented using a complaints management form.

The information to be recorded during the registration of the complaint will include the name and contact details of the complainant, the nature of the complaint, a description of the possible source(s) at the site associated with the complaint. Sound levels will then be monitored at the location of the complainant according to the description below, and a recommended action will be identified within two days with a timeline for implementation. Follow-up with the complainant will then take place to ensure that the issue has been resolved and follow-up monitoring will be completed where appropriate. Once the complainant is satisfied that that the issue has been resolved, the complaint will be formally closed out and a summary report will be completed by Denison and kept on file.

Routine and complaints-based noise monitoring will utilize the same methods as the baseline monitoring program, as described in Section 6.2.3. Sound levels will be monitored on a continuous basis using a calibrated Class 1 sound level meter and data logger, calibrated to a National Institute of Standards and Technology traceable standard within one year of its use in the program, and field calibrated using a Class 1 acoustic calibrator. The sound level meters log sound levels on a minimum one-hour basis (and logged on the hour for direct comparison to site meteorological data). At a minimum, the parameters to be logged include the energy equivalent sound level (Leq) and statistical parameters (Lmin, Lmax, L10, L50 and L90) logged on a continuous basis, and the Ldn logged on a 24-hour basis (midnight to midnight). The collected data will be compared with hourly meteorological data collected on-site for purposes of validation. The same validation parameters as outlined in Table 6.2-3 will be used. Any data collected under unrepresentative conditions will be discarded prior to analysis. For routine monitoring, the programs will be of a minimum one-week duration. For complaints-based monitoring, the duration will be set based on the nature of the complaint.

6.2.9 Noise Summary

Noise was selected as a VC in general based on the likelihood of Project-related activities to interact with and change the existing sound environment. Any change to the existing sound environment in the vicinity of the Project has the potential to affect Indigenous groups and the public in terms of creating nuisance noise that may affect human health and change animal behaviours as related to hunting activity. The assessment of Noise included a baseline monitoring program to establish existing conditions and the use of predictive models to assess how the Project may change the sound environment from existing conditions. The predicted changes to the sound environment were then assessed against federal and provincial guidelines to determine if the effects of the Project were significant and if mitigation measures were required.

Federal and provincial guidance documents include procedures for predicting the effects of a project, including the specific parameters to be assessed (e.g., 24-hour sound levels, daytime sound levels, nighttime sound levels, and measures of community annoyance) and thresholds for each parameter to be used to assess the effects. For instance, Health Canada uses a 24-hour sound level metric and a change in sound level between existing and future conditions to evaluate the effects of a project. The guidelines also identify the appropriate means of assessing project-related sound levels, which include predictions using internationally recognized software. The software used for these predictions was Cadna-A from DataKustik GmbH, which is based on ISO Standard 9613-2, being the industry standard for industrial noise predictions.

Sources associated with the Project were identified using information detailing the process description and feasibility studies developed to identify equipment requirements. Sound levels were conservatively calculated using engineering calculation approaches, manufacturer data, or measurement data for similar sources at similar sites. The site infrastructure and sources were input in the model and sound levels were predicted at sensitive locations, including leased properties and locations of interest to the Human Health and Ecological Risk Assessment. The predicted sound levels were then compared to the baseline sound levels and the thresholds from the guidance documents.

The predicted sound levels were below the threshold values from the federal and provincial guidelines at all receptor locations, indicating that additional mitigation measures would not be required. The closest sensitive location to the Project is a cabin identified as leased property 302506. While the predicted sound levels were less than the guideline values, the increase from baseline was predicted to be noticeable. Therefore, as a conservative approach, this effect was carried forward as a residual effect and mitigation measures and follow-up monitoring were recommended.

6.2.10 References

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Appendix 6-A Air Quality Technical Supporting Document

See file “S6_App 6-A Air Qualty TSD_Wheeler River”

Appendix 6-B Engagement Database Summary – Atmospheric and Acoustic Environment

See file: “S6_App 6-B Atmospheric & Acoustic Engagement_Wheeler River.pdf”

Appendix 6-C Climate Baseline and Greenhouse Gas Emissions Report

See file “S6_App 6-C Climate Baseline and GHG Emissions Report_Wheeler River.pdf”

Appendix 6-D Baseline Air Quality Monitoring Report

See file “S6_App 6-D Baseline Air Quality Monitoring_Wheeler River.pdf”

Appendix 6-E Acoustic Assessment Technical Supporting Document

S6_App 6-E Acoustic TSD_Wheeler River.pdf

Denison Mines

Wheeler River Project

Final Environmental Impact Statement

November 2024

Powering PEOPLE, PARTNERSHIPS AND PASSION.

Wheeler River Project

Final Environmental Impact Statement

Section 7 – Geology and Groundwater

November 2024

Denison Mines

Denison Mines Corp.

345 4th Avenue South

Saskatoon, SK, S7K 1N3

Roadmap

This roadmap of the Wheeler River Project Environmental Impact Statement (EIS) has been provided to summarize the main document sections and appendices of the EIS.

Wheeler River Project
Environmental Impact Statement

Executive Summary

PART I: INTRODUCTION AND CONTEXT	PART II: BIOPHYSICAL ENVIRONMENTAL ASSESSMENTS	PART III: HUMAN ENVIRONMENT ASSESSMENTS	PART IV: INTEGRATED TOPICS AND SUMMARY
Section 1: Project Introduction and Overview	Section 6: Atmospheric and Acoustic Environment	Section 10: Human Health	Section 14: Accidents and Malfunctions
Section 2: Project Description	Section 7: Geology and Groundwater	Section 11: Land and Resource Use	Section 15: Effects of the Environment on the Project
Section 3: Indigenous and Local Knowledge	Section 8: Aquatic Environment	Section 12: Quality of Life	Section 16: Assessment Summary and Conclusions
Section 4: Engagement	Section 9: Terrestrial Environment	Section 13: Economics	
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Abbreviations, Acronyms, and Units

Abbreviation / Acronym	Definition
COPC	Constituent of potential concern
CSM	Conceptual Site Model
Denison	Denison Mines Corp.
EA	Environmental assessment
EC	Electrical conductivity
EIS	Environmental Impact Statement
GWMP	Groundwater Monitoring Plan
IK	Indigenous Knowledge
ISR	In situ recovery
KI	Key Indicator
LK	Local Knowledge
LSA	Local Study Area
MF	Manitou Falls
MP	Measurable Parameter
ORP	Oxidation-Reduction Potential
Project	Wheeler River Project
RSA	Regional Study Area
VC	Valued Component
VWP	Vibrating wire piezometer

Units	Definition
%	percent
cm	centimetre
km	kilometre
km^2	square kilometre
L/s	litre per second
m	metre
masl	metres above sea level
mbgs	metres below ground surface
m^3	cubic metre
m/s	metre per second
m^3/hr	cubic metre per hour
m^3/s	cubic metre per second
mg/L	milligram per litre
µS/cm	microsiemen per centimetre

Glossary

Term	Definition
Adsorption	The retention of atoms, ions, or molecules onto the surface of another substance.
Advection	Process by which a solute is transported in groundwater and moves at the same velocity.
Alluvial (material, deposit, sediment, fan)	Unconsolidated material deposited in a sorted or semi-sorted condition by a stream or other body of running water, in a stream bed, floodplain, delta or at the base of a mountain slope as a fan.
Aquifer	Rocks or unconsolidated sediments that are capable of yielding a significant amount of water to a well or a spring.
Aquifer Test	A test which involves adding to or discharging from a well, measured quantities of water, and recording the resulting changes in head in the aquifer (during and after addition/withdrawal). Examples are slug tests, bail tests, and pumping tests.
Aquitard	A geologic formation that may contain groundwater but is not capable of transmitting significant quantities of groundwater under normal hydraulic gradients. In some situations, aquitards may function as confining beds.
Attenuation, Attenuate	The reduction or removal of groundwater constituents by the sum of all physical, chemical, and biological factors acting upon the groundwater. In geophysical terms, it refers to a reduction in energy or amplitude caused by the physical characteristics of a transmitting system.
Average Linear Groundwater Velocity	The velocity of groundwater moving through porous rock or sediment. It is the time required for the water to move from A to B divided by the linear distance from A to B.
Background concentration	The amount of a substance typically found in the air, water, or soil from non-site related activities.
Base Flow	The sustained low flow in a stream. Generally base flow is the inflow of groundwater to the stream.
Bedrock	A general term referring to rock that underlies unconsolidated material.
Borehole	A hole drilled or bored into the earth, and into which casing, screen, etc. may be installed to construct a well.
Borrow Pit	An excavated area where soil, sand, or gravel has been dug up for use elsewhere.
Boundary Condition	A specified numerical condition (e.g., specified water level or rate of flow in, or out, of a model) at a location within a mathematical model. Process variables are primarily computed (i.e., simulated) for nodes without boundary conditions.
Bounding	Bounding in the context of environmental assessment refers to establishing the limits or boundaries within which the assessment will be conducted. In this Section (Geology and Groundwater), the term bounding has been used specifically to establish the range, or upper or lower limit(s) (as specified), of values considered conservative and appropriate for the assessment based on available information in the literature and Project/site-specific testing (metallurgical, hydrogeological, etc.,).
Calibration	The process of matching a model simulation with observed data. Typically, one or more model parameters are varied within reasonable limits until a suitable match is obtained.
Characterization	A determination of the approximate concentration range of compounds of interest used to choose the appropriate analytical protocol. Also applied to refer to conceptualization of hydrogeologic conditions.
Conceptual (Site) Model	The idealization of a hydrogeological system which acts as a basis of further evaluation (e.g., mathematical model). The conceptual model includes assumptions on the hydrostratigraphy, material properties, dimensionality and governing processes.

Term	Definition
Confined Aquifer	A fully saturated aquifer overlain by a confining layer. The potentiometric surface (i.e., hydraulic head) of the water in a confined aquifer is at an elevation that is equal to or higher than the base of the overlying confining layer. Pumping wells in a confined aquifer lower the potentiometric surface which forms a cone of depression, but the saturated media remains saturated.
Connectivity	The degree to which a fracture network is connected. When defined statistically, fracture connectivity can be used to generate many different fracture network realizations for use in groundwater flow and mass transport models.
Conservative	A dissolved substance which moves as fast as water in the groundwater system and is not prone to attenuation beyond that occurring by diffusion and/or dispersion.
Consolidated	Naturally occurring geologic material that has been lithified and so has strength and resists disintegration.
Constituent	A component of a system or group (e.g., an ion within a suite of ions dissolved in groundwater).
Containment	The process of enclosing or containing hazardous substances in a structure, typically in a pond or lagoon, to prevent the migration of Constituents of Potential Concern into the environment.
COPC	Constituents of Potential Concern. Any physical, chemical, biological, or radiological substance in air, soil or water that could increase a concentration above background or baseline conditions.
Core	A continuous columnar sample of subsurface material extracted from a borehole. Such a sample preserves the features of the sampled material.
Corehole	The hole in the earth that remains after rock core has been collected. The corehole may naturally collapse when in unconsolidated deposits or remain open in solid rock environments.
(Drill) Cuttings	The rock fragments, sand grains, etc. produced at the drill bit by the drilling action and circulated to the surface in the drilling fluid where they can be sampled.
Decay	The gradual reduction in the magnitude of a quantity.
Density	The amount of mass per unit volume.
Desorption	Process of removing a sorbed substance by reversing adsorption or absorption.
Discharge	The rate of flow at a given time, measured as volume per unit time.
Discharge Area/Zone	An area in which there is upward groundwater flow in the subsurface. Groundwater flows toward the surface in a discharge area and may escape as a spring, seep, or baseflow, or by evaporation and transpiration.
Dispersion	The process by which a substance or chemical spreads and dilutes in flowing groundwater or soil gas.
Dissolution, Dissolve	Process of dissolving a solid to form ions or molecules uniformly distributed in water or another solvent.
Domain	In modelling, the segment of the subsurface being considered. It is defined by its boundaries and interior geometry (based on its hydrostratigraphy), and its material properties (porosity, hydraulic conductivity, etc.).
Downgradient	A downward hydrologic slope that causes groundwater to move toward lower elevations. Therefore, wells downgradient of a contaminated groundwater source are prone to receiving pollutants.
Drainage Pattern	The arrangement of natural stream courses in an area, in plan view. It depends on local geologic/geomorphologic features and history.

Term	Definition
Drawdown	A lowering of the water table of an unconfined aquifer or the potentiometric surface of a confined aquifer caused by pumping of groundwater from wells. The vertical distance between the original water level and the new water level.
Drumlin	Irish term for a small hill. Consists of glacial drift shaped by ice action into a 'hog- back', which is oval in plan and has its long axis pointing in the direction of ice movement. Drumlins often occur in groups.
Effective Porosity	The amount of interconnected pore space through which fluids can pass. Effective porosity is usually less than total porosity because some dead-end pores may be occupied by static fluid.
Esker	A narrow long ridge like form comprised mainly of gravel and sand. These stratified glacio-fluvial deposits were formed in a stream bed flowing inside the ice of a glacier generally at the glacier bottom. The glacio- fluvial deposits were then left in place after the ice melted.
Fate	The immediate or ultimate change in a chemical typically brought about by chemical or biological reaction.
Fault/Fault Zones	A fracture or zone of fractures along which there has been a displacement of the sides relative to one another and parallel to the fracture.
Finite Element (Model, Code)	An advanced numerical technique for solving partial differential equations, most useful for hydrogeological sites with complex geometry. As with finite difference models, a finite element model solves the hydrogeological system over a grid of many subregions, or elements.
Fluid Flux	The volume of flow movement through a unit cross-sectional area per unit of time due to a hydraulic gradient. Mass flux is the rate of movement of mass through a unit cross-sectional area per unit time in response to a concentration gradient or some advective force.
Fracture	A break in a rock formation as a result of structural stresses (e.g. faults, joints, shears). If they are open, fractures may provide pathways for fluid movement.
Geology	The science that deals with the earth's physical structure and substance, its history, and the processes that act on it.
Geomorphology	Geomorphology is the science dealing with the origin and evolution of landforms.
Glaciofluvial (Deposits)	Deposits related to the joint action of glaciers and meltwater streams.
Gradient	The rate of change in value of a physical or chemical parameter per unit change in position. For example, hydraulic gradient is equal to the difference in hydraulic head measured at two points (usually wells) divided by the distance separating the two points. The dimensions of head and distance are both lengths, therefore the gradient is expressed as a dimensionless ratio (L/L). A concentration gradient refers to the difference in concentration between two points and would have units of concentration over distance.
Groundwater	Underground water that fills pores in soils or openings in rocks to the point of saturation. In aquifers, groundwater occurs in sufficient quantities for use as drinking and irrigation water and other industrial purposes.
Groundwater Flow	Movement of water through openings in sediment and rock within the saturated zone.
Groundwater modeling/Model	A conceptual, mathematical, or physical system intended to represent a real system. A model's behaviour is used to understand processes in the physical system to which it is analogous.
Groundwater Plume	Constituents of Potential Concern (COPC) which dissolve into a groundwater system and are moved down gradient. The area of the aquifer containing the degraded water which resulted from the migration of a COPC is called a plume.
Groundwater Quality Assessment	The process of analyzing the chemical characteristics of groundwater to determine whether any hazardous materials exist.
Groundwater Table	That surface below which rock, gravel, sand or other material is saturated. It is the surface of a body of unconfined groundwater at which the pressure is atmospheric.

Term	Definition
Grout	A watery mixture of cement (and commonly bentonite) without aggregate that is used to seal the annular space around well casings to prevent infiltration of water or short-circuiting of vapor flow.
Heavy Metals	Metallic elements, some of which are required in trace concentrations for plant and/or animal nutrition, but which become toxic at higher concentrations (e.g., lead, copper).
Heterogeneity	The part of the subsurface that is different in some property (hydraulic conductivity, for example).
Heterogeneous	Composed of non-uniform constituents whose material properties vary in space. All geological material is heterogeneous, but the property of interest (porosity, for example) may be sufficiently uniform for the material to be treated as homogeneous in terms of that property.
Hydraulic Conductivity	A measure of the ability of a fluid to flow through a porous medium determined by the size and shape of the pore spaces in the medium and their degree of interconnection and also by the viscosity of the fluid. Hydraulic conductivity can be expressed as the volume of fluid that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow.
Hydraulic Gradient	The change in water level with distance. The concept is applicable to groundwater or surface water.
Hydraulic Head	Height above a datum plane (such as mean sea level) of the column of water that can be supported by the hydraulic pressure at a given point in a groundwater system. Equal to the distance between the water level in a well and the datum plane.
Hydrogeological Conceptual Model	A representation, often simplified and perhaps conceptual, of the hydrogeological flow system. The aspects important for the site are emphasized. See also model.
Hydrogeology	The study of groundwater, with particular emphasis on the chemistry and movement of water. The branch of geology concerned with water occurring underground or on the surface of the earth.
Hydrologic Cycle	The continued circulation of water between the ocean, atmosphere and land is called the hydrologic cycle.
Hydrostratigraphic Unit	A formation, part of a formation, or a group of formations which have similar hydrologic characteristics.
Igneous Rock	A rock or mineral which solidified from molten or partly molten material i.e., from a magma.
In situ	In its original place; unmoved; unexcavated; remaining in the subsurface.
Infiltration	The movement of water or other liquid down through soil from precipitation (rain or snow) or from application of wastewater to the land surface.
Lacustrine	Formed in, produced by or pertaining to a lake.
Landfill	A disposal facility where waste is placed in. Sanitary landfills are disposal sites for non-hazardous solid wastes. Secure landfills are disposal sites for hazardous waste. They are designed to minimize the chance of release of hazardous substances into the environment.
Leach, Leaching	The process by which soluble chemical components are dissolved and carried through soil by water or some other percolating liquid.
Leachate	A solution produced by the percolation of liquid through soil or solid waste, and the dissolution of certain constituents in the water.
Leachate Collection System	A system that gathers liquid that has leaked into a landfill or other waste disposal area and pumps it to the surface for treatment.
Lithology, Lithologic	A system for the description of rocks, with respect to mineral composition and texture.

Term	Definition
Mapping	Locating geological, chemical or geophysical information in space (as opposed to time, which is monitoring). The results are usually summarized of maps.
Mass Flux	Like fluid flux, but the mass of a chemical dissolved in groundwater which moves through a specified cross-sectional area per unit time.
Matrix	The solid framework of a porous medium. In fractured rock, matrix refers to the unfractured rock.
Migration	The movement of chemicals, bacteria, gases, etc. in flowing water or vapour in the subsurface.
Mineralogy	The study of minerals; formation, composition, properties, classification and occurrence.
Mineralization (context: uranium ore)	The process of formation and distribution of uranium minerals within a (uranium) ore body
Mineralization (context: groundwater)	The outcome of mineral dissolution in water. The extent of mineral dissolution is expressed as the total dissolved solids (TDS) in water, including groundwater.
Mitigation	Actions taken to improve site conditions by limiting, reducing, or controlling toxicity and sources.
Monitoring	Observing the change in a geophysical, hydrogeological or geochemical measurement with time.
Monitoring Wells	Special wells drilled at specific locations within, or surrounding, a hazardous waste site where groundwater can be sampled at selected depths and studied to obtain such information as the direction in which groundwater flows and the types and amounts of contaminants present.
Non-Unique	In geophysical interpretation and mathematical modelling, a problem for which two or more subsurface models, or parameter distributions, satisfy the observation data equally well.
Ore deposit	The economic portion of the uranium mineralize area that is being mined
Organic Compound	Substances containing carbon, with the exception of carbon dioxide (CO2) and carbonates (e.g., calcium carbonate, CaCO3).
Outwash (Deposits)	Stratified drift deposited by meltwater streams flowing away from melting ice.
Overburden	The layer of fragmented and unconsolidated material including loose soil, silt, sand and gravel overlying bedrock, which has been either transported from elsewhere or formed in place.
Oxidation-Reduction (redox)	A chemical reaction consisting of two half-reactions; an oxidation reaction in which a substance loses or donates electrons, and a reduction reaction in which a substance gains or accepts electrons. Redox reactions are always coupled because free electrons cannot exist in solution and electrons must be conserved.
Packer	A device placed in a well or borehole to isolate or seal a section at a certain level.
Paleoweathered	A weathering profile of a vertical assemblage of weathering zones (subsurface zones of bedrock alteration differing physically, chemically, or mineralogically from adjacent zones) as compared to the unaltered bedrock.
Partitioning	Chemical equilibrium condition where a chemical's concentration is apportioned between two different phases according to the partition coefficient, which is the ratio of a chemical's concentration in one phase to its concentration in the other phase.
Permeability	A qualitative description of the relative ease with which rock, soil, or sediment will transmit a fluid (liquid or gas). Often used as a synonym for hydraulic conductivity or coefficient of permeability.
pH	A measure of the acidity of a solution. pH is equal to the negative logarithm of the concentration of hydrogen ions in a solution. A pH of 7 is neutral. Values less than 7 are acidic, and values greater than 7 are basic.

Term	Definition
Phase	A homogeneous, physically distinct portion of the subsurface. For example, groundwater, soil gas.
Piezometer	A non-pumping well, generally of small diameter, which is used to measure the elevation of the water table or potentiometric surface. A piezometer generally has a short well screen and the water level within the casing is considered to be representative of the potentiometric surface at that particular depth in the aquifer.
Piezometer Nest	A set of two or more piezometers set in close proximity to one another but screened at different depths. This allows for determination of vertical flow gradients or differences in water chemistry with depth.
Plume	Constituents of potential concern dissolved in groundwater or vapour originating from a specific source and influenced by certain factors such as local groundwater or soil vapour flow patterns and character of the aquifer. The zone of impacts that exhibits dissolved-phase constituents at concentrations above some specified concentration level, such as background or baseline conditions.
Pore (Space)	An opening, void or interstice in a soil or rock mass.
Porosity	The ratio of the volume of pore spaces in a rock or sediment to the total volume of the rock or sediment.
Porosity, Primary	The pore spaces which were created at the time of deposition of a soil or rock unit.
Porosity, Secondary	The pore spaces which were created after the time of deposition of a soil or rock unit (e.g. fractures, solution channels).
Precipitation	a) Formation of solids out of dissolved constituents; it is caused by a change in conditions (e.g. temperature) b) Water that falls to the ground surface from the atmosphere as rain, snow, hail, sleet, etc..
Pumping Test	An aquifer test in which a well is pumped for a certain period of time and the change in hydraulic head in observation wells is recorded. It is used to determine the capacity of a well and hydraulic characteristics of the aquifer.
Radionuclide	A material with an unstable atomic nucleus that spontaneously decays or disintegrates, producing radiation. Nuclei are distinguished by their mass and atomic number.
Recharge	Addition of water to the groundwater system by natural or artificial processes.
Recharge Area/Zone	Area in the aquifer where there are downward components of hydraulic head. In this area, infiltration travels downward into the deeper sections of the aquifer.
Recovery	The rise in static water level in a well, after discharge from that well or a nearby well has ended.
Redox	Short for oxidation-reduction.
Reducing (Conditions)	Geochemical conditions favouring reduction reactions (e.g., SO4- conversion to H2S). Indicated by the occurrence of reduced forms of iron (Fe2+) and other species.
Residual	The amount of a pollutant remaining in the environment after a natural or technological process has taken place, e.g., the sludge remaining after initial wastewater treatment, or particulates remaining in the air after the air passes through a scrubbing or other process. This term can also be used in numerical modelling studies to refer to the difference between a simulated and observed value (e.g., water level).
Retardation, Retard	Retention of certain Constituents of Potential Concern in the subsurface due to one or more physical, chemical, or biological factors. Also known as attenuation.
Rock quality designation (RQD)	A standard technique in the mining industry for the qualitative and quantitative assessment of rock quality and degree of jointing, fracturing, and shearing in a rock mass.
(Overland) Runoff	That part of precipitation flowing overland to surface streams.

Term	Definition
Sample	A portion of material to be analyzed that is contained in single or multiple containers and identified by a unique sample number.
Saturated (Zone)	Portion of the subsurface environment in which all voids are ideally filled with water under pressure greater than atmospheric. The water table is the top of the saturated zone in an unconfined aquifer.
Sediment	The layer of soil, sand and minerals at the bottom of surface waters, such as streams, lakes and rivers that absorbs Constituents of Potential Concern.
Sensitivity Analysis	After a model is calibrated, a sensitivity analysis is often completed to address the sensitivity of the simulation result to specific input parameters. A sensitivity analysis is useful in determining additional field data requirements and for identifying non-uniqueness.
Solute	A substance dissolved in a solution.
Sorption	Process by which some material leaves the fluid phase and associates with the solid phase. The chemicals associated with the solid phase are sorbed.
Sorptive Retardation	The slowing of a chemical's migration in groundwater or soil vapour due to interaction (sorption/desorption) with the subsurface solids.
Source	A source is generally a mass of residual mass above background or baseline conditions located below ground surface, often below the water table.
Specific Conductance	The ability of a cubic centimeter of water to conduct electricity; depends on the quantity of ionized minerals in it. Measured in microohms per centimeter.
Static Water Level	The level of water in a well that is not being influenced by groundwater withdrawals. The distance to water in a well is measured with respect to some datum, usually the top of the well casing or ground level.
Storativity	The volume of water released from or taken into storage per unit surface area of aquifer, per unit change in head. Also known as storage coefficient.
Stratigraphy	The study of original succession (stratigraphic sequence) and age of unconsolidated materials and rock strata, dealing with their form, distribution, lithologic composition, fossil content, as well as geophysical and geochemical properties.
Surface Water	The portion of water which appears on the land surface; oceans, lakes, rivers, etc.
Surficial (deposits, materials, sediments)	Deposits overlying bedrock and consisting of soil, silt, sand, gravel and other unconsolidated materials.
Terrain Morphology	A stretch of land, especially with regard to its physical features.
Till	Consists of a generally unconsolidated, unsorted, unstratified heterogeneous mixture of clay, silt, sand, gravel and boulders of different sizes and shapes. Till is deposited directly by and underneath glacial ice without subsequent reworking by meltwater.
Topography	The relief and form of the land.
Total Dissolved Solids (TDS)	Concentration of TDS in groundwater expressed in milligrams per litre (mg/L), is found by evaporating a measured volume of filtered sample to dryness and weighing this dry solid residue.
Trace (element)	Any chemical (element) present in minute quantities in soil or water.
Transient	Occurring when the system is still changing with time; i.e., a steady state has not been attained. Most groundwater flow systems are transient, not steady state.
Travel Time	The time it takes (for example) Constituents of Potential Concern to travel from the source to a particular point downgradient.

Term	Definition
Uncertainty	The estimated quantity by which an observed or calculated value may depart from the true value. In numerical models, parameter uncertainty refers to the variance of a parameter from the baseline estimate.
Unconfined	Conditions in which the upper surface of the zone of saturation forms a water table under atmospheric pressure.
Unconfined Aquifer	An aquifer in which there are no confining beds between the capillary fringe and land surface, and where the top of the saturated zone (the water table) is at atmospheric pressure.
Unconsolidated Deposits	Deposits overlying bedrock and consisting of soil, silt, sand, gravel and other material which have either been formed in place or have been transported in from elsewhere.
Unconsolidated Material	Naturally occurring geologic material that has not been lithified into cohesive rock.
Unsaturated Zone	The zone between the land surface and the water table. It includes the root zone intermediate zone, and capillary fringe. The pore spaces contain water, as well as air and other gases at less than atmospheric pressure.
Upgradient	In the direction opposite of groundwater flow. An upgradient are that defines areas from which water would flow toward a contaminated area and, therefore, are not prone to impacts by the movement of groundwater.
Validation	Before a mathematical modelling code can be accepted for use, it must be validated, or proven to realistically simulate the processes for which it was designed. Validation is usually completed by comparing model results against a controlled laboratory or field scale experiment.
Water Balance (Hydrologic Budget)	A record of the outflow from, inflow to, and storage in a hydrologic unit like an aquifer, drainage basin etc.
Water Table	Upper surface of a zone of saturation, where that surface is not formed by a confining unit; water pressure in the porous medium is equal to atmospheric pressure (the phreatic surface). The surface between the vadose zone and the groundwater; that surface of a body of unconfined groundwater at which the pressure is equal to that of the atmosphere.
Watershed	The land area that drains into a stream or other water body.
Weathering	The process during which a complex compound is reduced to its simpler component parts, transported via physical processes, or biodegraded over time.
Well Collar	The height of the top of the casing above the ground surface

7 Geology and Groundwater

Section 7 of the Environmental Impact Statement (EIS) for the Wheeler River Project (the Project) is focused on Geology and Groundwater. The integrated biophysical and human environment assessment approach is illustrated in Figure 7-1. As a guide for EIS reviewers, Figure 7-2 provides a preview of the Valued Components (VCs) associated with the assessments completed in this section of the EIS.

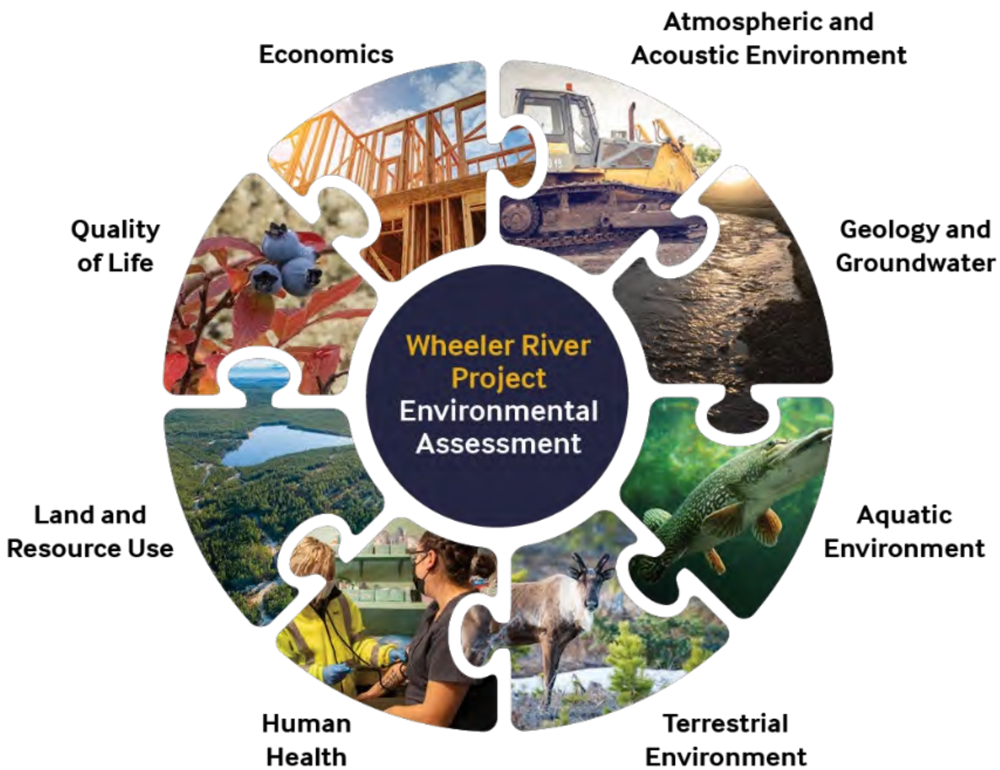

Figure 7-1: Biophysical and Human Environment Assessments for the Wheeler River Project Environmental Assessment

Figure 7-2: Geology and Groundwater – Valued Components

This subsection addresses the potential effects of the Project on the Geology and Groundwater VCs. The Geology and Groundwater VCs are treated together given their close relationship. This approach permits the description of existing and potential future conditions in sufficient detail to enable potential Project VC interactions and effects to be identified, understood, and evaluated.

The following are discussed herein as part of the environmental assessment (EA):

- scope of the assessment;
- influence of Indigenous Knowledge (IK), Local Knowledge (LK), and engagement on the assessment;
- summary of existing conditions relevant to the Geology and Groundwater VCs;
- identification and description of potential interactions between the Project and the Geology and Groundwater VCs;
- identification and description of mitigation measures applicable to the Geology and Groundwater VCs to eliminate, reduce, or control the potential adverse Project-related effects;
- identification of predicted Project-related residual effects on the Geology and Groundwater VCs after mitigation;
- characterization of the level of confidence in the predictions; and

- identification of potential cumulative effects.

Consistent with Section 5 Approach and Methodology of the Assessment, the Geology and Groundwater VCs are considered intermediate VCs, which means they are pathways or linkages to effects on receptor VCs. While a fulsome discussion and interpretation of residual effects on the Geology and Groundwater VCs is provided in this section, the determination of significance of these residual effects is considered within the report sections to which the VCs are linked.

Figure 7-3 is a graphic representation of the assessment process used in this EIS. As shown in Figure 7-3, all VCs selected for this EA went through a thorough residual effect evaluation. Since a change in an intermediate VC may lead to an effect on a receptor VC, significance determination is not completed on intermediate VCs, but integrated into the residual effect evaluation, residual effect characterization, and significance determination for related receptor VCs.

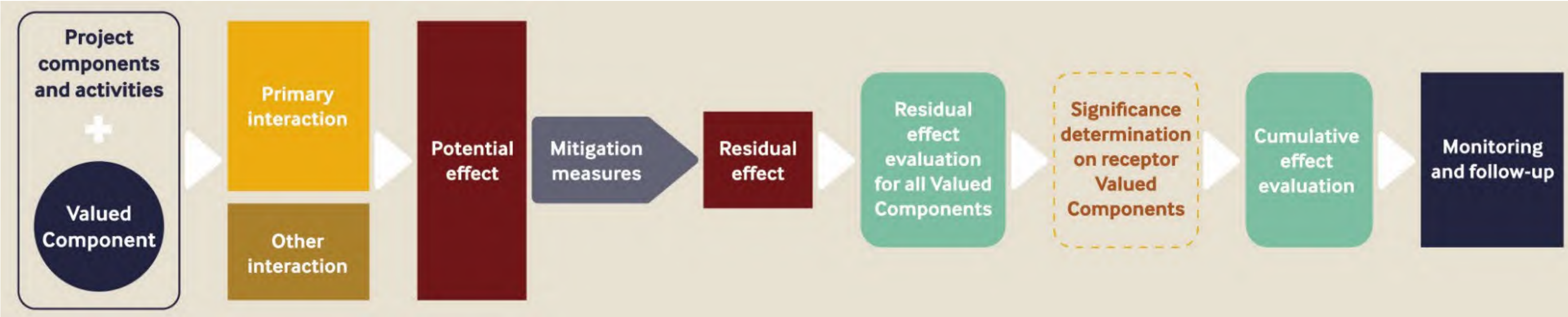

Figure 7-3: Environmental Assessment Process for the Wheeler River Project

7.1 Scope of the Assessment

Geology includes bedrock, soils, and geomorphology (i.e., the study of physical features on the earth and their relationship to underlying geological structures). Groundwater includes groundwater quantity and quality. The Geology and Groundwater assessment follows the overall EA approach and methods described in Section 5 and seeks to understand and characterize the potential residual effects of the Project and any foreseeable developments on the local geological environment and the chemical and physical groundwater environment and associated Geology and Groundwater VCs. Terrain and soil stability and groundwater quality and quantity are aspects of the environment that may be altered by the proposed Project.

This subsection describes the Geology and Groundwater components (i.e., groundwater quality and quantity) in the Project Area and evaluates potential interactions between the Geology and Groundwater VCs and proposed Project components and activities. These include mine contact with groundwater and potential discharge to local waterbodies during Operation, Decommissioning, and Post-Decommissioning. Linkages to other components of the environment include the following VCs: Section 8 Aquatic Environment, Section 9 Terrestrial Environment, Section 10 Human Health, and Section 11 Land and Resource Use.

The scope of the assessment of potential Project-related effects on the Geology and Groundwater VCs was guided by various federal and provincial laws, regulations, policies, and guidelines protecting groundwater quantity and quality in Canada and Saskatchewan, in addition to engagement with the public and Indigenous communities, IK, and LK. These inputs have informed:

- the scope of the assessment;
- the understanding of potential effects and pathways between the Project and groundwater quantity and quality during Construction, Operation, Decommissioning, and Post-Decommissioning;
- Measurable Parameters (MPs) to be used to quantify the potential effects of the Project on groundwater quantity and quality;
- the spatial and temporal boundaries of the assessment; and
- the approach for characterizing and determining the significance of the residual effects.

7.1.1 Valued Component Selection

Valued Components refer to environmental features that may be affected by a Project and have been identified as a VC of the local environment by the proponent, government agencies, Indigenous peoples, the scientific community, and/or the public. For this assessment, the shallow and deeper groundwaters are not considered to be a potable water source currently nor in the future within the Local Study Area (LSA; defined in Section 7.1.3.1), as detailed in Section 7.1.1.1.

Geology is recognized as an important component of the environment that may be affected by the Project. Changes to Geology could in turn lead to effects on other VCs selected for assessment. Acknowledging that changes to Geology are important aspects of the natural and human environment, Geology was referred to as an intermediate VC (i.e., does not have an assessment endpoint). Changes to this intermediate VC were evaluated to facilitate assessment of Project interactions, with links to other disciplines for inclusion in their assessments, including Sections 9 and 11.

Groundwater is an integral component of the hydrologic cycle and is considered an important environmental component and pathway (intermediate VC) to the receptor Surface Water Quantity and Surface Water Quality VCs. Groundwater was selected as a VC for assessment because it is important in maintaining ecological habitats through its influence on the surface water quantity (hydrology) and surface water quality of surface waterbodies, including wetlands. Indigenous Knowledge and engagement activities clearly identified the importance Interested Parties place on groundwater as a pathway to surface water, and the associated potential for changes in groundwater inputs to surface water to influence fish and fish habitat, sediment quality, benthic invertebrates, vegetation, wildlife, human health, and Indigenous land and resource use (Section 7.2).

Within the LSA, the Groundwater VC was considered an intermediate VC as it is a pathway to the aquatic environment. As an intermediate VC, the Groundwater VC does not undergo a significance determination.

As supported by comments and concerns provided by Interested Parties and informed by IK, maintaining groundwater quality and quantity is important for maintenance of surface water quality and health and the shared value of water and its life-sustaining properties (see Section 7.2). The rationale for the selection of the Geology and Groundwater VCs is summarized in Table 7.1-1. Linkages to other discipline assessments that consider potential effects of the Project on Geology and Groundwater are also provided. Figure 7.1-1, Figure 7.1-2, and Figure 7.1-3 are graphic representations of the main linkages among the Geology and Groundwater VCs and other VCs, illustrating the flow of assessment information from the Geology and Groundwater VCs.

Table 7.1-1: Valued Components and Rationale for Selection

Valued Component	Rationale for Selection	Discipline Assessments where Effects on Geology and Groundwater are Considered
Geology	Characteristics of Geology are recognized as fundamental components of the environment that may be affected by the Project. Changes to the local terrain and surface geomorphology could in turn lead to potential effects on other VCs selected for assessment. Components of Geology are important aspects of the natural and human environment. This VC is referred to as an intermediate VC (i.e., does not have an assessment endpoint).	Section 7 Geology and Groundwater Section 9 Terrestrial Environment
Groundwater: Quantity and Quality	Characteristics of Groundwater, and specifically groundwater quantity and quality, are important components that interact with other VCs (e.g., Section 8). If changed by Project activities, these characteristics of the Groundwater VC could affect terrestrial and aquatic biodiversity, as an example.	Section 7 Geology and Groundwater Section 8 Aquatic Environment Section 9 Terrestrial Environment Section 10 Human Health Section 11 Land and Resource Use

Figure 7.1-1: Integrated Assessment Approach – Key Connections between Geology and Other Valued Components

Figure 7.1-2: Integrated Assessment Approach – Key Connections between Groundwater Quantity and Other Valued Components

Figure 7.1-3: Integrated Assessment Approach – Key Connections between Groundwater Quality and Other Valued Components

7.1.1.1 Consideration of Groundwater as a Potable Water Source

The Groundwater VC was not considered a local potable water source. Groundwater is not currently used for domestic purposes based on the following information:

- A single domestic use well is listed in the Government of Saskatchewan, Water Security Agency, Water Well Information Database (WSA 2022) within a 100 km radius of the Project Area. This is a (shallow) well drilled by Cameco Corporation in 1969 to a depth of approximately 72 m bgs, installed in sand. There is also a shallow drinking water well at the existing Project camp, located over 2 km southwest of the Phoenix deposit. There are no records in the database of groundwater wells for non-industrial use (i.e., being used by residents in the area as a potable water source). During Operation, water treated in the potable water treatment plant for use as potable water for the Project may be sourced from shallow groundwater within the LSA (Section 2 Project Description).

- Groundwater use for potable water has not been documented throughout Denison Mines Corp.'s (Denison's) public engagement process.
- Existing water quality in the deep groundwater beneath the Phoenix area is characterized by several groundwater constituents exceeding drinking water guidelines (Appendix 7-A).

7.1.2 Key Indicators and Measurable Parameters

The assessment of Geology focused on potential changes to the surface topography or geomorphology of the Project Area and LSA.

The assessment of Groundwater focused on predicting changes in groundwater flow patterns, groundwater table elevations, and concentrations of selected constituents of potential concern (COPCs) that could affect local surface water. To provide focus, the potential effects assessment for Geology and Groundwater identified relevant Key Indicators (KIs) and MPs. These are defined as follows:

- **Key Indicator**: an important component or aspect of the VC that is expected to be affected (changed) as a result of the Project; and
- **Measurable Parameter**: a parameter or metric associated with the KI that can be used to detect and measure Project-related changes (e.g., change in levels of COPCs).

Table 7.1-2 summarizes the KIs and associated MPs for the Geology and Groundwater VCs. The KIs and MPs were selected based on professional judgement, understanding of the Project, similar EAs for mining projects in Canada, and comments provided during engagement activities with Interested Parties and IK (Section 7.2). The analysis of changes in KI values for Geology and Groundwater were provided to other disciplines for inclusion in their assessment (Table 7.1-2).

Table 7.1-2: Key Indicators and Measurable Parameters for the Geology and Groundwater Valued Components

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Terrain Morphology and Stability *Changes to surface topography and potential subsidence	In situ recovery (ISR) operations could result in localized subsidence at ground surfaces associated with extraction of rock mass within the active mining area (approximately 400 m bgs).	Vertical displacement (i.e., subsidence at ground surface). The standard units used to describe the surface topography and the measure of subsidence are metres above sea level (masl).
Groundwater Quantity *Groundwater flow patterns and discharge rates to local surface water *Groundwater elevation changes	Project activities could result in local and temporal changes in groundwater recharge and changes to groundwater levels and flow. As a pathway to surface water, changes in groundwater levels and natural flow patterns could affect discharges to local surface waterbodies.	Shallow and deep static groundwater levels measured at monitoring locations (masl), resulting in a measurable reduction in baseflow to surface waterbodies (L/s).
Groundwater Quality *Groundwater quality with a focus on groundwater discharge to local surface waterbodies (i.e., Whitefish Lake)	Project activities could result in local and temporal changes in groundwater quality in the deep and shallow groundwater as a result of typical mining operations. As a pathway to surface water, potential changes in groundwater quality from Project activites could affect the quality of groundwater discharging to local surface waterbodies.	Values of physical (temperature) and chemical parameters in groundwater (e.g., pH units or concentrations in mg/L or µg/L) screened in relation to risk-based surface water environmental quality criteria (where available).

7.1.3 Spatial and Temporal Boundaries

7.1.3.1 Spatial Boundaries

The spatial boundaries selected for the Geology and Groundwater assessment were chosen to allow for a full description of existing conditions in sufficient detail to enable potential Project-VC interactions and potential effects to be identified, evaluated, and assessed. This included understanding and assessing the contribution of the Project to cumulative effects. The spatial boundaries for the assessment of the Geology and Groundwater VCs are the same and consisted of an LSA and a RSA, as summarized in Table 7.1-3. The spatial boundaries are:

- **Project Area**: the area within which the Project and all components/activities are located (i.e., the Project footprint; the area of maximum physical disturbance). This area is not VC-specific but is consistent throughout the EA for all VCs.
  - The Project Area is considered in the evaluation of surface topography subsidence associated with the Geology VC. The overall Project Area and Operation have been designed to limit disturbance to the natural geological environment outside of the immediate mining area, and subsidence assessments at this level are required to capture potential local effects.

- **Local Study Area (LSA)**: The LSA is established to assess the potential, largely direct effects of the Project and represents the extent to which there is a reasonable potential for the Project or Project-related activities to interact with and potentially adversely affect the VCs.
  - The boundaries of the LSA were selected in consideration of the Project footprint, mining phases, depth of the in situ recovery (ISR) mining area, site engineering processes, and the spatial extent of potential direct effects of the Project on the VCs, including discharge of groundwater to surface waterbodies. The LSA includes the Project Area and portions of the Icelander River and Williams Lake drainage areas. Specifically, the LSA is bounded by Whitefish Lake and adjacent surface waterbodies to be consistent with the LSA of the aquatic disciplines (e.g., Surface Water Quantity, Surface Water Quality), as shown in Figure 7.1-4.
- **Regional Study Area (RSA)**: the area that surrounds and includes the LSA, established to assess the potential, largely indirect effects of the Project in a regional context. The RSA is large enough to capture the extent of potential effects (i.e., zone of influence) on a VC and defines the area within which cumulative effects may occur (i.e., cumulative effects assessment boundary).
  - The spatial extent was developed to reflect potential groundwater discharge locations within the regional watershed area in which the Project Area is located, and is the RSA defined for the Aquatic Environment (Figure 8.2-3 in Section 8).

Table 7.1-3: Spatial Boundaries for the Geology and Groundwater Valued Components

Study Area	Area	Description/Rationale
Local Study Area	173 ha (17.3 km²)	• Defines the expected extent of the direct and indirect effects from the Project. • Centered on the Phoenix Deposit (see Figure 7.1-4). • Extends 1.5 to 2.5 km in all directions until a surface waterbody is reached: ○ West: William Lake; ○ North: Kratchkowsky Lake; ○ Northeast: northern portion of Whitefish Lake (LA-6); ○ Southeast: McGowan Lake and LA-2; and ○ Southwest: LB-2. • Extends 2 km south of the mine to represent potential groundwater flowing toward Russell Lake. • Provides local context for evaluating groundwater quality and quantity changes and assessing potential residual effects.
Regional Study Area	Approximately 100 km radius surrounding the Project Area (7,850 km²)	• Is the RSA defined for the Aquatic Environment (i.e., Icelander River and William Lake drainage areas), and was defined as such to reflect potential groundwater discharge locations within the regional watershed area in which the Project Area is located.

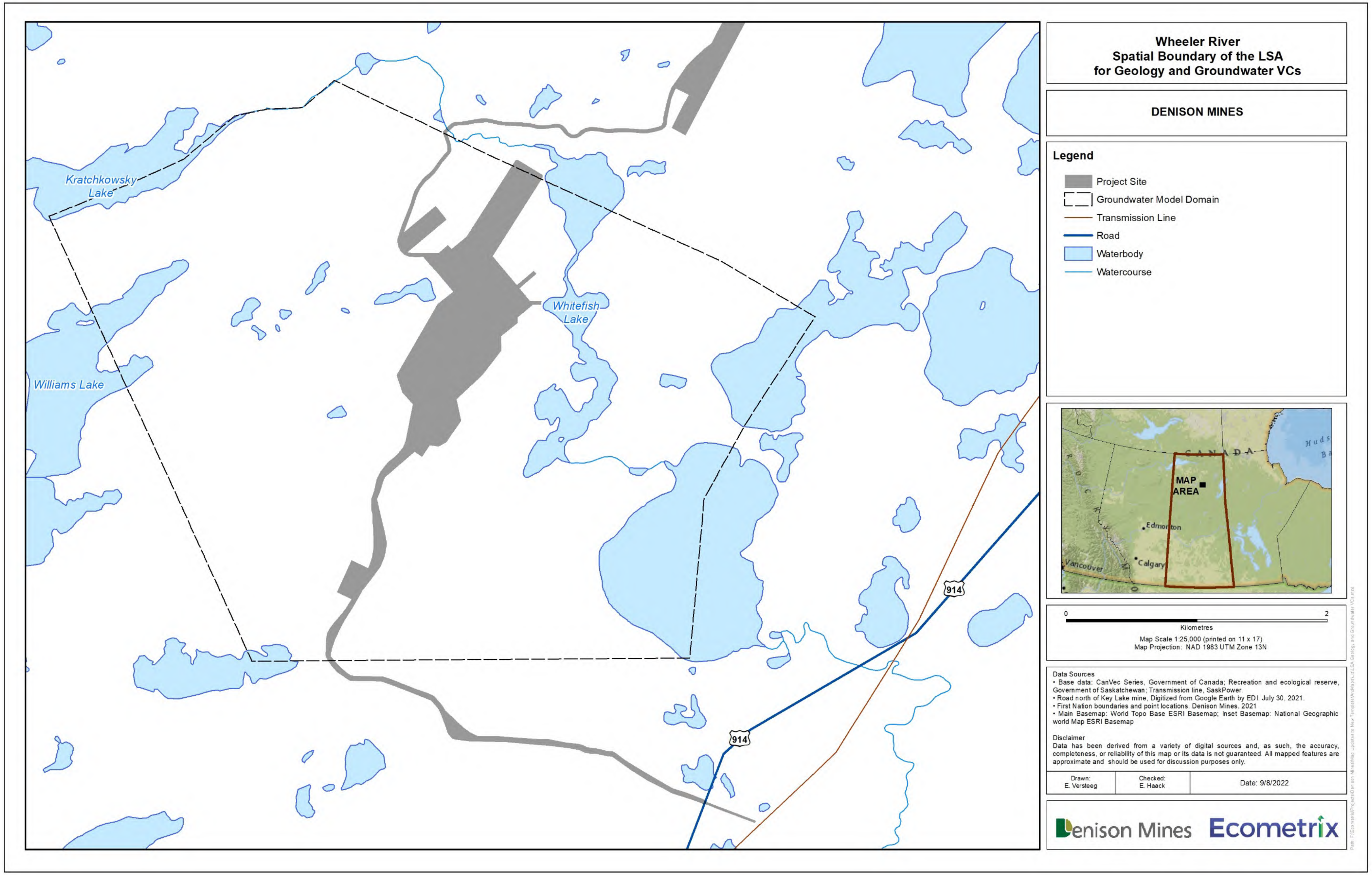

Figure 7.1-4: Spatial Boundary of the Local Study Area for the Geology and Groundwater Valued Components

7.1.3.2 Temporal Boundaries

The temporal boundaries represent the timeframes that the Project is expected to interact with and potentially affect the Geology and Groundwater VCs and, as appropriate, reflect seasonal and annual variations or biophysical constraints related to a VC. Temporal boundaries are based on the different phases of the Project, as described in the following list and in Section 2. The temporal boundaries of the Geology and Groundwater assessment considered all phases of the Project, including:

- Construction (Year 1 to 3);
- Operation (Year 3 to 18);
- Decommissioning (Year 18 to 23); and
- Post-Decommissioning (Year 23 to 38).

The temporal scope of the assessment for Geology and Groundwater also includes a 'future centuries' period following Post-Decommissioning that is unique and applied only to the Groundwater VC. The 'future centuries' temporal scope of the assessment for Groundwater considers the period for which the highest COPC concentrations in groundwater are predicted to interact with surface water based on groundwater modeling described in Appendix 7-C. Due to the relatively long travel time (relatively low groundwater velocities) between the mining area (Section 7.6.2.2.3) and the surface water environment where groundwater/surface water interactions are expected, as well as the potential for chemical reactions along the groundwater flow pathway, a 'future centuries' scenario was deemed appropriate to fully assess potential future effects beyond the Project timeline (i.e., 0 to 38 years). The 'future centuries' temporal scope was also developed in recognition of the concerns raised by Interested Parties through the engagement process around the potential for the Project to influence water quality into the future[1].

7.2 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

At its broadest level, IK can be understood as the unique and collective knowledge of Indigenous peoples that may include, but is not limited to, the environmental, cultural, economic, political, and spiritual conditions of a community or region. In this subsection, IK and LK are viewed as complementary and influential alongside western science to produce a full understanding of the potential effects of the Project, whether measurable or perceived. Both forms of information have been given full and fair consideration. Engagement is defined as the sharing and gathering of project-related information from Interested Parties, and the collaboration with Interested Parties in a good faith effort with the goal of developing mutually acceptable resolutions (Section 4.2 in

[1] 18-EN-ERFN-5.4, 18-EN-ERFN-5.72, and ERFN and SVS 2022.

Section 4 Engagement). Since 2016, Denison has been engaging with Interested Parties (i.e., local and Indigenous communities, residents, businesses, organizations, land users, and various regulatory authorities) to support the development of positive relationships and a mutual commitment to collaboration.

Denison has recorded and stored information regarding IK, LK, and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 18-EN-VILX-3.103). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment. Appendix 7-B provides a summary of unique identification numbers referenced within Section 7. The available LK data in support of the assessment did not specifically address Geology or Groundwater. Indigenous Knowledge addressing Geology or Groundwater came from two sources (i.e., ERFN and SVS 2022; KML and NVP 2022). Indigenous Knowledge quotes and citations from engagement activities were included herein to provide readers with the information considered as the Project advanced throughout the EA process.

Several questions from Interested Parties reflected their interest in understanding more about the groundwater system and how it is sampled, generally[2].

> "*Are there aquifers in the area*?" (20-EN-VILX-343.2).
>
> "*How do you sample streams underground*" (18-EN-VILX-3.103).

Interested Parties had questions, comments, or concerns regarding:

- how baseline information was collected and existing groundwater conditions[3];
- how ISR mining may influence:
  - terrain (i.e., subsidence at ground surface; 21-EN-ERFN-473.8);
  - groundwater flow conditions, including water levels and groundwater discharge quantity to surface waterbodies (18-EN-VB-4.37); and
  - groundwater quality, and that the influence may not be observed for some time[4]; and
- mitigation measures, plans, and monitoring for groundwater protection[5].

[2] 18-EN-VILX-3.103, 18-EN-VPL02.53, 20-EN-VILX-343.2, and 21-EN-ERFN-447.19.

[3] 16-EN-VPL-105.5, 17-EN-NSEQC-112.6, and 18-EN-VILX-3.105.

[4] 18-EN-VILX-3.32, 18-EN-VB-4.38, 18-EN-ERFN-5.72, 18-EN-ERFN-5.4, 19-EN-ERFN-140.25, 21-EN-BNFN-479.7, and 21-EN-ERFNSUR-456.24.

[5] 16-EN-VILX-109.29, 18-EN-VPL-2.33, 18-EN-VPL-2.57, 19-EN-ERFN-140.28, 19-EN-ML37-62.9, 19-EN-ML82-62.21, 21-EN-ERFN-458.12, 21-EN-ERFN-474.1, 21-EN-LLRIB-392.5, 21-EN-SUR-446.92, 21-EN-VILX-443.17, and 21-EN-VILX-443.19.

Examples include:

> "*Ground freezing would reduce the amount of water that is needed to be discharged*" (18-EN-VB-4.37).

> "*In that area there are moose calving areas, whitefish spawning areas – a lot of creeks, inlets and outlets. The drilling – as a former driller back in the 80s, for water wells and diamond drilling – it may not impact underground hydrology right away but maybe 15-20 years down the road. Even the pH of the water changes with time with things that are happening. The ecosystem becomes disrupted. Those are some of the things we wanted to express*" (18-EN-ERFN-5.4).

> "*What happens when the freeze wall melts? Will there be monitoring of ground water during this*?" (21-EN-VILX-443.19).

Concerns on these same themes occurred in IK. An example includes:

> "*The community requires confidence that when incidence occurs with these mining methods there are plans in place to recover solutions that could impact groundwater quality. With so many Indigenous nations under boil water advisory coupled with water security becoming a real phenomenon, it is imperative that we understand the protection of water process implicitly*" (KML and NVP 2022).

The comments from both IK and the engagement record were considered within the context of community interest in the groundwater remaining supportive of surface water quality and health. The shared value of water and its life-sustaining properties is understood through the IK, LK, and engagement data related to the Surface Water Quality VC (Section 8).

> "*The lands and waters, we are definitely connected as peoples of English River. If we don't have the lands, we are not connected. If we don't have the water... Water is life to us*" (ERFN and SVS 2022).

Indigenous Knowledge and engagement activities clearly identified the importance placed on groundwater as a pathway to surface water by Interested Parties and the associated potential for changes in groundwater inputs to surface water to influence fish and fish habitat, sediment quality, vegetation, wildlife, human health, and Indigenous land and resource use. Examples include:

> "*Changes to the environment, including declines in water quality and water levels and increase in habitat damage from wildlife*" (ERFN and SVS 2022).

> "*Water Levels: Concern that water usage from the prospective mine could affect lake and river levels thereby having impacts on the fish and fishery*" (ERFN and SVS 2022).

This affirms the need to include Geology and Groundwater as VCs and intermediate VCs to the aquatic environment in the EA, to help inform the assessment of surface water quality and human health. Based on the IK and engagement activities, it is understood that additional detail is expected with respect to the potential effects of the Project on Geology and Groundwater, and this section of the EIS is responsive to that expectation. Specific ways in which data from IK and engagement activities influenced the Geology and Groundwater assessment are detailed in the following subsections.

Baseline Conditions and Conceptual Site Model

Substantive effort on Denison's part since 2006 has been directed towards developing an extensive database of existing (baseline) geological and groundwater conditions, providing Interested Parties the confidence that the subsurface environment for the Project is understood. The baseline assessment is provided in Appendix 7-A.

Project Interactions and Mitigation

Indigenous Knowledge and feedback from the community were used to inform scoping for Project interactions, pathway analysis, and mitigative strategies and approaches. Specific mitigation strategies to protect the Geology and Groundwater VCs were developed at the beginning of the Project, including a limited construction footprint and the use of a freeze wall system to reduce the potential for groundwater and surface water interactions.

Site Monitoring and Management

Information and feedback by the community during engagement was considered in the development of monitoring activities during Operation, Decommissioning, and Post-Decommissioning. As part of mining operations, detailed monitoring activities will be completed to assess the performance of various components of the Project associated with engineering mining designs, subsidence, and infrastructure designs to protect the Geology VC within the Project Area and LSA. Groundwater management, monitoring, and mitigation, and evaluation of groundwater effects, were considered important to maintaining groundwater levels and water quality within the Project Area and LSA.

7.3 Existing Environment

A Baseline Geology and Hydrogeology Report (see Appendix 7-A) was prepared as part of the EIS submission and describes the existing environment for the Project. The Baseline Geology and Hydrogeology Report builds on the Phoenix deposit geological model developed by Denison (Denison 2022a), which uses geological and numerical modelling functionalities in Leapfrog Geo™ 2021.2. The model includes lithology, structure, and alteration models from field data collected over more than 16 years of exploration activities.

The outcome of the Baseline Geology and Hydrogeology Report was the development of a robust hydrogeological Conceptual Site Model (CSM). The CSM provided the basis for development of a numerical groundwater flow and transport model for the baseline and Post-Decommissioning phases, which will be used over the life of the Project to inform groundwater conditions and the establishment of Decommissioning objectives (see Section 7.6.1).

The methodology used to characterize existing conditions is provided in Appendix 7-A and is summarized in the following subsections. Characterization of existing conditions relied upon information from regional studies (pertaining to the Athabasca Basin, and including (not exclusively) Sibbald et al. 1976; Macdonald 1980; AECL 1994; Ramaekers and Catuneanu 2004; Campell 2007; Harvey and Bethune 2007; Yeo and Delaney 2007; Cameco 2012a; Ng et al. 2013; Power 2014; Alexandre 2020; Bosman and Ramaekers 2015) and Project-specific information. Project-specific information was extensive and included the following:

- A database of geologic, geochemical, and geotechnical data for the Project, representing data collected over 16 years of exploration activities and more than 300 drill holes. The database contains a wide range of data for most of the exploration drill hole locations, including major lithologies and various geotechnical fields (e.g., estimates of rock quality designation, fracture intensity, core recovery percentages, and alteration).
- Composite samples collected from core material every 5 to 20 m through the Athabasca Supergroup Sandstones and discrete samples collected every 0.5 m within and proximal to the ore zone for bulk geochemical composition (elemental analysis). Clay mineralogy was determined from the bulk geochemical composition of the samples (elemental analysis) using a normative clay calculation. Mineralogy was further evaluated in a subset of location and depth intervals by infrared mineral analysis (i.e., PIMA) and/or petrography.
- Matrix permeability, hydraulic conductivity, porosity, and dry density values determined from permeameter data (Scibek 2019; Denison 2022b).
- Hydrogeological assessments, including packer tests and pumping and injection tests (Golder Associates 2014; Petrotek 2020; Petrotek 2021; Petrotek 2022; borehole testing by Denison analyzed by Ecometrix as part of Appendix 7-A).
- Groundwater quality from 26 single-interval groundwater monitoring wells, each sampled on one to three occasions from 2019 to 2021 following well development. Samples were submitted for general chemistry, dissolved metals, trace elements, and radionuclide analyses to the Saskatchewan Research Council Environmental Analytical Laboratory, and for tritium to A.E. Lalonde AMS Laboratory (University of Ottawa).
- Water level elevations in wells and open holes (390 water levels recorded in over 150 open hole core holes). Manual water levels were recorded on sampling events in the monitoring wells and pressure transducers provided continuous water level elevation data for several groundwater wells.

7.3.1 Physical Geography

Ground surface topography regionally has been shaped by glacial and fluvial processes active for over tens of thousands of years. The most important associated topographic features in the region are the northeast to southwest trending drumlins and eskers that are separated by lowland areas of well drained glaciofluvial outwash sands and gravels, and poorly drained till plains with associated muskeg/wetlands. The ground surface elevation in the area, including and immediately surrounding the Project Area, varies from a high of approximately 600 masl located between the Phoenix and Gryphon deposits, to a low of 494 masl at McGowan Lake in the southeast (Figure 7.3-1). Ground surface topography (locally) overlying the Phoenix deposit ranges from 520 to 550 masl (Figure 7.3-1).

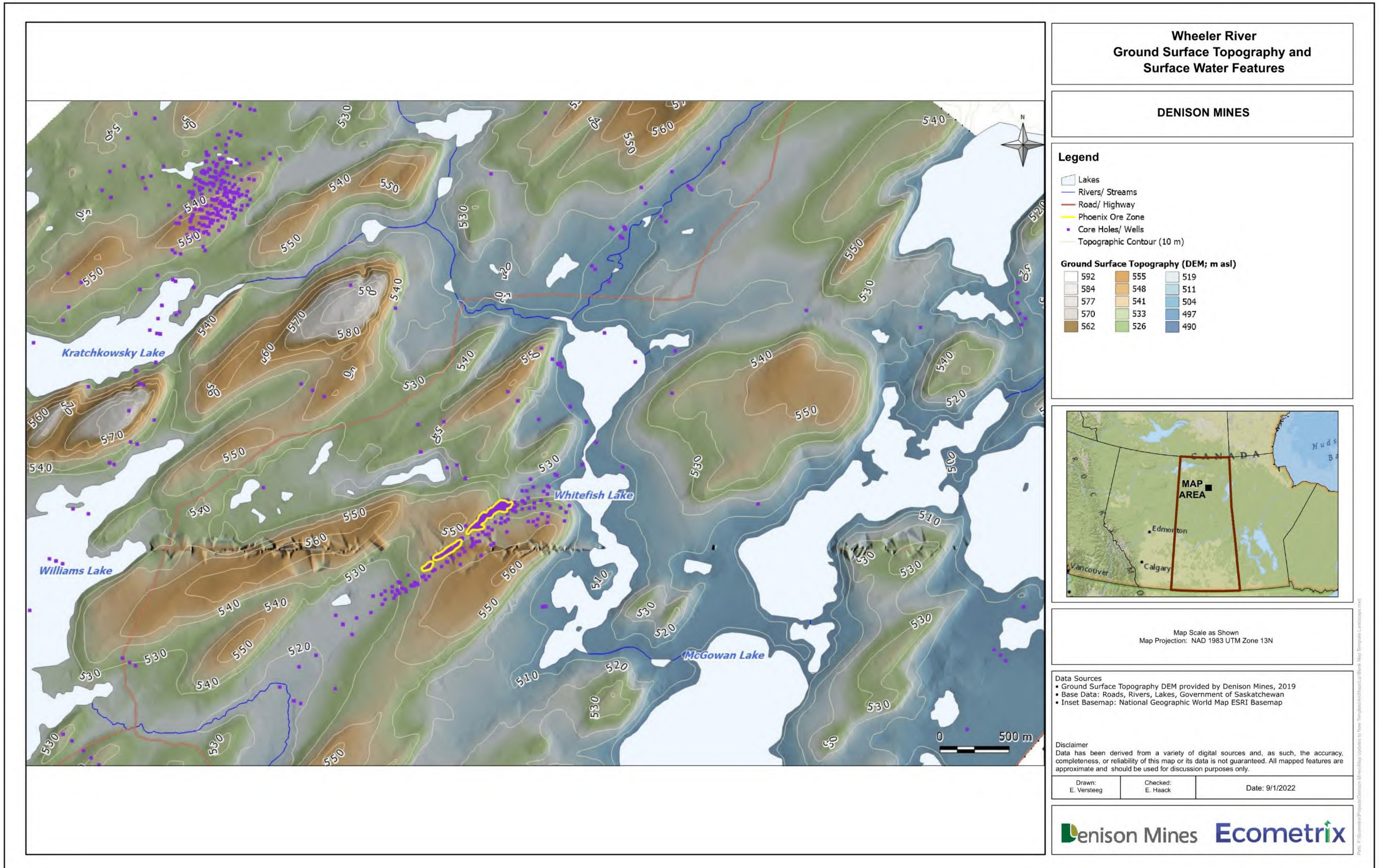

Figure 7.3-1: Ground Surface Topography and Surface Water Features

7.3.2 Geological Setting

The Wheeler River uranium deposit is located on the eastern margin of the Athabasca Basin in northern Saskatchewan. Like other uranium deposits on the eastern margin of the Athabasca Basin (described in Jefferson et al. 2007), the Phoenix deposit is located at the base of the sandstones and conglomerates of the Athabasca Supergroup (Bosman and Ramaekers 2015), just above the major unconformity that separates the sandstones and the underlying granitic gneisses and other basement rocks of the Wollaston Group (Yeo and Delaney 2007; Figure 7.3-2). This unconformity represents a period when the basement rock was exposed and subject to extensive weathering and erosion. The elevation at the top of the unconformity within the Phoenix area ranges from a high of approximately 310 masl to a low of 120 masl.

There are uncertainties associated with the depositional models for the ore zone, but a plausible model suggests there was ductile faulting and subsequent weathering and erosion of the various basement rock lithologies. These faults were reactivated after the deposition of the Athabasca Supergroup sandstones along weak graphite-rich ductile shear zones. At the Phoenix site, this included the WS Shear zone and the Hanging Wall Shear zone (Arseneau and Revering 2010). Uranium (VI) (i.e., hexavalent uranium, U^{6+})-bearing and oxidizing basinal fluids within the sandstone reacted with reducing fluids in the basement, resulting in uranium (VI) being reduced to uranium (IV) (i.e., tetravalent uranium, U^{4+}), and uraninite being precipitated (Alexandre 2020).

The Phoenix deposit is overlain and underlain by a natural barrier unit or halo that has limited the release or subsurface migration of uranium, and other chemical constituents associated with the ore zone, outside of the ore body itself. This natural barrier zone has limited the migration of chemical constituents in groundwater for more than 1 billion years. This inference - regarding the natural barrier unit's role to limit migration of chemical constituents away from the ore zone – is the authors' professional opinions on the present-day conditions which includes persistence of the ore body over geologic time and differences in groundwater chemistries within and outside the ore body. The information reviewed and used to formulate this inference is presented in detail in Appendix 7-A. The barrier units include the Upper and Lower Clay Zones, and Sulphide Cemented zones shown in Figure 7.3-3.

A summary of the geologic characterization present in the LSA, from basement rock to overburden, is provided in the following subsections. By way of introducing the geologic setting, the interpreted lithologic surfaces for the LSA are shown in cross section in Figure 7.3-4. The ore zone position just above the unconformity and the associated natural barrier units are shown schematically in Figure 7.3-3. Shown in Figure 7.3-2 is that the Phoenix ore bodies are long and narrow (approximately 25 to 50 m wide), directly overlie or are near a graphitic pelite unit of the basement rock, and are associated with the WS Shear zone. The lithologic units in the LSA are also summarized in Table 7.3-1 in Section 7.3.3.

7.3.2.1 Basement Rock

Basement rocks beneath the Phoenix deposits are Paleoproterozoic-aged metasedimentary, metavolcanics, pegmatites, gneisses and schists (Figure 7.3-2). The basement rocks have undergone several periods of alteration following their original deposition, which influenced the hydrogeological setting. These include:

- metamorphism;
- alteration post-metamorphism (less than 1800 Ma) and prior to deposition of the Athabasca Supergroup sandstones (1700 Ma; Adlahka, 2021; Toma et al., 2022);
- paleoweathering on the bedrock surface prior to subsidence and basin formation; and
- hydrothermal alteration associated with uranium ore mineralization. The most intense areas of hydrothermal alteration occur alongside the highest-grade mineralization, and alteration decreases (and eventually disappears) in all directions with distance away from the ore zone (Macdonald 1980; Wilson 1986; Harvey and Bethune 2007).

Faults within the basement rocks trend in a northeast-southwest direction. Following this trend, the WS Shear zone is a reverse fault that has a 55-degree (northeast to southwest) azimuth and a 55-degree dip to the southeast (Figure 7.3-2). There are also several west-east trending cross faults that lie roughly perpendicular to the WS Shear zone and propagate through the ore zone and basement rocks.

A quartzite ridge occurs north of the Phoenix deposit. "Quartzite ridges" are topographic features of the sub-Athabasca unconformity surface (Li et al., 2015). They are an alteration facies resulting from pre-Athabasca Supergroup basement silicification, that cause relief at the unconformity surface of up to 200 m (Card, 2014). A quartzite ridge occurs west of the Pheonix deposit and has a southwest-northeast trend, which parallels the Phoenix deposit. The elevation at the top of the unconformity within the Phoenix area is approximately 310 m asl along the quartzite ridge, in comparison to an elevation of approximately 150 m asl at the Phoenix deposit (Appendix 7-A). The quartzite ridge is interpreted as a low permeability zone that acts as a barrier to fluid flow, and played a role in controlling alteration patterns and mineralization (Card, 2014; Li et al., 2015).

7.3.2.2 Ore Deposit

As introduced above, the uranium ore deposit lies proximal to the unconformity between the basement rocks and the overlying Athabasca sandstone. The Phoenix ore bodies are long and narrow (approximately 25 to 50 m wide) and are located within or near a graphitic pelite unit. Hydrothermal alteration associated with the ore zone is a discontinuous envelope of clay alteration and a sulphide-cemented rock zone that extends into the overlying sandstone and the underlying basement (Figure 7.3-3). This black, clay-rich zone is approximately 3 m thick on average and locally hydraulically isolates the ore zone from the overlying sandstones and underlying weathered basement rock. The ore zone has complex mineralogy, including uraninite (Fe, Pb, Cu, Zn) sulfides, nickel arsenides, aluminum phosphate sulphate minerals, oxide, carbonate, and clay minerals and quartz.

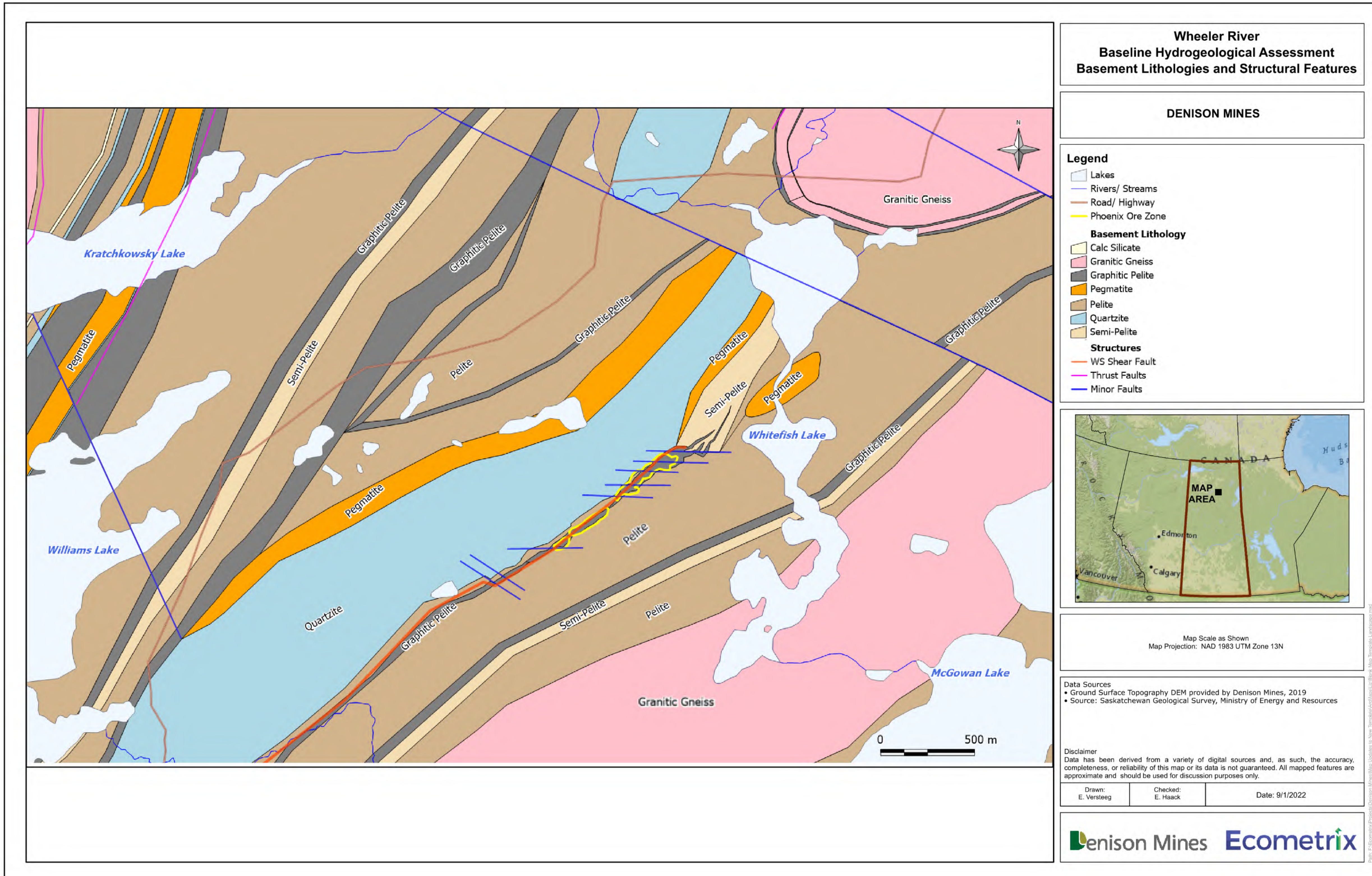

Figure 7.3-2: Basement Lithologies and Structural Features

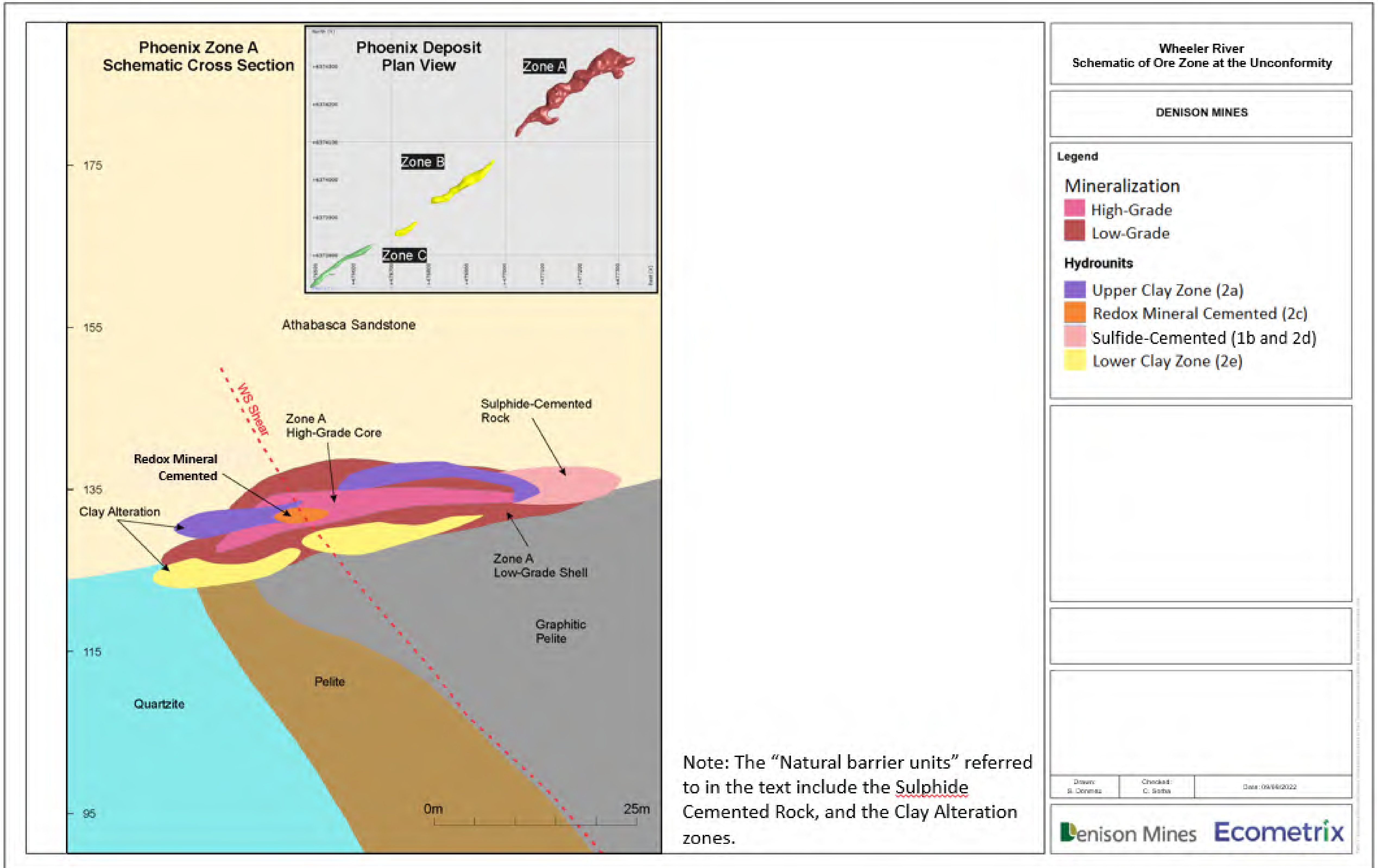

Figure 7.3-3: Schematic of the Ore Zone at the Unconformity

7.3.2.3 Athabasca Supergroup Sandstones and Conglomerates

Overlying the basement rock are Proterozoic-aged consolidated sandstones and conglomerates of the Athabasca Supergroup that were deposited 1.5 to 1.74 billion years ago (Creaser and Stasiuk 2007). These sedimentary rocks are horizontally bedded and were deposited in an intracontinental sedimentary basin initially marked by alluvial fans, braided rivers, and possibly shallow marine or lacustrine to eolian environments (Ramaekers and Catuneanu 2004; Ramaekers 1990).

The Athabasca Supergroup sandstones are subdivided into formations within the Manitou Falls Group (MF), (Bosman and Ramaekers, 2015). From shallowest to deepest, the MF Group present in the LSA includes the MFd (Dunlop Formation), MFc (Collins Formation), MFb (Bird Formation), and the MFa (Read Formation (Figure 7.3-4). The Read Formation is abbreviated as MFa in this report, and as MFr in Bosman and Ramaekers (2015); both abbreviations refer to the same formation. The MFa (Read Formation) underlies the MFb but is not present across the entire LSA as it pinches out against the quartzite ridge north of the Phoenix deposit. The sandstones are differentiated by their proportions of conglomerate beds and presence of clay intraclasts (Ramaekers et al. 2007). The Read Formation of the Manitou Falls Group hosts most of the uranium mineralization associated with the Phoenix deposit; some mineralization lies within the underlying paleoweathered basement (Figure 7.3-3). The Athabasca Supergroup sandstones consist almost entirely of quartz (Ramaekers 1990) and any detrital feldspar that was present was altered to clay minerals, such as kaolinite and illite, during the 200-million-year long period of diagenesis that impacted the Athabasca Basin (Sibbald et al. 1976; Hoeve and Quirt 1984). The Athabasca Supergroup sandstones are relatively iron-rich (median iron oxide [Fe_2O_3] concentrations of 0.24% in unmineralized samples [Alexandre 2020] and Project-specific information) and are characterized by thoroughly oxidized redbed sequences (Jefferson et al. 2007). Some portions of the MF Group including the upper portions of the Read Formation were silicified during diagenesis, whereby quartz cement sealed the sandstone's primary porosity (Alexandre 2020; Ng et al. 2013) and effectively reduced groundwater flow through the sandstone matrix and made it prone to brittle fracturing.

Regionally, sub-basin scale hydrothermal alteration halos have been recognized to be spatially associated with unconformity-type deposits. The alteration halo associated with the Pheonix deposit is of the 'egress type' (as defined by Jefferson et al. 2007), in that it extends primarily outwards and upwards into the Athabasca Supergroup sandstones and is interpreted to have resulted when hydrothermal fluid and gases were released along the shear zone and propagated along zones of weakness in the rock, including fractured and faulted bedrock. Hydrothermal alteration and desilicification occurs in the area overlying and east of the Phoenix deposit to Whitefish Lake, particularly in the Athabasca Supergroup sandstones above the WS Shear zone and associated splays. This zone of desilicification, enhanced fracture frequency, and elevated friability is interpreted to be the result of the merging of two different tectonic stress fields in the area

(Quantec Geoscience 2014). The matrix desilicification has effectively resulted in completely to partially unconsolidated sands. The Desilicified Zone, delineated by cores logged as having very low rock quality designation values, high fracture intensity, and high friability, is shown in Figure 7.3-5.

The sandstones have also been faulted and fractured, which affects the movement of groundwater through these units. Faults in the sandstone represent reactivated brittle basement faults along the northeast-southwest trending WS Shear zone, or responses to volume adjustments in the sandstone during hydrothermal alteration and mineralization.

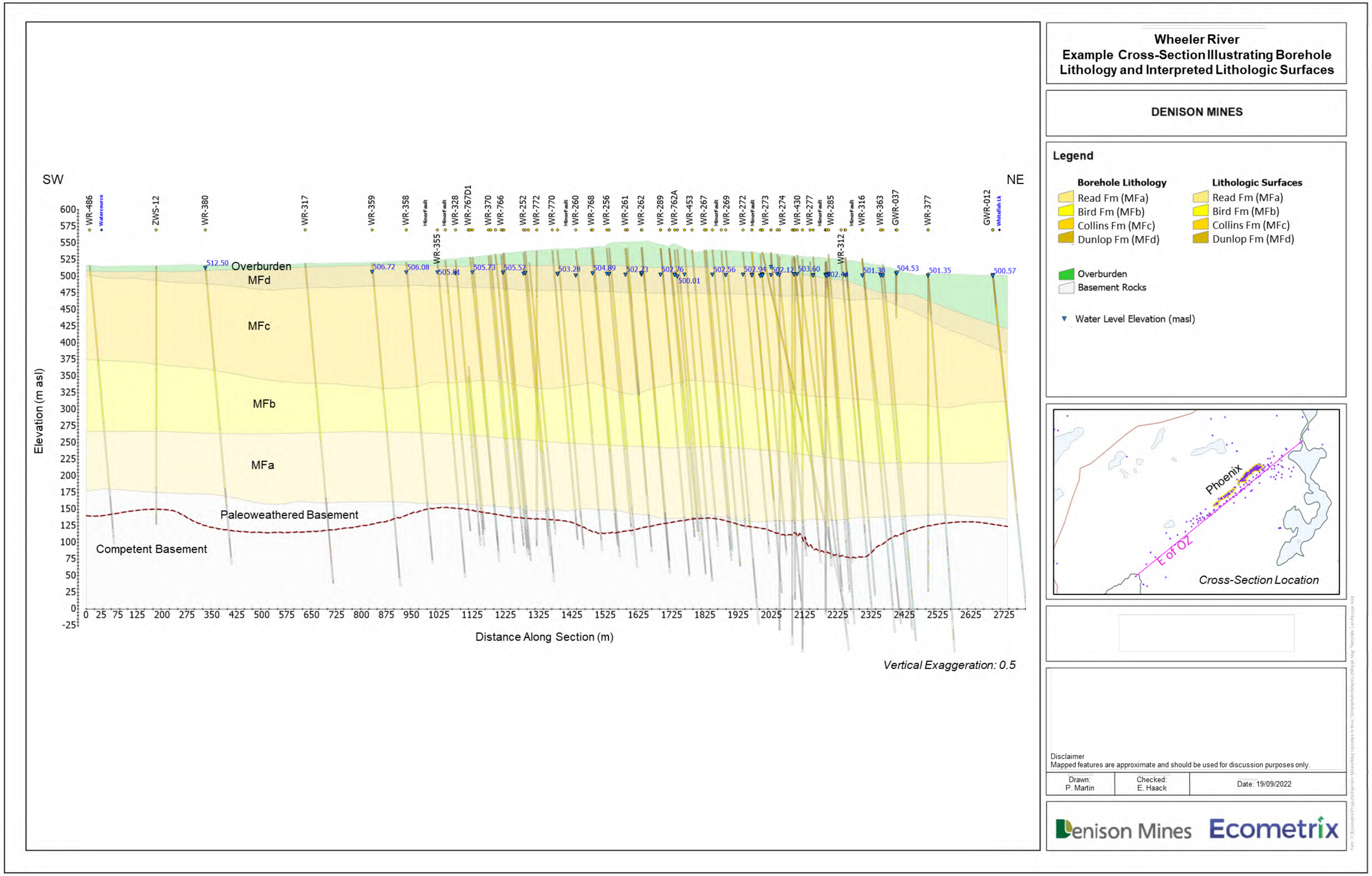

Figure 7.3-4: An Example Cross-section Illustrating Borehole Lithology and Interpreted Lithologic Surfaces

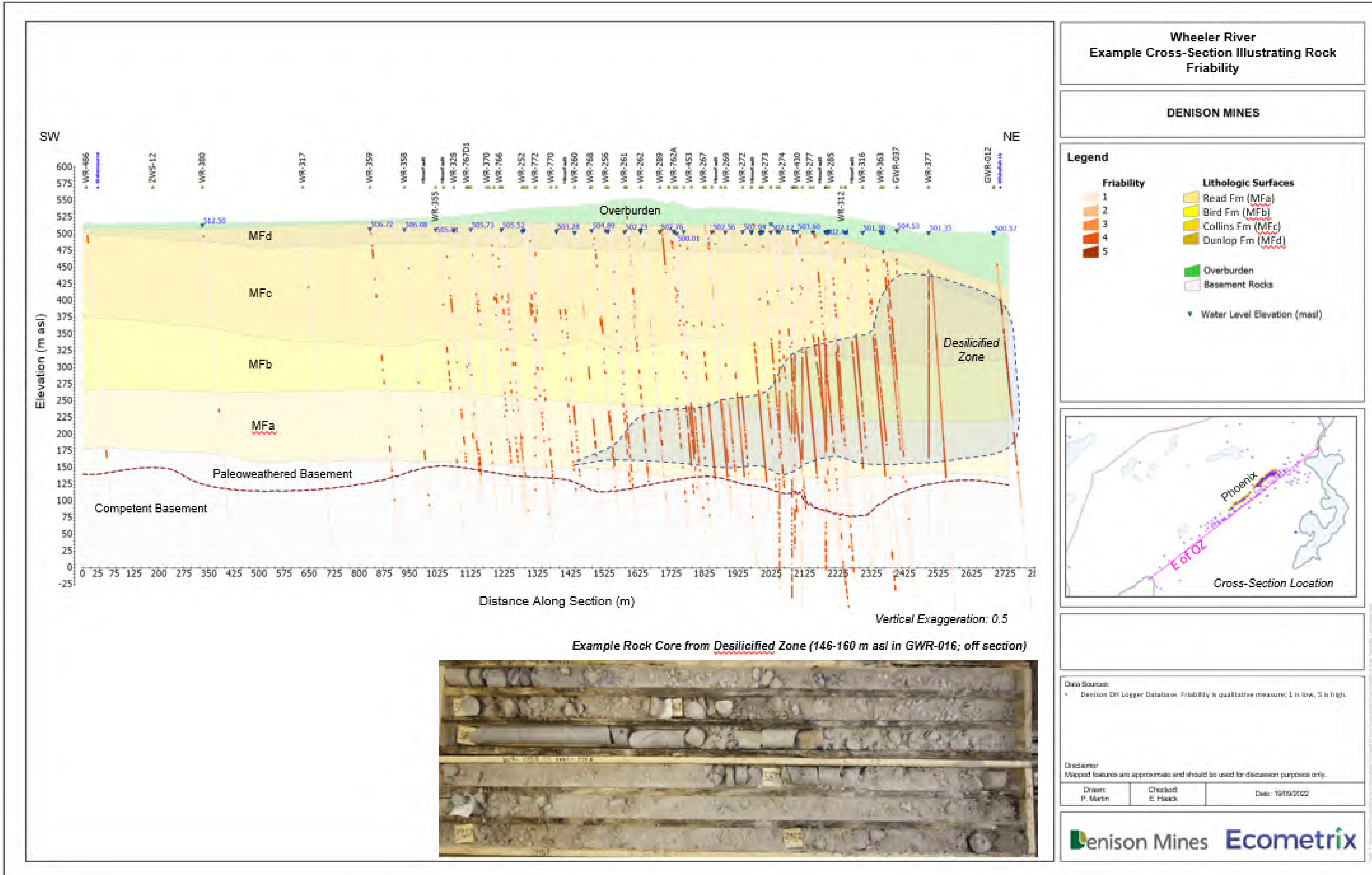

Figure 7.3-5: Example Cross-section Illustrating Rock Friability

7.3.2.4 Overburden

The regional geomorphology is typical of the Athabasca Plain Region and is dominated by landforms associated with continental glaciation, such as drumlins, eskers, outwash plains, and till plains (Figure 7.3-6). Drumlins and eskers present in the region trend in a northeast to southwest direction and form topographic highs on the landscape. Drumlins rise over 50 m above the surrounding land surface in some areas regionally, including the drumlin lying between the Phoenix and Gryphon deposits (Figure 7.3-6).

Based on regional-scale 1:250,000 mapping (Figure 7.3-6 and descriptions from borehole logs that describe surficial sediments, the surface deposits in the region consist predominantly of outwash sand and glacial till with organic and alluvial sediments (Power 2014; Campbell 2007; Schreiner 1984). In the LSA, data from corehole logging indicate overburden thickness ranges from less than a few metres on low-lying areas to over 100 m in the northwestern reaches of Whitefish Lake where weathering and glacial erosion of the sandstone bedrock formed a bedrock valley or 'trough' (as shown in the far northeast extent of the cross section in Figure 7.3-4).

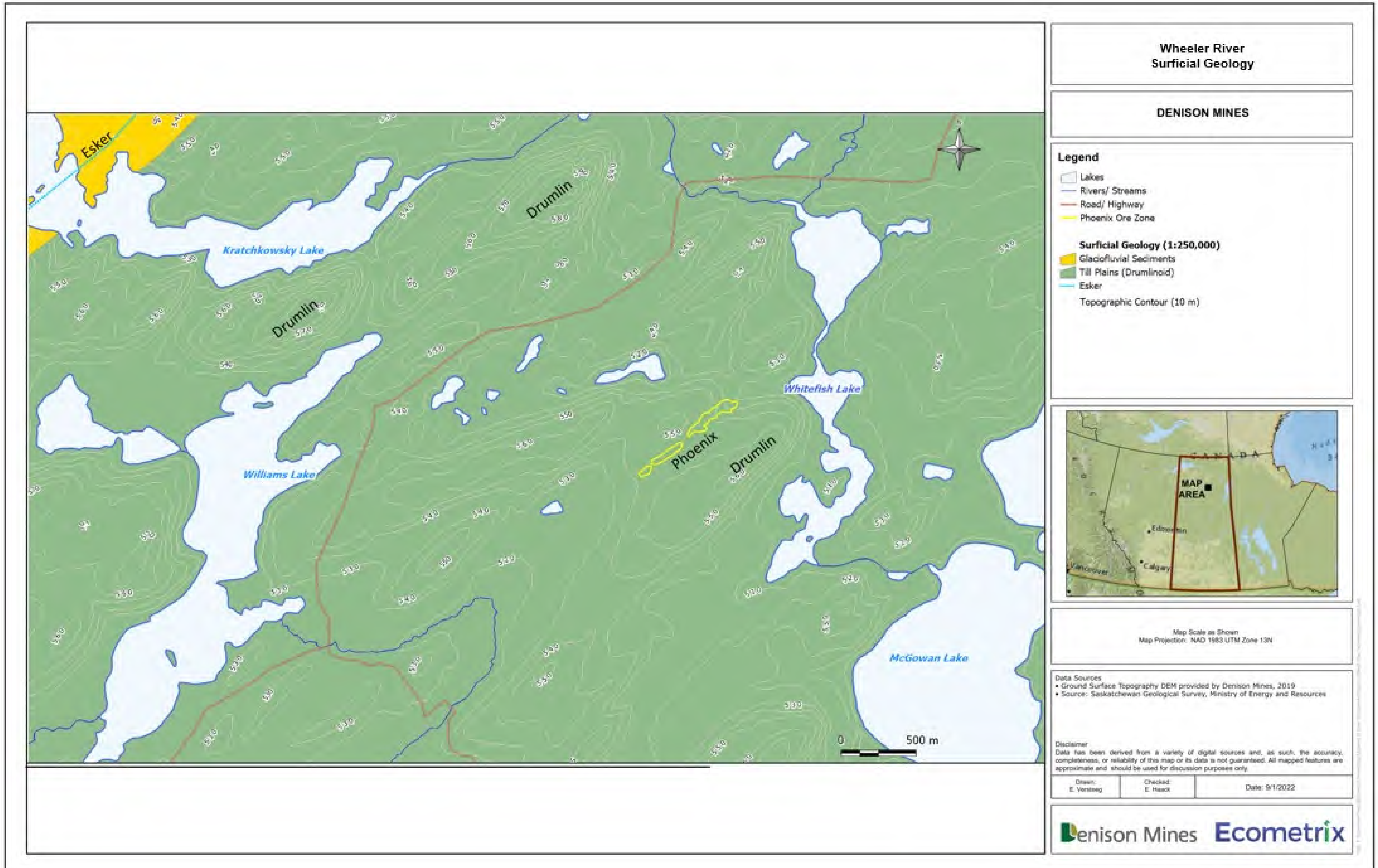

Figure 7.3-6: Surficial Geology

7.3.3 Hydrogeological Setting

Hydrostratigraphic units can be derived from stratigraphic or lithologic units based on their general hydrogeologic properties. Units that can transmit reasonable volumes of water are referred to as aquifers, while units that do not readily transmit water are referred to as aquitards. As the hydraulic conductivity in fractured rock settings is generally dominated by secondary porosity features such as faults and fractures, the hydrostratigraphic units do not necessarily align with lithologic, geologic, or stratigraphic boundaries. In addition, geologic or stratigraphic units that have similar hydrogeologic properties are often grouped together to form hydrostratigraphic units.

Nine hydrostratigraphic units were defined within the LSA. These are summarized in relation to subsurface geology (lithological units) in Table 7.3-1, and pictorially in the hydrogeological CSM, presented as Figure 7.3-7.

Table 7.3-1: Lithologic and Hydrostratigraphic Units

<table>
<tr><th colspan="2">Lithologic Unit</th><th>Hydrostratigraphic Unit (Aquifer/Aquitard)</th></tr>
<tr><td colspan="2">Overburden</td><td>Overburden Aquifer</td></tr>
<tr><td rowspan="5">Manitou Falls Group / Athabasca Supergroup</td><td>Dunlop Fm –MFd</td><td rowspan="2">Upper Sandstone Aquifer</td></tr>
<tr><td>Collins Fm –MFc</td></tr>
<tr><td>Bird Fm –MFb</td><td rowspan="2">Intermediate Sandstone Aquitard (and Desilicified Zone Aquifer)</td></tr>
<tr><td rowspan="2">Read Fm (MFa)</td></tr>
<tr><td>Lower Sandstone Aquifer (and Desilicified Zone Aquifer)</td></tr>
<tr><td colspan="2">Upper Barrier Zone (clay cap and sulphide-cemented rock)</td><td>Aquitard (overlying the ore zone)</td></tr>
<tr><td colspan="2">Ore Zone (high grade friable zone)</td><td>Ore Zone Aquifer</td></tr>
<tr><td colspan="2">Lower Barrier Zone (clay cap and sulphide-cemented rock)</td><td>Aquitard (underlying the ore zone)</td></tr>
<tr><td colspan="2">Paleoweathered and Competent Basement</td><td>Basement Aquitard</td></tr>
</table>

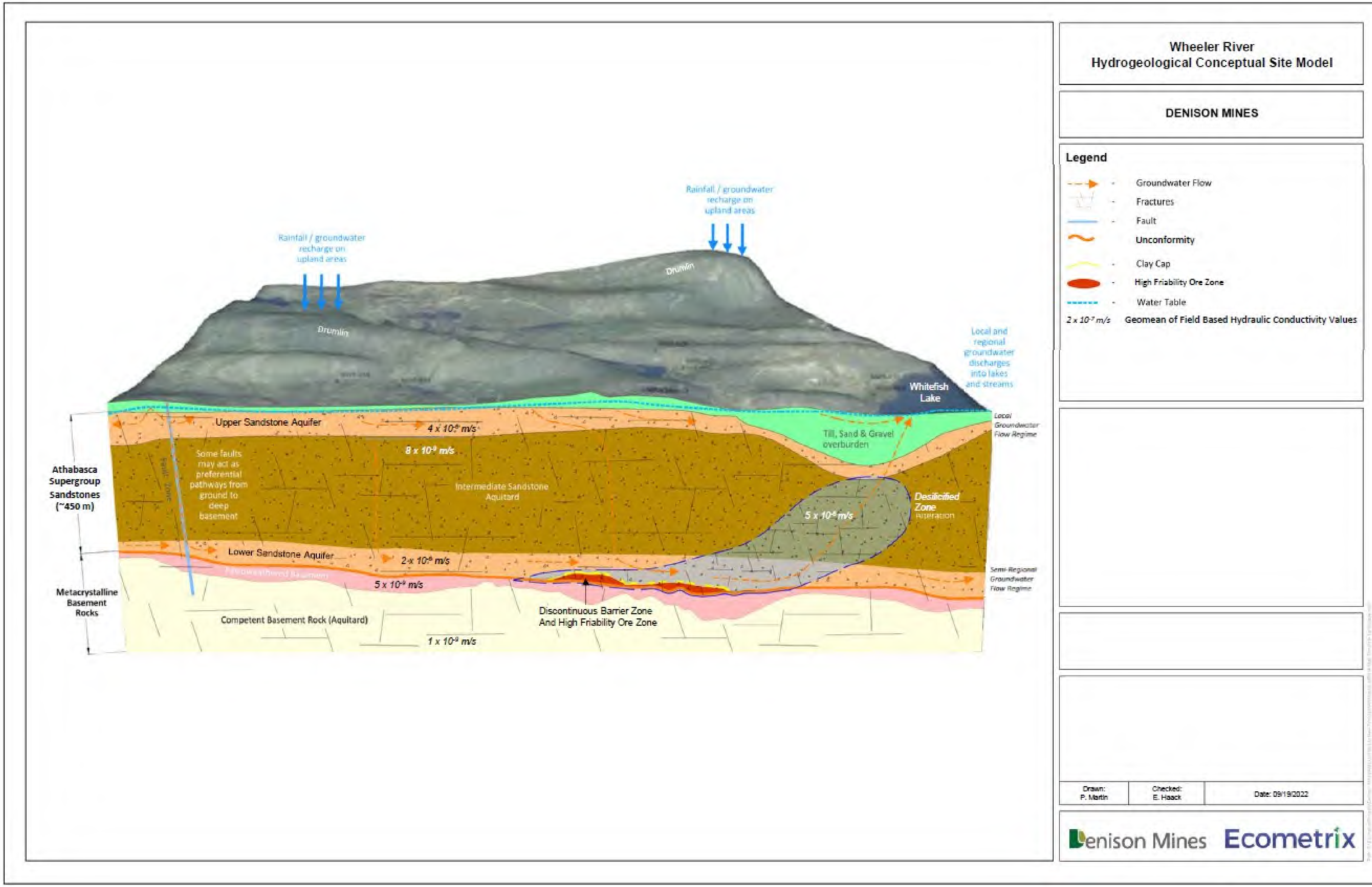
Wheeler River
Hydrogeological Conceptual Site Model
DENISON MINES
Legend
Groundwater Flow
Fractures
Fault
Unconformity
Clay Cap
High Friability Ore Zone
Water Table
2 x 10-7 m/s
Geomean of Field Based Hydraulic Conductivity Values
Rainfall / groundwater recharge on upland areas
Rainfall / groundwater recharge on upland areas
Drumlin
Drumlin
Local and regional groundwater discharges into lakes and streams
Whitefish Lake
Local Groundwater Flow Regime
Upper Sandstone Aquifer
4 x 10-6 m/s
8 x 10-9 m/s
Till, Sand & Gravel overburden
Athabasca Supergroup Sandstones (~450 m)
Some faults may act as preferential pathways from ground to deep basement
Intermediate Sandstone Aquitard
5 x 10-6 m/s
Desilicified Zone
Lower Sandstone Aquifer
2 x 10-6 m/s
5 x 10-9 m/s
Semi-Regional Groundwater Flow Regime
Metacrystalline Basement Rocks
Competent Basement Rock (Aquitard)
Discontinuous Barrier Zone And High Friability Ore Zone
1 x 10-9 m/s
Drawn: P. Martin
Checked: E. Haack
Date: 09/19/2022
Denison Mines
Ecometrix

Figure 7.3-7: Hydrogeological Conceptual Site Model

7.3.3.1 Aquifer Properties

Methodologically, the combination of the fracture frequency and normative clay content features is interpreted to have the greatest influence on the observed hydraulic conductivity trends in the area surrounding the Phoenix deposit. The degree of fracturing results in the potential capability to transmit water, and thus have zones of enhanced hydraulic conductivity. This potential enhancement of hydraulic conductivity is counteracted where sufficient clay content is present, as the clays in the rock tend to infill and seal the available fractures.

Hydraulic conductivity, porosity, and storage values of the hydrostratigraphic units in the LSA are summarized in Table 7.3-2.

Table 7.3-2: Summary of Hydrostratigraphic Unit Properties

Hydrostratigraphic Units	Field-Based Hydraulic Conductivity (m/s)		Effective Porosity (%)	Storage[2]
	Range	Geomean[1]		
Overburden Aquifer/Aquitard	3×10^{-6} and 2×10^{-4}	-	25% (sand); 18% (till)	20% (Sy)
Upper Sandstone Aquifer	4×10^{-7} to 1×10^{-4}	3.7×10^{-6}	1 to 5%	1×10^{-5} (Ss)
Intermediate Bedrock Aquitard	1×10^{-10} to 3.8×10^{-6}	8.4×10^{-9}	1 to 10%	
Desilicified Zone	1×10^{-6} to 2×10^{-5}	4.8×10^{-6}		
Lower Sandstone Aquifer	7.8×10^{-8} to 3×10^{-5}	2.2×10^{-6}		
Upper and Lower Barrier Zone Aquitard (clay cap and sulphide-cemented rock)	Hydraulic tests have not been completed on these units as they are relatively thin in comparison to overlying/underlying units.[3]			1×10^{-6} (Ss)
Ore Zone Aquifer				
Basement Aquitard	1.1×10^{-11} to 1.1×10^{-5}	4.8×10^{-9}		

Notes

1 A geomean value was not calculated for the Overburden Aquifer/Aquitard or the Upper and Lower Barrier zone as only two measurements were available for each unit.

2 Sy values expressed as a percent of total volume. Ss values expressed in units of 1/m.

3 Screened intervals of the wells often intercept the ore zone and upper or lower barrier zones. Elevated hydraulic conductivity values were interpreted to reflect the ore zone aquifer and lower values reflect the barrier zone aquitard.

Overburden is generally sand-rich with minor silt and clay content, resulting in an aquifer that ranges from high to moderate hydraulic conductivity.

Aquifer zones within sandstone result from fractured zones (presumably associated with faulting) and areas of lower clay content. The Upper Sandstone Aquifer is comprised of fine- to medium-grained sandstone that has a very low (less than 3%) normative clay content. The Intermediate Sandstone Aquitard is comprised of competent fractured sandstone that has normative clay contents that vary from 4 to 10%. Like the Upper Sandstone Aquifer, groundwater flow within this unit is controlled by fracture spacing, orientation, connectivity, and aperture thickness; however, the normative clay content in this hydrostratigraphic unit is conceptualized to reduce or seal the fracture apertures and their connectivity and, in turn, reduce the hydraulic conductivity of the unit. Denison staff noted that fractures observed in cores drilled in the MFb B and MFc units often had red hematite smearing or clay that appears to have healed once open fractures (Sorba 2021). The Lower Sandstone Aquifer is comprised of fractured and faulted sandstone that overlies the basement rock units. This unit has a consistently low normative clay content (less than 4%).

Hydraulic conductivity values for the Desilicified Zone are expected to vary depending on the alteration and local extent of friability of the sandstone, but in general, higher hydraulic conductivity values are expected, as shown in Table 7.3-2.

The hydraulic properties within the Basement Aquitard unit vary as the properties are dependent on the fracture or fault properties. The highest hydraulic conductivity values are expected along the primary fault zones, including the WS Shear zone where the rock is more fractured. Lower hydraulic conductivity values are observed in most portions of the Basement Aquitards where the basement rocks are competent and fracture frequency is low.

7.3.3.2 Groundwater Flow Systems

As presented in Figure 7.3-7, groundwater flow in the LSA is conceptualized to occur in two groundwater flow regimes. The uppermost flow system is unconfined and includes groundwater flow through the overburden and Upper Sandstone Aquifer. The lower, semi-regional system is confined by the Intermediate Sandstone Aquitard and includes flow through the Lower Sandstone Aquifer and (locally) in the Ore Zone Aquifer.

Horizontal groundwater flow in the deeper, semi-regional flow system is generally directed from the west to the east and southeast, as interpreted by water level and groundwater quality observations (Figure 7.3-8). Groundwater flow within the Overburden and Upper Sandstone Aquifer is influenced by ground surface topography and surface water features (Figure 7.3-9). Flow in the upper groundwater flow regime is derived from recharge in the local area, whereas groundwater flow within the semi-regional groundwater flow system is derived from a combination of regional groundwater flow from upgradient sources and vertical flow through the Intermediate Sandstone Aquitard. Vertical gradients are interpreted to be directed downward in areas west of the Phoenix deposit and upward beneath the surface waterbodies, such as Whitefish and Williams lakes.

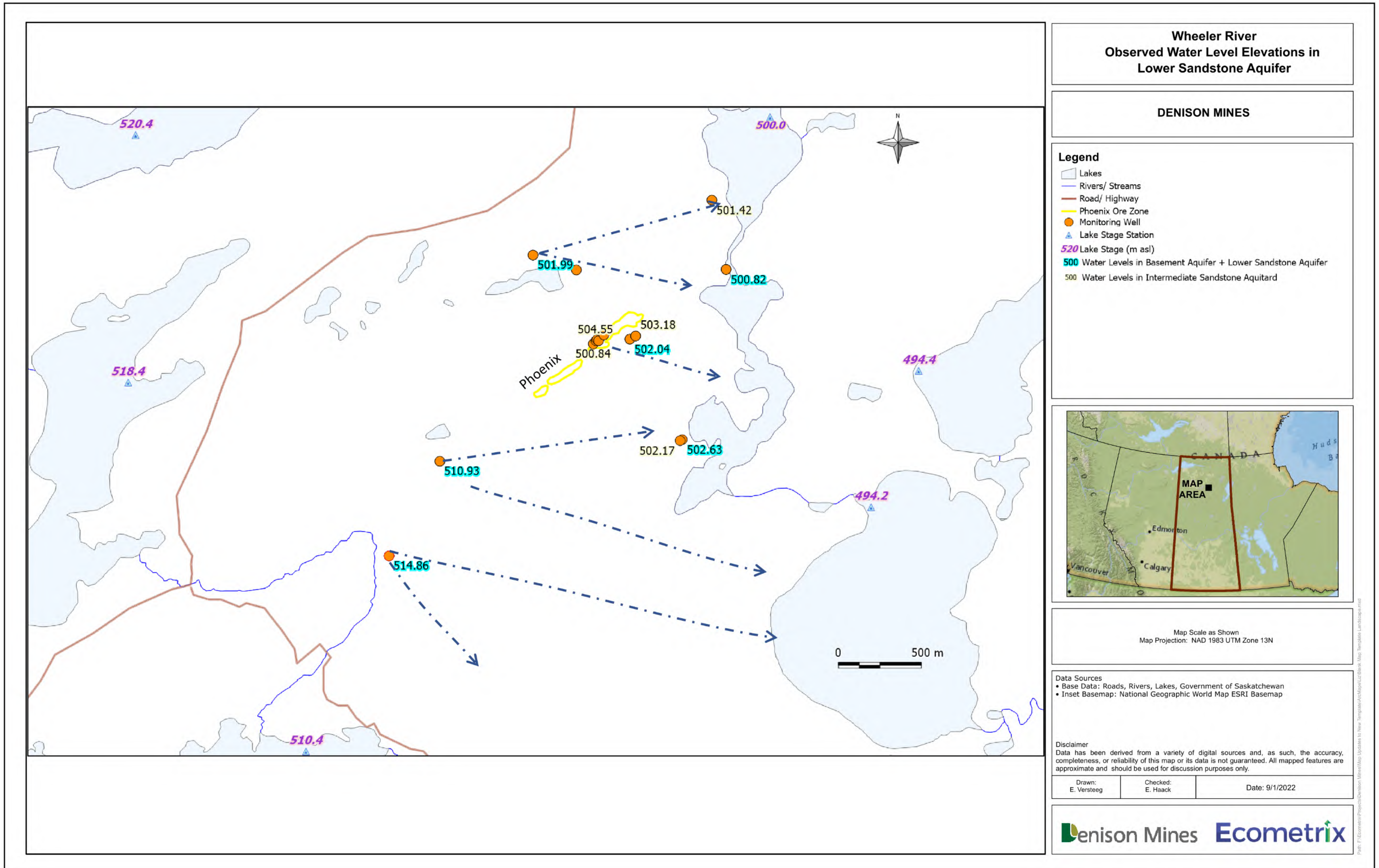

Figure 7.3-8: Observed Water Level Elevations in the Lower Sandstone Aquifer

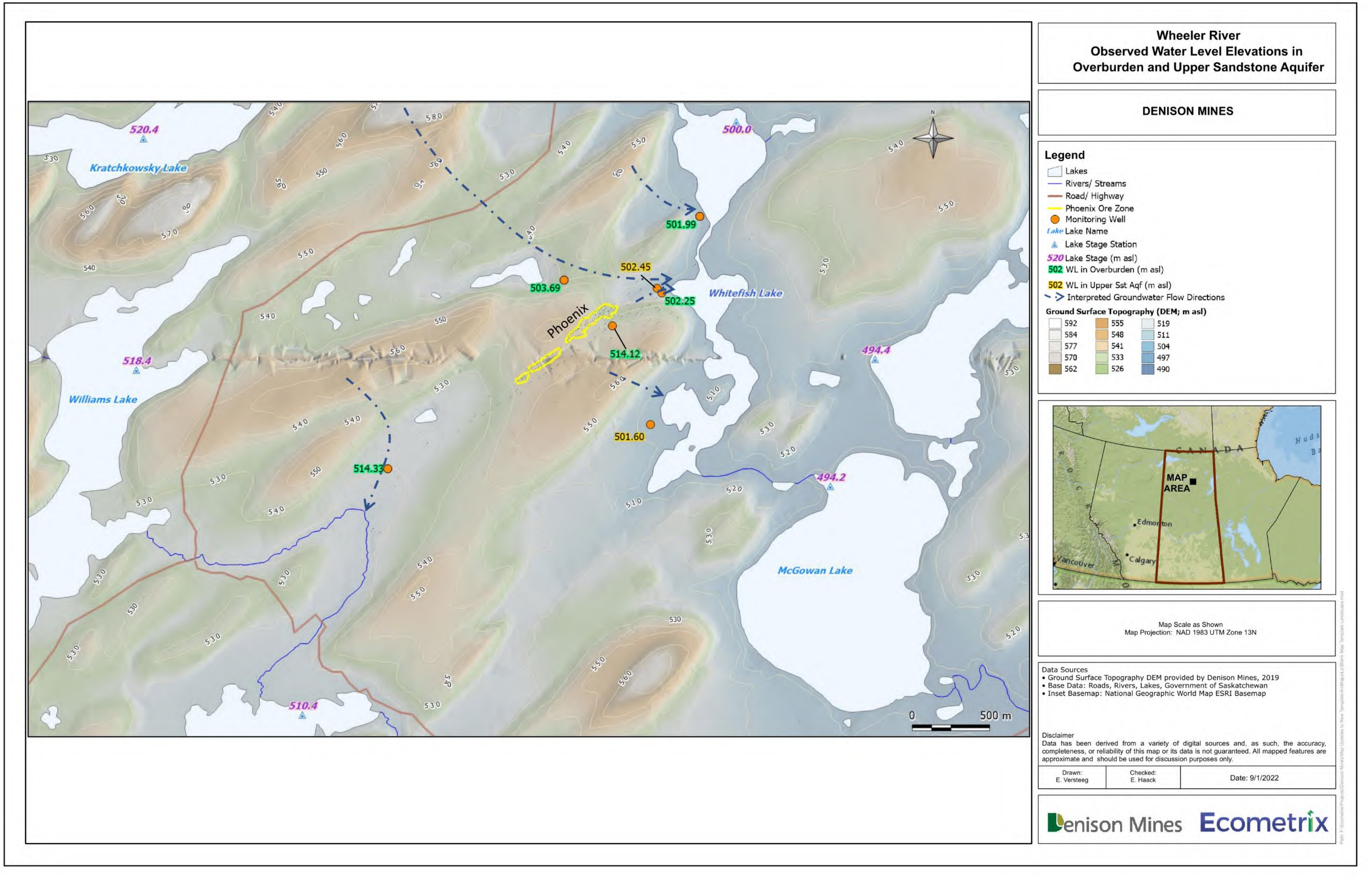

Figure 7.3-9: Observed Water Level Elevations in the Overburden and Upper Sandstone Aquifer

7.3.3.2.1 *Groundwater Recharge and Discharge*

Groundwater recharge occurs across much of the LSA, and after infiltrating to the water table, flows toward the local streams and surrounding lakes where it discharges to the surface. Recharge from the Local Flow System to the Lower Sandstone Aquifer is conceptualized to occur along fault zones (see Section 7.3.3.2.2) and where downward gradients are present.

Within the LSA, shallow groundwater in the Overburden and Upper Sandstone Aquifer is conceptualized to discharge into Whitefish Lake, which is located approximately 500 m east of the deposit and has a lake level of approximately 500 masl (Figure 7.3-9). Other major lakes in the area include Kratchkowsky Lake and Williams Lake, located west of the Phoenix deposit, which have lake levels of 520 and 518 masl, respectively (Figure 7.3-9). McGowan Lake, located southeast of Whitefish Lake and 2 km from the Phoenix deposit, has a lake elevation of 494 masl (6 m lower than Whitefish Lake), while Russell Lake, located 6 km south of the deposit, has a lake elevation of 488 masl.

The elevations observed in water levels between the Phoenix deposit and Whitefish Lake consistently exhibit an upward hydraulic gradient from the Lower Sandstone Aquifer (and ore zone) into Whitefish Lake (Figure 7.3-8) through the Desilicified Zone in the Intermediate Sandstone Aquitard. It is interpreted that the elevated hydraulic conductivity value represented by the Desilicified Zone creates a preferential pathway for water to discharge into Whitefish Lake, rather than continuing to stay in the Lower Sandstone Aquifer and discharge to Russell Lake. It is possible that some deeper regional flow within the Upper Sandstone Aquifer may discharge to Russell Lake south of the Phoenix site. However, despite the fact there is hydraulic potential for groundwater in the Lower Sandstone Aquifer to discharge to Russell or McGowan lakes, the Intermediate Sandstone Aquitard acts to hydraulically separate the Lower Sandstone Aquifer from the overlying Upper Sandstone Aquifer and the local groundwater flow regime in the Russell Lake and McGowan Lake areas.

Discharge to streamflow measurements have been shown to consistently increase from above Whitefish Lake to below McGowan Lake. Similarly, discharge to streamflow measurements along the drainage course west of the Phoenix deposit were measured to increase from upstream areas to the outlet at McGowan Lake. Low flow discharge per unit area is estimated to be approximately 125 mm/yr. This suggests that local groundwater discharge is sustaining streamflow even during low precipitation periods.

7.3.3.2.2 *Hydraulic Influence of Fault Zones and Drill Holes*

<u>Fault Zones</u>

Vertical fracture or fault zones that hydraulically connect the Local (upper) and Semi-Regional (lower) groundwater flow regimes are present throughout the Athabasca Basin (Ramaekers 1981; Kotzer and Kyser 1990; Sibbald et al. 1990). The distribution of monitoring wells outside of the

Phoenix ore zone area makes it difficult to identify these features with confidence, but these features may exist between data points.

Water level trends throughout the region surrounding the Phoenix deposit are largely consistent across the area (Figure 7.3-8, Figure 7.3-9, and Appendix 7-A). Large scale faults that extend from ground surface through the sandstone into the top of basement rock were not evident in the core; however, water levels in the deep sandstone and basement rocks in the areas west of the Phoenix ore zone are higher than those in the ore zone. For example, it is interpreted that the WS Shear zone (fault) may extend to ground surface and act as a preferential pathway for water to flow quickly from surface into the Lower Sandstone Aquifer. This interpretation is supported by groundwater quality within the Lower Sandstone Aquifer southwest of the Phoenix deposit (see Section 7.3.3.3).

Drill Holes

Exploration boreholes drilled in the Phoenix area, where left partially plugged to protect surficial aquifers, have the potential to provide preferential flow paths between the Overburden and Upper and Lower Sandstone Aquifers. Exploration holes were reportedly grouted approximately 10 to 20 m above and below the ore zone, resulting in open holes remaining throughout the overlying materials. These portions of the open holes may act as open conduits for groundwater flow through the 400 m of Athabasca Supergroup Sandstone. During Operation, select exploration boreholes will be re-utilized for narrow diameter injection wells that will be developed with monitoring devices for the determination of excursions and water levels. Exploration boreholes not selected for the use of narrow injection wells will be grouted to surface to seal off any remaining conduit.

Currently, these boreholes may be influencing the local vertical gradients observed in monitoring wells close to the Phoenix deposit, but as all observation wells local to the ore zone are screened at considerable depth (i.e., over 200 m), it is difficult to understand the potential influence of these open holes. These pathways will be considered during the planning and design of the groundwater monitoring plan (GWMP).

7.3.3.3 Baseline Groundwater Chemistry

The network of single interval groundwater monitoring wells in the LSA is shown in Figure 7.3-10. The GWR (‘Groundwater, Regional’) series wells were installed in all lateral directions around the ore zone and, for the most part, were advanced in groups of three. The groups of three wells targeted each of the local and regional groundwater flow zones, including: a) the Overburden and Upper Sandstone Aquifers (overburden, MFd, and upper MFc); b) the Intermediate Sandstone Aquitard (lower MFc and upper MFb); and c) the Lower Sandstone Aquifer (lower MFb and MFa). These groups of wells are referred to as ‘clusters’.

One monitoring well, GWR-031, is installed across the ore zone and Paleoweathered zone. Groundwater quality from this well is considered most reflective of Paleoweathered zone hydrochemistry of all the wells installed in the study area. Monitoring wells installed within or across the ore zone include GWR-032, GWR-038. GWR-039, GWR-040, GWR-041, and GWR-042.

Monitoring well GWR-004 was installed in the Basement Aquifer in Phase 3 of the Phoenix deposit, but due to the small drill/core size, cannot support sampling. An attempt was made to sample the basement rock as part of the Gryphon Shaft Pilot Hole Drill Support Program (SRK Consulting 2018a). Due to low permeability and groundwater recovery, it was not possible to collect a sample from the basement rock. Groundwater quality for the basement rock is available from information available from Cigar Lake (AECL 1994) and the *Millennium Project Environmental Impact Statement: Annex D, Regional Geology and Hydrogeology* (Cameco 2012a).

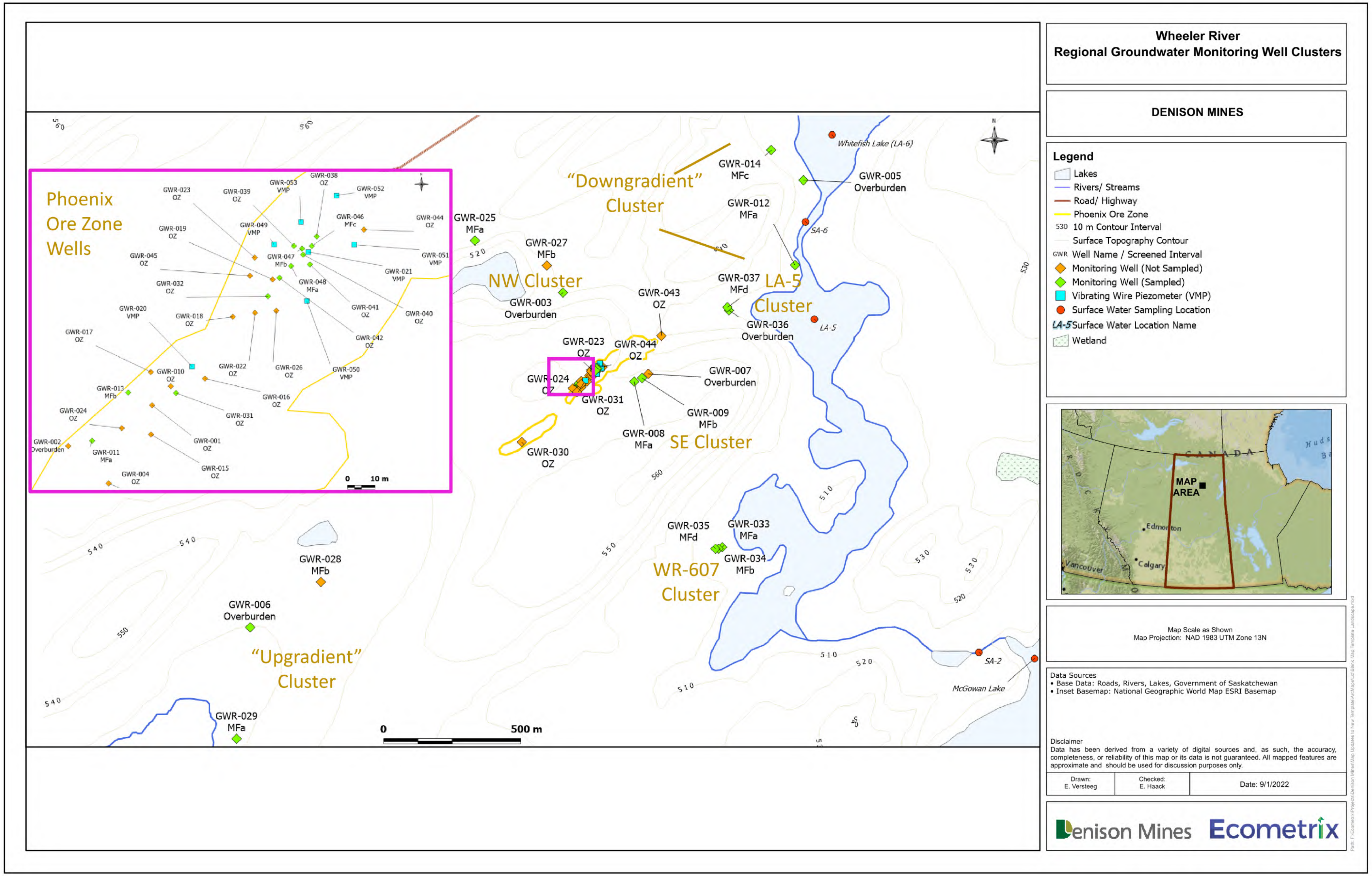

Figure 7.3-10: Regional Groundwater Monitoring Well Clusters

Tabulated groundwater quality measured within the LSA is provided in Appendix 7-A. Groundwater across hydrostratigraphic units is generally characterized by low mineralization (i.e., total dissolved solids concentrations less than 1,000 mg/L). Concentrations of radiological constituents and a small number of heavy metals and trace elements measured in groundwater associated with the uranium deposit in the Phoenix area are generally orders of magnitude lower in overlying hydrostratigraphic units and surface water than they are in the ore zone groundwater samples, as demonstrated for uranium concentrations spatially in Figure 7.3-11. This is evidence of a very low mass flux of these constituents from the ore zone and a discontinuous barrier zone aquitard that envelopes the ore zone over time.

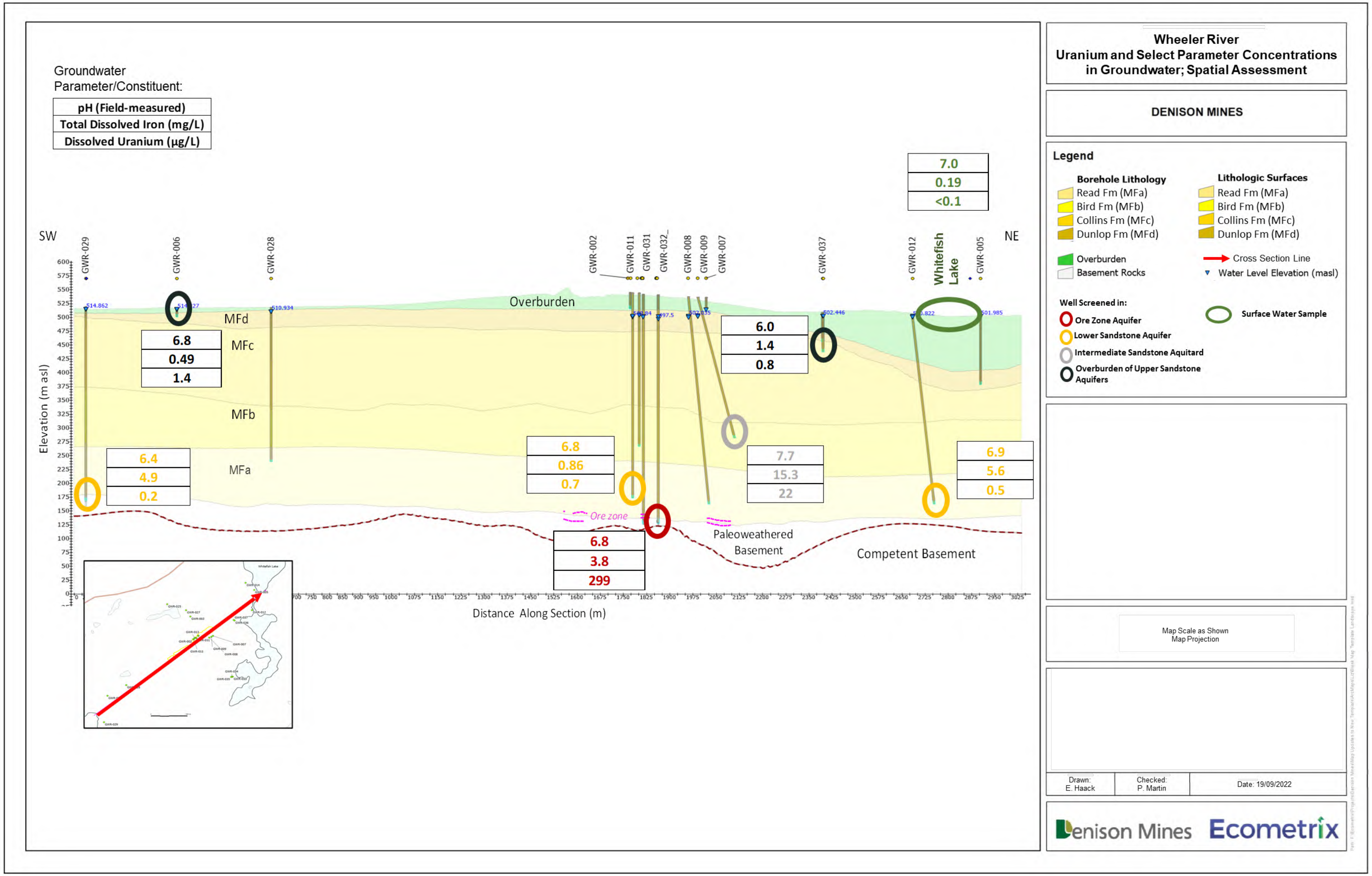

Figure 7.3-11: Uranium and Select Parameter Concentrations in Groundwater – Spatial Assessment

The groundwater chemistry measured supports the presence of a Local Flow System, Intermediate Sandstone Aquitard, and Lower Sandstone Aquifer in the study area. The chemistry of groundwater in the Local Flow System is that of recharge water with a relatively low pH (due to contact with organic matter in the upper soil profile) that has become mineralized through dissolution of quartz, feldspars, kaolinite, and illite. The chemistry of groundwater in the Intermediate Sandstone Aquitard is similar to the Local Flow System in terms of major ion composition, but a longer residence time in the aquitard has led to more extensive mineral dissolution and higher mineralization with a similar hydrochemical type. Higher relative variability in concentrations of groundwater constituents measured in monitoring wells from the Intermediate Sandstone Aquitard may reflect the localized influence of desilicification on the flow conditions, and consequently on groundwater quality conditions.

The Lower Sandstone Aquifer is characterized spatially by two types of groundwater. The first groundwater type is most like that observed in the Local Flow System. This reflects hydraulically active fractures and fault systems that allow fresh recharge water to penetrate and mix with deeper waters in the aquifer. The second type of groundwater is within the zone of thermal alteration around the ozone and has relatively high mineralization, thought to be the result of dissolution of remnant halide salts present on grain boundaries and in intragranular pores within the rock matrix at depth in the Athabasca Sandstones.

Groundwater quality results suggest that connectivity between the Upper Sandstone Aquifer and Intermediate Sandstone Aquitard is limited. Desilicification of these formations to the northeast of the ore zone may affect interconnectivity of these units on a localized scale. Although limited in number of samples available, groundwater quality in the Paleoweathered zone for the Project assessment suggests a distinct geochemical environment from that of the overlying Athabasca Sandstone hydrostratigraphic units.

7.4 Assessment of Project-related Effects

This subsection describes the process by which interactions between Project components and activities and the Geology and Groundwater VCs were identified and evaluated. A Project interaction analysis was used to focus the assessment on key interactions between the Project and the environment. The key interactions were evaluated to determine the significance of potential residual effects on the VCs.

Primary pathways that may lead to residual effects after incorporation of mitigation are further characterized in subsequent subsections of the assessment, as required. As such, the discussion of Project-related interactions and mitigation measures (Sections 7.4.1, 7.4.2, and 7.5) helps to focus the remainder of the assessment on those interactions (i.e., effects pathways) likely to result in residual adverse effects.

7.4.1 Potential Project-Valued Component Interactions

Potential Project-related interactions with the Geology and Groundwater VCs are summarized by Project phase in Table 7.4-1 and Table 7.4-2, respectively. Potential interactions in the summary tables were ranked in accordance with the following categories using professional judgement, understanding of the Project, recent EAs for mining projects in Canada, and comments provided during engagement:

- **Primary Interaction** (✓): The pathway is likely to result in an environmental change relative to the base case and/or guideline values that could contribute to residual effects on Geology and/or Groundwater VCs.
- **Other Interaction** (✓): Project activity is expected to interact with the Geology and/or Groundwater VCs. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects. The interaction has the potential to result in a measurable minor environmental change but would have a negligible residual effect on Geology and/or Groundwater relative to base case and/or guideline values. Such pathways are not expected to contribute cumulatively to other Project effects or to the effects of other previous, existing, or reasonably foreseeable developments to cause a significant effect.
- **No Interaction**: Project activity is not expected to interact with the Geology or Groundwater VCs due to environmental design features or mitigation. The Project activity would not be expected to result in a measurable environmental change relative to base case values and therefore would have no residual effects on Geology and/or Groundwater.

Table 7.4-1: Potential Project Interactions for the Geology Valued Component

Project Phase/Activity	Key Indicator #1 Terrain/Subsidence
Construction Activities	
Development of access roads and air strip	
Site preparation and earthworks; clearing, levelling, and grading of the Project Area	
Power generation – generators	
Installation of main substation and distribution of power around site	
Wellfield and freeze hole drilling; ground freezing	
Batch plant operation (concrete); crusher at borrow area	
Development of surface infrastructure (camp, operations centre, plants, ponds, pads, and support facilities)	
Waste management (composting, domestic and industrial landfill operation, recycling)	
Water management (including treatment and site runoff)	
Groundwater supply	
Surface water withdrawal	

Project Phase/Activity	Key Indicator #1 Terrain/Subsidence
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	
On-site and off-site operation of vehicles and transport of materials	
Air transportation for workers	
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Operation Activities	
Operation of the ISR wellfield	✓
Wellfield and freeze wall drilling	✓
Operation and expansion of freeze wall	✓
Batch plant operation (grout and cement); crusher in borrow area	
Expansion of pond and pads	
Operation of the processing plant and production of uranium concentrate	
Water withdrawal from groundwater or surface waterbody	
Management of surface water (including seepage and site runoff)	
Water treatment, both domestic and industrial	
Water release to surface waterbody	
Waste management (composting, domestic and industrial landfill operation, recycling)	
Hazardous waste management (temporary storage, handling, and off-site transportation)	
Storage and disposal of drill waste rock, process precipitates, and industrial wastewater treatment plant precipitates	
On-site and off-site operation of vehicles and transport of materials	
Power supply – primarily power from the grid, also generators and back-up generators	
Package and transport of nuclear substances	
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	
Air transportation for workers	
Progressive decommissioning and reclamation	
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Decommissioning Activities	
Site water management, treatment, and release	
Mining horizon remediation and thawing of freeze wall	
Process water treatment and release	
Closure of ISR and freeze wells and related infrastructure	
Decontamination of surface facilities and injection, recovery, and monitoring wells	
Asset removal (including site power transmission lines and electrical infrastructure)	

Project Phase/Activity	Key Indicator #1 Terrain/Subsidence
Demolition and disposal of non-salvageable surface infrastructure and materials	
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	
Generators	
Waste management (composting and landfill operation)	
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)	
On-site and off-site operation of vehicles and transport of materials	
Reclamation of disturbed areas	
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Post-Decommissioning Activities	
Environmental monitoring	
Regulatory site inspections	
Engagement – Site visit from Interested Parties	

A check mark ✓ indicates an 'other' interaction and a grey check mark (✓) indicates a primary interaction.

Table 7.4-2: Potential Project Interactions for the Groundwater Valued Component

Project Phase/Activity	Groundwater Valued Component	
	Key Indicator #1 Groundwater Quantity	Key Indicator #2 Groundwater Quality
Construction Activities		
Development of access roads and air strip		
Site preparation and earthworks; clearing, levelling, and grading of the Project Area	✓	
Power generation – generators		
Installation of main substation and distribution of power around site		
Wellfield and freeze hole drilling; ground freezing	✓	✓
Batch plant operation (concrete); crusher at borrow area		
Development of surface infrastructure (camp, operations centre, plants, ponds, pads, and support facilities)	✓	
Waste management (composting, domestic and industrial landfill operation, recycling)		
Water management (including treatment and site runoff)		✓
Groundwater supply	✓	
Surface water withdrawal		
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)		

Project Phase/Activity	Groundwater Valued Component	
	Key Indicator #1 Groundwater Quantity	Key Indicator #2 Groundwater Quality
On-site and off-site operation of vehicles and transport of materials		
Air transportation for workers		
Regulatory site inspections		
Engagement – site visit from Interested Parties		
Operation Activities		
Operation of the ISR wellfield	✓	✓
Wellfield and freeze wall drilling	✓	✓
Operation and expansion of freeze wall	✓	✓
Batch plant operation (grout and cement); crusher in borrow area		
Expansion of pond and pads	✓	✓
Operation of the processing plant and production of uranium concentrate		✓
Water withdrawal from groundwater or surface waterbody	✓	
Management of surface water (including seepage and site runoff)	✓	✓
Water treatment, both domestic and industrial		✓
Water release to surface waterbody		
Waste management (composting, domestic and industrial landfill operation, recycling)		✓
Hazardous waste management (temporary storage, handling, and off-site transportation)		✓
Storage and disposal of drill waste rock, process precipitates, and industrial wastewater treatment plant precipitates		✓
On-site and off-site operation of vehicles and transport of materials		
Power supply – primarily power from the grid, also generators and back-up generators		
Package and transport of nuclear substances		
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)		
Air transportation for workers		
Progressive decommissioning and reclamation		
Regulatory site inspections		
Engagement – site visit from Interested Parties		
Decommissioning Activities		
Site water management, treatment, and release	✓	✓
Mining horizon remediation and thawing of freeze wall	✓	✓
Process water treatment and release	✓	✓
Closure of ISR and freeze wells and related infrastructure	✓	✓

Project Phase/Activity	Groundwater Valued Component	
	Key Indicator #1 Groundwater Quantity	Key Indicator #2 Groundwater Quality
Decontamination of surface facilities and injection, recovery, and monitoring wells		✓
Asset removal (including site power transmission lines and electrical infrastructure)		
Demolition and disposal of non-salvageable surface infrastructure and materials		
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	✓	✓
Generators		
Waste management (composting and landfill operation)		✓
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)		
On-site and off-site operation of vehicles and transport of materials		
Reclamation of disturbed areas	✓	
Regulatory site inspections		
Engagement – site visit from Interested Parties		
Post-Decommissioning Activities		
Environmental monitoring	✓	✓
Regulatory site inspections		
Engagement – Site visit from Interested Parties		

A check mark ✓ indicates an 'other' interaction and a grey check mark (✓) indicates a primary interaction.

7.4.2 Potential Project-related Effects

Based on the anticipated Project interactions analysis summarized in Table 7.4-1 and Table 7.4-2, key interactions and potential effects that warrant further assessment were identified. These potential effects have a greater potential to result in an adverse residual effect or to be a concern to Indigenous peoples, governments, or the public. The following subsections provide an overview of what is known and understood about the potential effects. Understanding of the potential effects is based on professional judgement, understanding of the Project, similar EAs for mining projects in Canada, and comments provided during engagement.

Project interactions determined as "No Interaction" were not carried forward for further assessment for one or more of the following reasons:

- the Project activities do not interact with the Geology or Groundwater VCs (e.g., on-site and off-site operation of vehicles and transport of materials);
- the Project activities are managed under another discipline (e.g., Aquatic Environment); and/or

- the Project activities are deemed to be a part of routine operations or expected activities with best management practices or health and safety plans (e.g., asset removal [including site power transmission lines and electrical infrastructure]).

The primary potential effect from the Project on the Geology VC is changes to soil terrain and stability during Operation. The primary potential effect from the Project on the Groundwater VC is changes to groundwater quantity and quality during Construction, Operation, Decommissioning, and Post-Decommissioning associated with mining activities and following remediation of the mining area. For clarity throughout this section, the definition of the mining area provided in Section 2 is summarized herein. The mining area includes:

- the ‘active mining area’, which is the target ore zone;
- a zone extending between 11 and 13 m above the active mining area that represents the maximum vertical height over which the injected mining fluids will migrate upwards from the ore zone during active mining; and
- a zone extending 50 m vertically upwards from the active mining area (that incorporates the active mining area and the 11 to 13 m zone defined in the previous bullet) that was selected to account for potential upset conditions.

Denison has committed to containing mining solutions within the mining area. Residual effects associated with the mining area have been shown through groundwater modelling simulations to be confined to the LSA (see Section 7.6).

Primary pathways that may result in changes to the environment and one or more associated measurement indicator(s) and that have the potential to cause a greater than negligible effect on the Geology and Groundwater VCs were evaluated and carried forward to the mitigation measures discussion (Section 7.5) and, if warranted, to the residual effects evaluation (Section 7.6).

The Project components, activities, and expected interactions with the Geology and Groundwater VCs are presented in Table 7.4-3. Detailed descriptions and evaluations of the key potential effects that were identified as having primary or other interactions with the Project are presented in the following subsections.

Table 7.4-3: Potential Project-related Effects by Project Phase for the Geology and Groundwater Valued Components

Project Activity	Potential Effect within the Local Study Area	Project Interactions[1]
Construction		
Site preparation, site clearing, and grading Development of surface facilities Wellfield and freeze hole drilling; ground freezing Groundwater withdrawal(s) for water supply	Construction of the surface facilities and site preparation for the Project may physically alter groundwater recharge rates, groundwater levels, and flow conditions within the shallow hydrostratigraphic units to surface water receptors. Groundwater withdrawal for water for construction purposes may cause changes to the groundwater system within the shallow hydrostratigraphic units.	EX Groundwater Quantity
Refuelling of equipment and general site construction activities	Spills or leaks from Construction may cause changes to the shallow groundwater quality.	EX Groundwater Quality
Operation		
Operation of the ISR wellfield Operation and expansion of freeze walls Landfills, ponds, waste management, contaminated waste storage, septic fields Surface storage and disposal of waste rock and plant precipitates.	Operation of the ISR wellfield may result in subsidence of the ground surface in the area of the well field, associated with extraction of rock mass (ore) at significant depth (approximately 400 m) below ground.	EX Terrain Morphology and Stability
	Groundwater withdrawals for water during Operation may cause changes to the groundwater system within the shallow hydrostratigraphic units. Mining and freeze wall operation may physically alter groundwater levels and flows within the shallow hydrostratigraphic units and, to a lesser degree, within the deeper hydrostratigraphic units.	EX Groundwater Quantity
	Mining may affect shallow groundwater quality in the wellfield area and deep groundwater quality within the LSA. This would include issues with potential excursions or migration of mining fluids and uranium-bearing solution through earlier exploration drill holes in the LSA that have been partially plugged to protect surficial aquifers. Spills, leaks, leachate from ponds, and landfills may cause changes to shallow groundwater quality.	EX Groundwater Quality
Decommission and Post-Decommissioning		
Landfills, ponds, waste management, contaminated waste storage Mining area remediation and thawing of freeze wall Environmental monitoring	Groundwater withdrawal(s) for water for Decommissioning may cause changes to the groundwater system within the shallow hydrostratigraphic units.	EX Groundwater Quantity
	Most surface facilities are to be decommissioned and materials removed from the Project Area (Section 2). Spills, leaks, and leachate from the industrial landfill and the Industrial Wastewater Treatment Plant precipitate pond may cause changes to shallow groundwater quality. Remediation of the mining area and migration of dissolved COPC concentrations in remediated groundwater during Decommissioning and Post-Decommissioning, respectively, may affect shallow and deep groundwater quality.	EX Groundwater Quality

Project Activity	Potential Effect within the Local Study Area	Project Interactions[1]
Future Centuries		
A period following Post-Decommissioning that is unique and applied only to the Groundwater VC. This temporal scope subtends the period over which the highest concentrations of COPC dissolved in groundwater are predicted to interact with the Surface Water Quality VC.	Long-term potential (i.e., hundreds to thousands of years) for COPCs dissolved in remediated groundwater to migrate along the natural groundwater flow path from the mining area, which is predicted to be eastward within the deeper groundwater units and then upward through the Desilicified Zone toward Whitefish Lake. The potential effect is migration of COPCs dissolved in groundwater from the mining area to proximal surface waterbodies.	P Surface Water Quality VC

1 P = Primary Interaction; EX = 'Other' Expected Interaction.

7.4.2.1 Potential Effect #1: Groundwater Quantity – Construction to Decommissioning (General Activities)

Construction of surface facilities, site preparation, site operations, and Project-related water demands over the life of the Project have the potential to physically alter groundwater levels and flow within the shallow hydrostratigraphic units. A detailed study was completed to evaluate baseline groundwater flow to local surface water receptors (e.g., Whitefish Lake) using a robust dataset of available hydrology and hydrogeology information for the Project and the predictive numerical groundwater model (Appendix 7-C).

The KI for this assessment was groundwater flow and discharge to Whitefish Lake, the most susceptible local receptor. The MP for this assessment was baseflow to surface waterbodies (L/s). The potential effect on groundwater levels and baseflow to local surface water receptors was completed using the calibrated numerical groundwater model and the water demands calculated for all phases of the Project.

<u>Baseline Pre-mining Groundwater Baseflow and Water Balance</u>

The calibrated groundwater model (Appendix 7-C) was used to evaluate the regional groundwater budget (Table 7.4-4). The groundwater budget is presented for steady-state, pre-mining conditions and, as such, represents what is expected to occur within a typical year.

Most of the inflow is simulated in the model to occur as groundwater recharge, which is supplied through annual precipitation (i.e., infiltration of rainfall, runoff, and snowmelt). Additional inflow is provided via some of the natural ponds within the LSA (e.g., near GWR-025 and further west toward the Gryphon deposit) and from deep regional groundwater flow within the Lower Sandstone Aquifer, which enters the model near Kratchkowsky (north) and Williams (west) lakes. Deep regional groundwater flow is estimated to be a relatively minor part of the groundwater flow budget, as deep inflows account for less than 1% of the total inflow into the LSA. Similarly, deep regional outflow south toward Russell Lake is estimated to be negligible (0.2%).

Most water leaving in the model is simulated to exit as groundwater discharge (seepage) to surface waterbodies. Such groundwater discharge supports stream baseflow in otherwise dry conditions. Most groundwater discharge occurs to the lakes; the distribution of discharge to the various lakes is presented in Table 7.4-5. Whitefish Lake is simulated to receive 55% of the groundwater flowing through the model domain, with smaller amounts discharging to lakes in the southeast (McGowan Lake and LA-2) and southwest (LB2 and the river between Williams Lake and LB-2). Katchkowsky and Williams lakes receive relatively small amounts of the groundwater recharged within the model domain.

Table 7.4-4: Regional Water Budget (Average Annual Rates)

Element	Water In (m^3/d)	Water Out (m^3/d)	Comment
Groundwater Recharge from Precipitation	6,365		Inflow at Ground Surface
Interaction with Lakes	510	6,903	Inflow/Outflow at Ground Surface
North Inflow	22		Lateral Inflow to Lower Sandstone Aquifer
South Outflow		15	Lateral Outflow from Lower Sandstone Aquifer toward Russell Lake
West Inflow	21		Lateral Inflow to Lower Sandstone Aquifer
Sum	6,918	6,918	

Table 7.4-5: Groundwater Discharge to Surface Waterbodies

Element	Water In (m^3/d)	Water Out (m^3/d)	Percentage (%) of Groundwater Recharge that Discharges to Surface Features in the LSA
Whitefish Lake		3,517	55%
McGowan Lake and LA-2		1,938	30%
Kratchkowsky Lake and Williams Lake		445	7%
LB-2 and Inflowing River		1,003	16%
Interior Ponds	510		8%
Sum	510	6,903	

As indicated by the regional water budget, most of the groundwater flow through the model domain occurs within the shallow portions of the model domain (i.e., the Overburden and Upper Sandstone Aquifer). Additional sub-domain water budgeting suggests that 99% of groundwater flow occurs through the Upper Sandstone and Overburden deposits, extending from the groundwater recharge areas to discharge areas at the respective lakes and rivers. Similarly, it was calculated that flow from the Lower Sandstone Aquifer, up through the Desilicified Zone, accounts for less than 1% of the groundwater discharge to Whitefish Lake. This suggests that any deep groundwater discharge from the vicinity of the ore zone will be a small proportion of the groundwater received within Whitefish Lake.

Groundwater discharge to Whitefish Lake is estimated to be 40 L/s (3,456 m^3/d or 0.04 m^3/s), which is a small component (approximately 3%) of the average surface flow through the lake (average of 1.4 m^3/s). The component of groundwater discharge from the Lower Sandstone Aquifer is 1% of the total groundwater discharge, or 0.03% of the total flow through Whitefish Lake. At low flow conditions (7Q10; provided in Appendix 8-B in Section 8 [2011–2019 Baseline Hydrology Summary Report – Wheeler River Project, Denison Mines]), the estimated surface flow through Whitefish Lake is 0.81 m^3/s, indicating that the portion of deep groundwater discharge could reach a maximum level of 0.05% ($4x10^{-4}$ m^3/s) of the flow through Whitefish Lake.

Evaluation of Groundwater Conditions During Mine Operations

An overview of the site water balances during Construction, Operation, and Decommissioning is provided in Table 7.4-6, as referenced in Section 2. This table provides a summary of the water needs for certain Project activities, planned water treatment (both potable and wastewater), and the general flow of managed water at the site.

Table 7.4-6: Site Water Balance

Category	Source/Destination	Phase			EIS Bounding Scenario
		Construction (Year 1 to 3)	Operation (Year 3 to 18)	Decommissioning (Year 18 to 23)	
Water Taking	Groundwater Source	20 m^3/hr	31.3 m^3/hr	35.5 m^3/hr	40.5 m^3/hr
	Surface Water Feature(s)	20 m^3/hr	31.3 m^3/hr	35.5 m^3/hr	40.5 m^3/hr
	Onsite Runoff Collection	1 m^3/hr	1 m^3/hr	1 m^3/hr	n/a
	Onsite Storage Facility	10,000 m^3	252,763 m^3	252,763 m^3	n/a
Water Discharge	Underground Water Discharge	0	0	0	
	Surface Water Feature(s)	6.5 m^3/hr	36.5 m^3/hr	36.5 m^3/hr	81 m^3/hr
	Onsite Storage Facility	10,000 m^3	252,763 m^3	252,763 m^3	n/a

Designed mining operations include the use of groundwater for several purposes, including to supply domestic water use within the camp and make-up water to the ISR plant, and to support the wash bay and drilling activities. Numerical modelling was applied to evaluate changes in groundwater flow conditions during Operation. Pumping demand in the model was estimated to be the following:

- 20 m^3/hr (5.6 L/s) during Construction (Year 1 to 3) to support drilling activities and development of the freeze wall;
- 31.3 m^3/hr (8.7 L/s) during Operation (Year 3 to 18); and
- 35.5 m^3/hr (9.9 L/s) during Decommissioning.

Other changes to groundwater flow conditions were incorporated into the model. Recharge is anticipated to be reduced (estimated at 50%) within the freeze wall area but enhanced over the footprint/area of the borrow pit (20%). Groundwater inflow from the septic effluent pond is estimated at 2.5 m^3/hr (0.7 L/s). The reduced hydraulic conductivity associated with the planned vertical freeze walls was incorporated within the groundwater model simulations.

The pumping demand and changes to recharge were incorporated into a transient simulation performed using the calibrated groundwater flow model. The model simulation was started 10 years prior to mining, such that changes due to mining were introduced mid-simulation. The simulation was continued for more than 50 years to include the entire period of ISR mining and subsequent flushing of the ore zone.

Figure 7.4-1 illustrates the predicted change in groundwater level elevations due to planned groundwater pumping. Pumping is planned from three wells located outside of but proximal to the ISR wellfield and installed in the Upper Sandstone Aquifer (Well A, Well B, and Well C). The expected drawdown ranges from a maximum value of 9 m for Well B (reached during Decommissioning when pumping rates are highest) to a minimum value of 2.4 m for Well C (reached during Decommissioning). The predicted drawdown is proportional to the estimated local hydraulic conductivity. Pumping ceases during Post-Decommissioning and groundwater levels are predicted to return to baseline (pre-mining) levels approximately nine years later (i.e., at year 34 of the life of the Project; Figure 7.4-1).

Figure 7.4-2 illustrates the predicted changes to average streamflow through Whitefish Lake over the life of the Project. Groundwater discharge to Whitefish Lake is predicted to be reduced by as much as 25% (from 41 to 31 L/s) during Decommissioning. During Construction and Operation, groundwater discharge is predicted to be reduced to a lesser extent (approximately 10% during Construction; up to approximately 17% during Operation). Groundwater discharge to Whitefish Lake is predicted to begin to recover to baseline (pre-mining) conditions during the early years of Post-Decommissioning when pumping has ceased. Recovery of groundwater discharge to Whitefish Lake is predicted to reach 90% four years into Post-Decommissioning. Full recovery of groundwater discharge to Whitefish Lake (to pre-mining levels) is asymptotically approached and predicted to be achieved nine years into Post-Decommissioning (i.e., at year 23 of the life of the Project). However, because groundwater discharge to Whitefish Lake is a small component of the flow through the lake (average flow estimated as 1.41 m^3/s or 1,410 L/s), the change in water quantity within Whitefish Lake during all Project phases is predicted to be negligible and too small to measure.

Consequently, the potential effect on water quantity in Whitefish Lake is expected to be of low magnitude over a moderate length of time. This outcome is considered likely as Project water use is small relative to surface flow through Whitefish Lake, which has been measured over the years of streamflow monitoring (2011 to 2019; Appendix 8-B in Section 8).

The water demand and water balance evaluations, along with standard mitigation measures (Section 7.5), suggest that the potential effect on water quantity at surface water discharge zones (e.g., Whitefish Lake) is expected to be negligible. Therefore, this potential effect is not expected to be a primary contributor to potential residual effects following the application of proposed mitigation measures (Section 7.5).

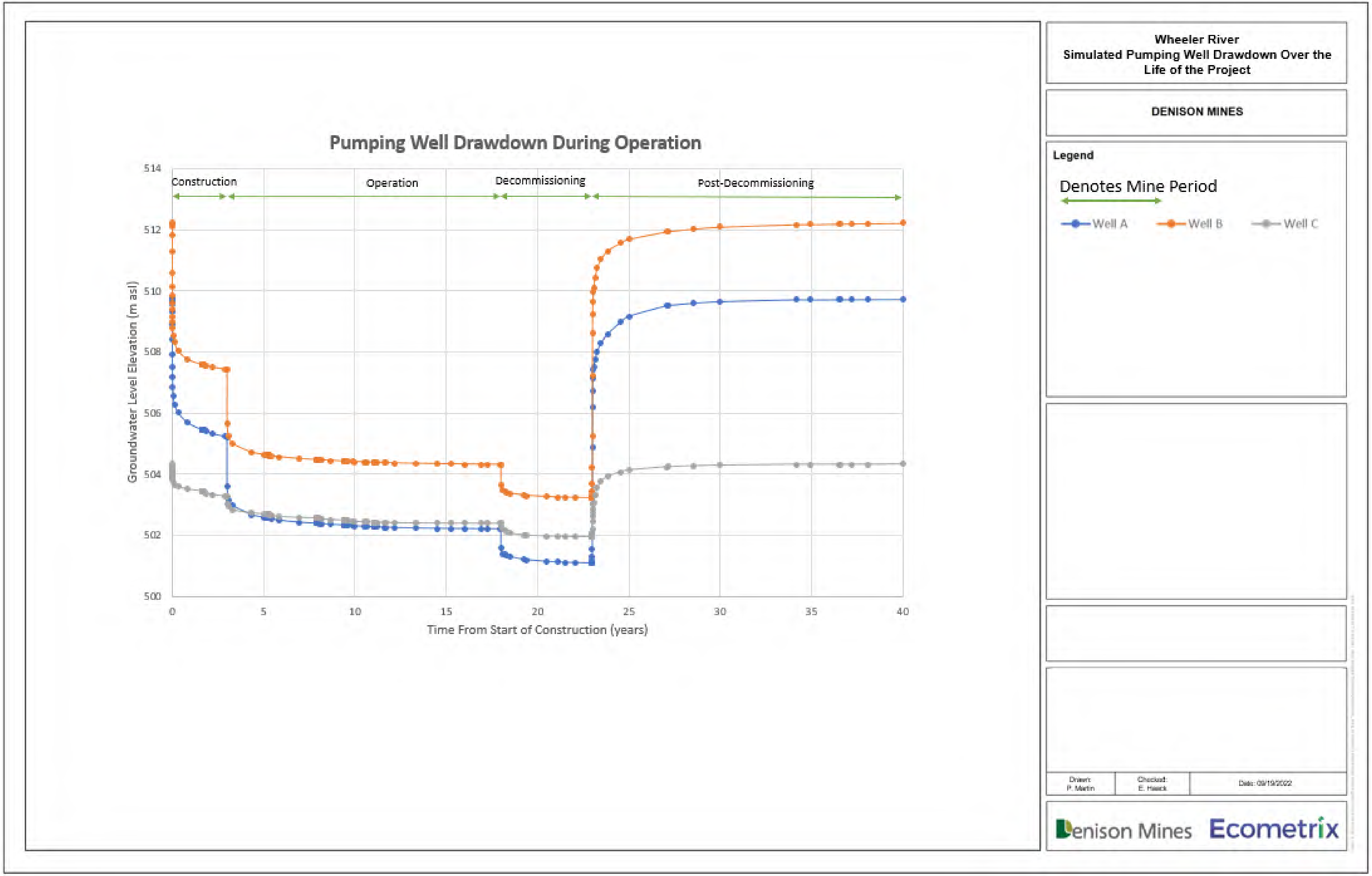

Figure 7.4-1: Simulated Pumping Well Drawdown Over the Life of the Project

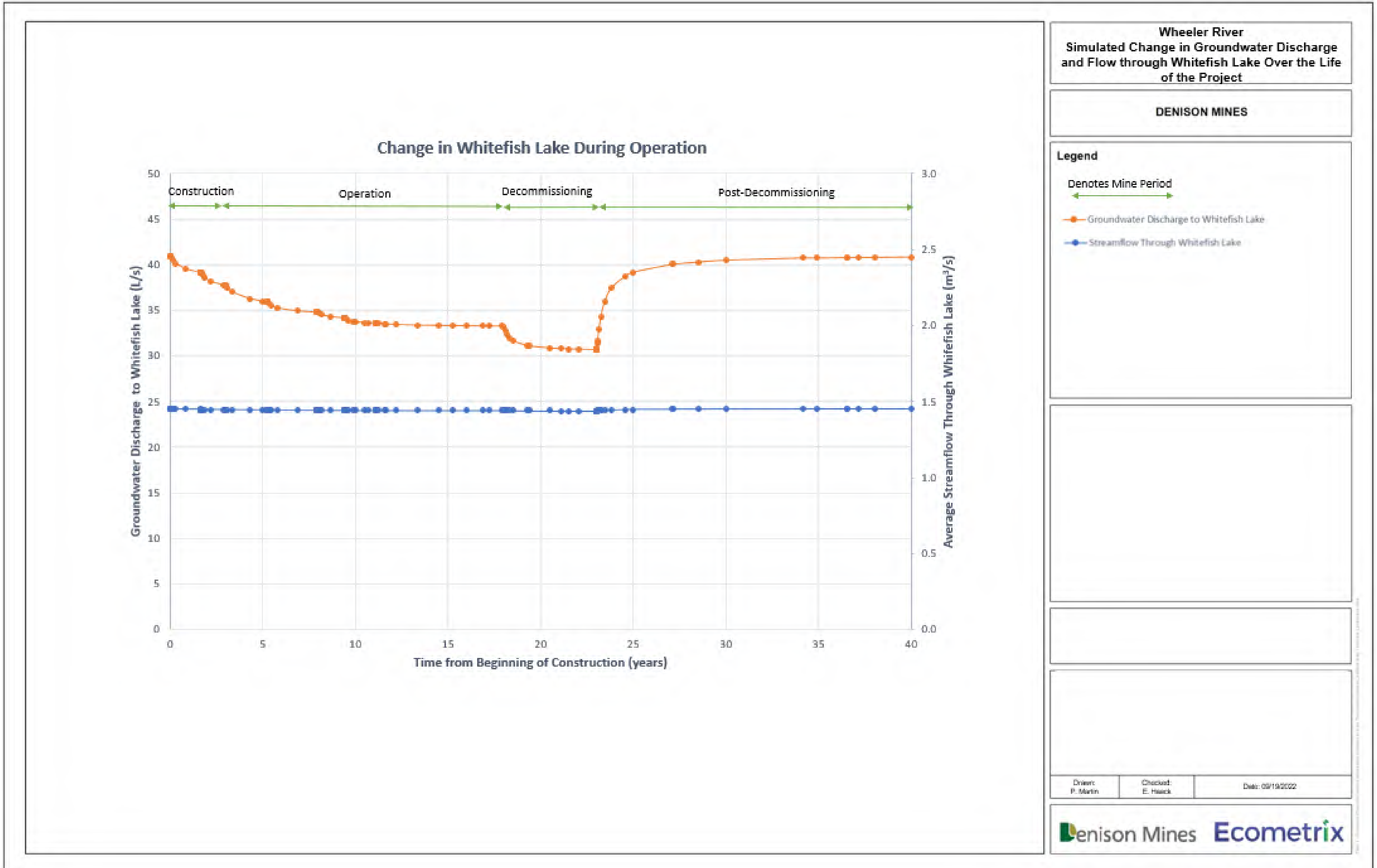

Figure 7.4-2: Simulated Change in Groundwater Discharge and Flow through Whitefish Lake Over the Life of the Project

7.4.2.2 Potential Effect #2: Terrain Morphology and Stability – Operation

One component of the geologic assessment focused on subsidence at ground surface associated with extraction of rock mass (ore) at significant depth (approximately 400 m) below ground, from within the active mining area. Geological conditions in terms of rock and mineral composition stratigraphy (i.e., how geological materials are arranged in sequence with depth/spatially) and structural components (i.e., faulting and fracturing) are well understood based on Project-specific and regional information (Section 7.3 and Appendix 7-A).

Maintaining the stability of the rock matrix while leaching rock (ore) mass is critical for protecting the overlying aquifers, preventing substantial surface disturbance, safeguarding casing integrity, and mitigating plug-off of the remaining ore as well as mining extraction efficiently. To aid in advancing the Project, a study was undertaken to evaluate the geomechanical stability of rock mass within the Phoenix deposit, overlying sandstones, and underlying basement rock following ore extraction with ISR and including the presence of the proposed freeze wall. The geomechanical study (RESPEC, 2024) is presented as Appendix K of Appendix 7-A. Specifically, a full-scale 3D model of northeast extent of the ore zone, and specifically the northern half-length of Zone A shown in Figure 7.3-3, was developed to evaluate stress redistribution in the case of failure of remnant rock from rock mass removal. Average material properties were assumed for hydrostratigraphic units in the Pheonix deposit and surrounding rock, including hydrostratigraphic units shown in Figure 7.3-3. In the numerical model, instantaneous and random rock removal representing 30% by volume and 3% by volume for the high-grade ore zone and low-grade ore zone, respectively, was assumed.

Quantified in the model was the competency of the remnant rock based on the predicted stress field and the potential for tensile fracturing of the rock. The modelling results indicated that the highest predicted failure volumes in remnant rock are associated with the ore zone (41%), but that predicted failure volumes decrease substantively to 8-26% in the immediately surrounding clay zones, and are very limited (0.02%) in the overlying sandstones, including within the desilicified zone, and underlying bedrock. In addition, no (0%) failure was predicted within the freeze wall itself. Importantly, associated vertical displacement of host rock into the mined cavity is predicted to be limited to values of no more than 49 cm in the ore zone and decrease to 0-7 cm only 4-5 m from the low-grade ore zone. Overall, predicted failure conditions are limited to 5-8 m of the extent of the low-grade ore zone and there is limited potential instability in the freeze wall.

Subsidence at ground surface from displacement of host rock was predicted to be negligible. The average vertical displacement at ground surface is 2.5 mm.

The assessment evaluated what is considered the 'worst-case' scenario from a stability perspective. The model evaluated post-extraction stability as a single mass loss event across the entire active mining area. In reality, the mining area will be mined in phases and the phased approach is anticipated to lessen potential effect(s) on geological stability. In alignment with the modelling approach, the potential Project-related effect of subsidence was assumed to occur, essentially instantaneously, upon termination of mining (i.e., at the end of Operation). The modelling work is considered to provide a worst-case bounding scenario: if subsidence were to occur during the Project phases or in the years following mining, the extent of vertical displacement is not expected to exceed that predicted in the modelling.

The potential for subsidence related to changes in fluid balance within the freeze wall during Operation was also considered. The freeze wall will provide hydraulic containment between the internal wellfield and the external regional groundwater system with each well pattern maintaining a 1.7% 'bleed' to maintain hydraulic gradients towards recovery wells. This results in an isolated hydrogeological environment within the freeze wall, separate from the regional groundwater system but considered an unconfined aquifer within the freeze wall, being open to atmosphere. The "extra" water pumped (i.e., the water pumped in excess of injection) will be derived from stored groundwater within the sandstone units above the ore zone, and from the underlying paleoweathered zone, within each phase of Operation that is surrounded by freeze walls. The volume of stored water was estimated using the calibrated groundwater flow model (Appendix 7-C), which contains 3D volumes for the saturated soil and rock within each of the walled phases, including appropriate porosity values. These volumes of stored water were compared to the volume pumped within each phase of operation, over the expected period of extraction based on the mining plan. The stored volume of water was calculated to be 3.4 (Phase 1) to 9.7 (Phase 4) times the estimated excess pumped volume. In other words, there is ample stored water within each walled phase to supply the excess pumped volume. The excess pumping creates a hydraulic gradient toward the ore zone within each walled phase, which will help to avoid vertical spreading of the UBS during operations. If monitoring during operations indicates water levels are falling quicker than anticipated, additional water could be added within the walled phase, within the Upper Sandstone Aquifer.

Given the above, a fluid balance (or flow rate balance) was conducted as part of wellfield planning to inform Feasibility Study production rates within the mining zone contained within the confines of the freeze wall. Freeze studies concluded a no flow boundary once closure of the freeze wall is established along the perimeter of the mining area. Additional modelling within the mining area, including groundwater (FEFLOW) and production (Goldsim) modelling, were applied and although a net increase in volume is anticipated over the life of mine, a net draw is maintained on a well pattern basis to maintain 'bleed' and inward hydraulic gradient during active mining operations. To maintain fluid balance and not draw down the water table in the overlying sandstone units, additional sources of water from groundwater wells outside the freeze wall will be injected inside of the freeze wall as part of normal drilling operations during wellfield development and will be accounted for in the balance. This ensures potential for subsidence related to water table drawdown in the upper sandstone units is mitigated. Operating parameters rely on a relative net water balance for successful operations and would not support a significant drawdown of the water table owing to ground subsidence concern.

Beyond subsidence, changes in hydraulic conductivity localized to the mining area and anticipated to be associated with ISR mining were incorporated as part of the assessment of potential effects on groundwater quantity and quality (Section 7.6.2.2.3).

Monitoring will be undertaken to evaluate any vertical displacement at ground surface and the monitoring program will include a contingency plan, as described in Section 7.8.1. Therefore, this potential effect is not expected to be a primary contributor to potential residual effects following application of the proposed mitigation measures.

7.4.2.3 Potential Effect #3: Groundwater Quality – Construction (General Activities)

During Construction, refuelling and general fuel handling will be required as part of routine site operations. Spills or leaks from these activities may cause changes to shallow groundwater quality in discrete and localized areas. Figure 2.2-1 in Section 2 shows the Project layout with the location of the fuel storage and general fuel handling areas delineated. As provided, the potential source areas are located within a discrete and defined area of the site.

Specific Project designs, best practices, and standard mitigation measures (Section 7.5) will be employed to eliminate, reduce, or control such activities during Operation. As such, this potential effect is not expected to be a primary contributor to potential residual effects following application of proposed mitigation measures.

7.4.2.4 Potential Effect #4: Groundwater Quality – Operation (In Situ Recovery Mining and Surface Facilities)

Routine operation of ISR mining may affect shallow and deep groundwater quality within the Project Area and LSA. Groundwater quality within the mining area is expected to change because of direct contact with the mining solution during Operation.

Mining solution and uranium-bearing solution may enter groundwater outside of the mining area and freeze wall via accidents or malfunctions. Examples of accidents and malfunctions include well damage and release outside of the mining chamber and adverse effect(s) to groundwater from the surface via spills at the pumphouses or leaks along the pipelines (Section 14 Accidents and Malfunctions).

Shallow groundwater quality may be changed via accidents and malfunctions related to spills or leaks from waste pads and ponds, spills of hazardous substances (e.g., reagents and fuels), leaks from water treatment plant ponds, and leaching from the landfill (accidents and malfunctions are considered in Section 14). Figure 2.2-1 in Section 2 shows the Project layout with the location of the ponds, pads, and landfills, along with general construction details (e.g., double lining system with leak detection and collection), delineated. Details regarding the functions of the surface facilities, including their sizes and liner systems, are provided in Section 2. A summary is also provided in Table 7.4-7.

Within the broader context of terrain stability, it is noted that natural seismic activity in Northern Saskatchewan is quite rare with no significant events in recorded history (refer to Section 15.2 Seismic Events).

Mining induced seismicity has been of interest for some time, with mining-induced seismicity reported in Canadian hard-rock mines since the 1920s (Hudyma et al, 2017) and the first formal Canadian research on the problem starting in the 1930s (Hedley, 1992). Hasegawa et al. (1989) and Ortlepp (1992) describe several mechanisms by which induced seismicity may be capable of occurring in relation to underground (excavation based) mining; though, those mechanisms generally relate to discrete, large-scale rockmass failures whereas more than 90% of seismic events can be categorized as micro seismic events with moment magnitude < 0 (Hudyma, 2008).

In Saskatchewan, investigations of inducted seismic have been completed in association with potash mining and uranium operations. Sedghizadeh et al. (2023) applied statistical methods to investigate the nature of micro seismicity in a potash mine. Clustering analysis of micro seismicity indicated that the majority of events could be treated as independent background events mostly driven by underground mining operations; however, there is some clustering of seismicity and the formation of limited aftershock sequences of the “burst-type” (i.e., those that have only one parent event and many children). For example, with respect to uranium mining (Barghwal and van der Baan) investigated the source mechanisms and possible causes of micro seismicity recorded in an underground Uranium mine for a period of one month in January 2011. The events occurred near the main working level at 480 m depth and show some temporal correlation with the daily rate of rock removal. The study concluded the observed micro seismicity occurred due to reactivation of pre-existing faults that were favourably oriented in the static stress state created by the extensive horizontal tunnel network and due to dynamic stress due to rock crushing activities.

Despite the above noted link between seismicity and conventional hard-rock mining techniques / operations, as well as compared to high pressure liquid injection processes, the potential for mining-induced seismicity from the nature of the ISR mining that is proposed by the Project is interpreted as being quite low, given that the mechanisms that are purported to create or induce seismicity will not occur. Nevertheless, potential for mining-induced events for the Project that could be postulated to occur as the result of a few sources are discussed below for completeness: 1) collapse of cavity voids from leaching, 2) hydraulic fracturing, and 3) use of permeability enhancement techniques.

1. Collapse of cavity voids. To clarify, the portion of the deposit being mined is never truly a void (as in a large empty underground cavern); rather, what remains will be a honeycomb textured environment with water filled interstices. The mined area is filled with a fluid at all times, whether it be a mining solution, groundwater, or the neutralizing solution. This is different from a more traditional underground operation such as Cigar Lake where there is physical excavation of the orebody, leaving a temporary air-filled space. Although the uranium ore is high-grade by global standards it is not entirely massive in nature. As such, the uranium will be leached in a 'honeycomb' texture leaving behind a structure of partial intact rock mass with the remaining area being filled by fluid. This retains the pressure balance of the mining zone with the adjacent water-saturated rock masses. In terms of void

space creation and collapse of the overlying strata, modelling has demonstrated that only 0.05% by volume of desilicified material immediately overlies the ore zone and would be subject to collapse (Appendix 7-C, Attachment K). This low volume and percentage are determined to not be of significant seismic concern.

2. Hydraulic fracturing. EIS Section 2.2.1.4.2 Wellfield Operation provides a comparison of ISR mining pressures to conventional fracking pressures used in the oil and gas industry. Conventional fracking pressures used in the oil and gas industry can vary; however, common pressures to induce fracturing can range up to 15,000 psi and require injection of fracking fluids of up to 16,000 liter per minute over periods of three to four days. Fracking fluids are comprised of a slurry of water, proppant (generally silica sand), and chemical additives to support and maintain the open fracture system after fracking is conducted. Conversely, ISR mining for the Project is planned at nominal pressures of 100 psi, intermittent pressures of up 250 psi, and average flow rates of 30 liters per minute within a recovery well. The ISR mining method proposed for the Project is markedly different than fracking. For example, looking at intermittent pressures alone, ISR pressures are anticipated to be 60 times lower than fracking pressures.

3. Permeability enhancement techniques. EIS Section 2.2.1.4.3 Permeability Enhancement outlines the three types of techniques being considered for the Project: mechanical, Propellant, and hydraulic options. Propellants are classified as a low hazard explosive (S.1 special-purpose explosives, low hazard explosives, per Explosive Regulations, section 36). Propellants technically do not explode (like classic mine explosives which detonate) but rather burn through a process called deflagration. Deflagration means the material burns slower than the speed of sound, thus no shock waves are generated. Propellant permeability enhancement methods reach injection pressures of up to 8,000 psi and are near instantaneous over periods of milli seconds. Neither ISR mining or permeability enhancement is expected to produce mining-induced seismicity.

Under normal operating conditions there is no expected mining-induced seismicity. See also Bounding Scenario 4 Failure of the Freeze Wall in Section 14.

Specific Project designs, best practices, and standard mitigative measures, such as liners and pumping to control fluid movement (outlined in Table 7.4-7 and Section 7.5), will be employed to eliminate, reduce, or control potential Project-related effects on shallow groundwater. Potential Project-related effects from ISR mining will be mitigated via operation of the freeze wall and other measures as outlined in Section 7.5. As such, these potential Project-related effects are not expected to be a primary contributor to potential residual effects following application of the proposed mitigation measures.

Table 7.4-7: Surface Facilities that May Contribute Constituents of Potential Concern to Groundwater

Facility #	Structure	Function	Construction
11	Process Water Pond	Captures water from a variety of areas, including the process precipitate storage pad and special waste pad.	Double composite liner systems with leak detection.
12	Wellfield Runoff Pond	Captures runoff from the wellfield and the special waste pad.	Double composite liner systems with leak detection.
13	Clean Waste Rock Pond	May be constructed beside the clean waste rock pad to collect runoff, as required.	Single geomembrane liner with protection.
14	Domestic Wastewater Treatment Plant and Pond	Receives water from the Domestic Wastewater Treatment Plant.	Composite liner system.
16	Effluent Monitoring and Release Ponds, and Treated Effluent Discharge Line	Receives treated water primarily from the Domestic Wastewater Treatment Plant and the Industrial Wastewater Treatment Plant. Option to recycle water from these ponds back into the processing plant via the process water pond. The treated effluent discharge line runs from the effluent monitoring and release ponds into Whitefish Lake.	Composite liner system. Discharge line double walled with heat tracing. Trail along length of discharge line allowing visual inspection.
20	Domestic Waste Landfill with Leachate Collection Pond	Accepts materials, including wood, non-recyclable plastics, broken furniture, textiles, and non-recyclable items from the camp and operations centre.	Composite liner system with leachate collection. Pond is double composite liner system with leak detection.
21	Construction Waste Laydown Area	Located next to the future domestic landfill. Temporary storage of leftover construction materials.	Not lined. Base soil compacted. Bermed to prevent run on and run off.
22	Industrial Waste Landfill with Leachate Collection Pond and Industrial Laydown Area	Accepts industrial wastes generated at site, including waste with chemical and/or low-level (as defined by the Canadian Nuclear Safety Commission) radiological waste contamination.	Double composite liner system with leak detection between the composite liners and a leachate collection system above the primary (or upper) composite liner. Leachate pond has double liner system with leak detection.
23	Hazardous Waste Storage Pad	Denison identified a need to have a small (250 m^2) pad designated for temporary storage of hazardous waste such as paints, solvents, hydrocarbons, and used oil.	Composite liner system.
24	Process Precipitate Pond	Receives radioactive process precipitates.	Double liner system with leak detection capabilities.
25	Industrial Wastewater Treatment Plant Precipitate Pond	Receives non-radioactive industrial wastewater treatment plant precipitates.	Composite liner system.

Facility #	Structure	Function	Construction
26	Special Waste Pad	Expected to contain primarily mineralized core and cuttings from wellfield development.	Double composite liner system with leak detection capabilities.
27	Clean Waste Rock Pad	Receives clean waste rock, generated as sandstone cuttings and core from drilling activities.	Single geomembrane liner with protection.
42	Wash Bay and Scanning facility	Area to clean items, equipment, and vehicles that may have been in contact with potential contaminants.	May have a single geomembrane liner with protection. Perimeter berms and a lined sump for collection.

7.4.2.5 Potential Effect #5: Groundwater Quality – Decommissioning (In Situ Recovery Mining and Surface Facilities)

Groundwater quality in the mining area will be remediated during Decommissioning to meet acceptable levels (Section 2). These acceptable levels are the Decommissioning objectives, also referred to as the remediation targets (Section 2), and are described further in Section 7.6.2.1. The freeze wall functions as tertiary containment and when utilized, will remain in place until it can be demonstrated that groundwater quality in the mining area meets these objectives, after which time thawing of the freeze wall will occur. This will allow the eventual re-establishment of the pre-operational groundwater flow regime in the LSA.

Similar to Potential Effect #4 (Section 7.4.2.4), Decommissioning of the ISR wellfield may affect shallow and deep groundwater quality proximal to the mining area within the LSA. This potential effect is expected to be localized and at a depth associated with groundwater in and proximal to the mining area.

Most surface facilities will be decommissioned and removed during Decommissioning (Section 2). While the facilities remain and during Decommissioning, shallow groundwater quality may be changed by accidents and malfunctions related to leachate leaks from waste pads and ponds, spills of hazardous substances (e.g., reagents and fuels), leaks from water treatment plant ponds, and leaching from the landfill.

The potential Project-related effects during Decommissioning are not expected to be a primary contributor to potential residual effects following application of the mitigation measures outlined in Section 7.5.

7.4.2.6 Potential Effect #6: Groundwater Quality – Post-Decommissioning and Future Centuries

There is the potential for COPCs dissolved in groundwater following the remediation process in the mining area during Decommissioning to migrate in groundwater as part of natural groundwater flow conditions in the subsurface within the LSA. The ‘future centuries’ period has been defined as part of the assessment for the Groundwater VC and includes the period over which groundwater quality downgradient of the mining area, potentially affected by dissolved COPC concentrations, may ultimately discharge to proximal surface water sources. The ‘future centuries’ period has been defined as hundreds to thousands of years, reflecting the relatively low groundwater velocities of the hydrostratigraphic units between the ISR mining area and the receiving environment (Whitefish Lake), and the difference in dissolved COPC behaviour along the groundwater flow path.

A rigorous numerical model was used as a predictive tool for careful evaluation of groundwater flow and spatial temporal behaviour of residual mass of COPCs dissolved in groundwater following thawing of the freeze wall. The model and results are summarized in Section 7.6.2 and presented in Appendix 7-C. The model is founded on proven scientific principles and processes (e.g., groundwater flow, contaminant transport, and geochemical reaction processes) that allowed future conditions to be evaluated.

The results of the numerical model support the conclusion that following implementation of appropriate mitigation during Decommissioning, the potential effect of the Project on the Groundwater VC is not expected to result in a potential residual effect. Dissolved COPC concentrations migrating from the remediated mining area to Whitefish Lake (i.e., the local surface water receptor) are expected to remain below values that would result in an environmental risk (Section 7.6.2).

7.5 Mitigation Measures

Following the identification of potential Project-related effects (Section 7.4), the next step in the evaluation was the development of environmental design features and mitigation measures that could be incorporated into the Project. Mitigation is defined as the elimination, reduction, or control of the potential adverse effects of the Project and may include measures associated with compensation of effects that cannot be mitigated by other means. Environmental design features and mitigation measures were developed through an iterative process between the Project's engineering and environmental teams, supplemented with input from Project-specific or regional engagement with other parties. The environmental design features and mitigation measures were selected considering their effectiveness for implementation and maintenance, and their appropriateness within the context of the identified potential Project-related effects.

Table 7.5-1 provides a summary of the mitigation measures for the Geology and Groundwater VCs related to the six key potential Project-related effects (Section 7.4.2). The mitigation measures refer to Project-specific mitigation and include, but are not limited to, engineering design features and responses, best management practices, management plans, and training.

Table 7.5-1: Summary of the Mitigation Measures Based on Project Phases for the Geology and Groundwater Valued Components

Valued Component	Key Indicators	Measurable Parameters	Project Activities Resulting in Primary Interactions	Project Phase	Mitigation Measures
Geology	Terrain morphology and stability	Vertical displacement (i.e., subsidence at ground surface) (m).	In situ recovery operations affecting subsidence at ground surface associated with consolidation of rock mass (ore) at significant depth (approximately 400 m) below ground.	Operation	Incorporation of specific Project design components and practices, including: • subsidence at ground surface within the wellfield is expected to be on the ~2-3 mm level and is beyond the range of current Lidar technology (with resolution of 10 cm). Injection and recovery wells will be collared at surface and surveyed regularly to monitor for any changes in collar height over time.
Groundwater	Groundwater quantity 1. Groundwater flow patterns and discharge rates to local surface water. 2. Groundwater elevation changes.	Change in shallow and deep groundwater levels measured in monitoring wells (m) and baseflow to surface waterbodies (L/s).	Site preparation, site clearing, and grading. Development of surface infrastructure. Ground freezing. Water supply and surface water releases.	Construction to Decommissioning	Incorporation of specific Project design components and practices, including: • limiting the construction footprint (i.e., Project Area) to the extent possible to reduce the potential for reductions in groundwater recharge and limit the number of watersheds overprinted by the Project Area; • designing the Project to limit water use and enhance water recycling; and • implementing water management best practices to reduce site runoff and recharge to aquifers. In addition, commitment to follow-up on ongoing hydrogeological evaluations, as well as monitoring and adaptive management, including: • groundwater elevations in the groundwater well network; and • water elevations of surface waters within the LSA.
	Groundwater quality Focus on changes to groundwater discharge to local surface waterbodies (i.e., Whitefish Lake).	Changes in concentrations of physical and chemical parameters in groundwater (mg/L or µg/L) compared to appropriate risk-based surface water environmental quality criteria.	Water management. Fuel management and refuelling of equipment and general site construction activities.	Construction	• Incorporate best management practices to avoid effects on groundwater from hazardous substances, including those outlined in Section 2. No fuels, oils, or other hazardous substances will be stored within 100 m of any waterbody and no equipment maintenance or re-fuelling will be conducted within 100 m of a waterbody. • Develop environment management plans, programs, and procedures to provide consistent and responsible practices. • Make sure employee training programs and procedures are in place.
	Groundwater quality Focus on changes to groundwater discharge to local surface waterbodies (i.e., Whitefish Lake).	Changes in concentrations of physical and chemical parameters in groundwater (mg/L or µg/L) compared to appropriate risk-based surface water environmental quality criteria.	In situ recovery operations affecting groundwater, in particular concentrations of COPCs dissolved in groundwater.	Operation	Incorporation of specific Project design components, including: • establishment of the freeze wall before mining operations to hydraulically isolate the mining area from the surrounding groundwater environment; • creation of hydraulic controls that will limit vertical migration to the zone 50 m above the ore zone within the freeze wall; • design injection and recovery wells to have secondary containment; • recognize option to drill additional wells to recover mining solution excursions; • design pipelines to have secondary containment or catchment; • establishment of a leak detection system for wells and pipelines; • implementation of a groundwater monitoring well network within and surrounding the outer perimeter of the freeze wall, and a groundwater monitoring (quantity and quality) plan; • development of contingency plans, including drilling additional wells into any potentially contaminated areas for recovery of the mining solution back to surface; and • development of contingency plans to respond to excursions.

	Groundwater quality
	Focus on changes to groundwater discharge to local surface waterbodies (i.e., Whitefish Lake).
		Changes in concentrations of physical and chemical parameters in groundwater (mg/L or µg/L) compared to appropriate risk-based surface water environmental quality criteria.	Site infrastructure (e.g., landfills and pads) affecting groundwater, in particular concentrations of COPCs dissolved in groundwater.	Operation	Incorporation of Project design components, including:
					• design landfill and pads with geomembrane liner protective systems and double liner systems with leak detection and leachate collection systems appropriate for the materials stored;
					• store hazardous substances in approved storage areas with secondary containment, as required; and
					• implement appropriate monitoring and management plans, including:
					  ○ a groundwater monitoring well network and GWMP for surface facilities;
					  ○ environment, health, and safety management plans, programs, and procedures;
					  ○ waste management plans, programs, and procedures; and
					  ○ employee training programs and procedures.

Valued Component	Key Indicators	Measurable Parameters	Project Activities Resulting in Primary Interactions	Project Phase	Mitigation Measures
	<u>Groundwater quality</u> Focus on changes to groundwater discharge to local surface waterbodies (i.e., Whitefish Lake).	Changes in concentrations of physical and chemical parameters in groundwater (mg/L or µg/L) compared to appropriate risk-based surface water environmental quality criteria.	Migration of COPCs dissolved in groundwater along the groundwater flow path from the mining area to the receiving environment (Whitefish Lake) at concentrations outside of those predicted to not pose an environmental risk through numerical modelling.	Decommissioning	Incorporation of Project design components, including: • mining area remediation during Decommissioning – water will be injected into the mining area via injection wells and then recovered through the recovery wells to flush residual COPC mass in groundwater; • continued groundwater remediation until appropriate levels (i.e., Decommissioning objectives), protective of the environment over the long term (i.e., ‘future centuries’ period), are achieved; • implement groundwater monitoring (quantity and quality) within and exterior to the former freeze wall and along the groundwater flow path to demonstrate that groundwater conditions are aligned with those bounded by the modelling predictions, and, as such, are protective of the receiving environment; and • develop contingency plans, including drilling additional wells into potentially contaminated areas for recovery of the mining solution back to surface.

7.6 Residual Effects Evaluation

7.6.1 Life of Mine (0 to 38 years)

Given the incorporation of mitigation measures outlined in Section 7.5, no residual effects to the Geology and Groundwater VCs were predicted during the life of the Project (i.e., 0 to 38 years). The proposed design features and mitigation measures are considered effective and protective within the context of the identified Project-related effects.

7.6.2 Future Centuries Period

The temporal scope of the assessment for the Groundwater VC included consideration of a 'future centuries' period. The potential for residual effects during this period is a consequence of dissolved-phase COPC mass in groundwater within the mining area following Decommissioning. Residual COPC mass is derived from mobilization of elements/compounds from the (natural) minerals during mining and, in some cases, from chemicals in the mining solution.

Remediation of groundwater during Decommissioning is a mitigation measure. Numerical modelling was used as a tool to establish Decommissioning objectives in terms of concentrations of COPCs in groundwater, such that the Surface Water Quality VC is protected.

7.6.2.1 Decommissioning Objectives

The process of groundwater remediation in the mining area during Decommissioning is described in Section 2. It involves circulation of water (with or without addition of chemical reagents to accelerate groundwater quality recovery) through the mining area until it can be demonstrated that recovered water has reached and been stabilized at groundwater quality Decommissioning objectives.

Metallurgical testing, including column tests and core flooding tests, have been undertaken at the Saskatchewan Research Council to understand the anticipated evolution of groundwater hydrochemistry as groundwater quality in the mineralized zone is restored. Details on the metallurgical testing are provided in Appendix F of Appendix 7-C. The constituents with concentrations that were outside of the range of values observed for baseline conditions in the leachate during metallurgical testing reflect the mineralogy of the ore zone and the mining fluids. The mining fluids are expected to be made up of sulfuric acid, iron sulphate, and hydrogen peroxide (Section 2). Groundwater constituents identified as COPCs associated with mining of the ore zone include:

- pH;
- sulfate and chloride;
- uranium, iron, aluminum, and heavy metals/trace elements (i.e., As, Cd, Co, Cu, Cr, Pb, Mo, Ni, Se, V, and Zn); and

- radionuclides (i.e., 226Ra, 230Th, 210Pb, and 210Po).

Although not a chemical parameter, metallurgical testing has indicated that temperature in the active mining area during Operation is expected to exceed that of ambient groundwater by 10°C or more. Thus, temperature is included as a measurable parameter for groundwater for the Project. Electrical conductivity is included as a measurable parameter but not as a COPC for the Project, as a bulk indicator of water quality. Further, existing redox conditions in the ore zone are strongly reducing. Strongly oxidizing conditions need to be created for oxidation of U(IV) in uraninite to U(VI) and solubilization of uranium. Measurement of oxidation-reduction potential (ORP) is also suggested as a, for the most part, qualitative indicator of groundwater conditions – meaning, not as a COPC but as a measurable parameter with respect to groundwater quality for the Project.

The leachate chemistries used to conceptualize remediated groundwater quality for input into the reactive transport model were primarily from two coreflood tests: Coreflood#2B and Coreflood#3C. In the coreflood tests, core flushing was done using groundwater and amended with sodium hydroxide (1.5 g/L; Coreflood #2B) or bicarbonate (150 to 1,500 mg/L $NaHCO_3$; Coreflood #3C). 'Restored Solution #1' and 'Restored Solution #2' were developed to represent the bounding scenarios for groundwater quality evaluated in the reactive transport model, to assess the potential for environmental effects following remediation of the ore zone. Details on the development of the chemistry of the restored solutions from the metallurgical testing is provided in Appendix F of Appendix 7-C. The hydrochemistry of Restored Solution #1, which has a lower pH and generally higher COPC concentrations, is provided in Table 2.3-3 of Section 2 and was largely the focus of numerical modelling in support of the EIS (Appendix 7-C). The hydrochemistry of Restored Solution #2 is provided in Appendix 7-C.

As introduced in Section 7.4.2, the mining area is made up on three different zones, including the active mining area, the anticipated maximum extent of upward migration of mining fluids (11 to 13 m above the active mining area), and potential upset conditions (50 m above the active mining area). Within the 3D reactive transport model, the mining area was conceptualized as two zones in terms of water quality following remediation. These two zones are shown in Figure 7.6-1. Both zones are limited laterally by the freeze wall. The first zone was assumed to have water quality equivalent to Restored Solutions #1 or #2 and extends from the base of the paleoweathered zone through to the anticipated maximum extent of upward migration of the mining fluids. This maximum upward extent was conservatively assumed to be 15 m overlying the active mining area, compared to the 11 to 13 m that is expected. Solution #1 (pH 4.3) has a lower pH and, generally, higher COPC concentrations compared to Solution #2 (pH 6.1); as such, it is considered to potentially pose a higher risk to the receiving environment and was the focus of 3D reactive modelling.

A second zone, extending between 15 and 50 m above the active mining area was defined as having water quality equivalent to mixing of Restored Solutions #1 or #2 by 50% with groundwater of baseline quality. For the Project, as with other ISR projects, it is anticipated that there will be a certain degree of outward migration (horizontal and vertical) of the oxidizing solution beyond the boundary of the wells/production area. This was recognized in identifying the potential upset conditions as 50 m above the ore zone (Section 7.4.2). Outward migration of fluids from the active mining area is a result of normal hydrodynamic behaviour, and the area affected outside of the ISR injection and recovery well pattern is often referred to as the 'flare' (IAEA 2001). Inclusion of the 'flare' in predictive numerical modelling has precedence in ISR projects, related both to ISR performance (e.g., Cameco 2012b) and the fate and transport modelling downgradient of the ore zone (e.g., Johnson et al. 2016).

It has been concluded through 3D reactive transport (Appendix 7-C) and environmental risk assessment (Appendix 10-A in Section 10) that water quality that achieves concentrations for COPCs equivalent to that of Restored Solution #1 does not pose an environmental risk (Section 7.6.2.2.4) and Section 10.1.4.2.3 in Section 10). Decommissioning objectives (Section 2.3.3.1.1 in Section 2) have thus been proposed as water quality achieving that of Restored Solution #1.

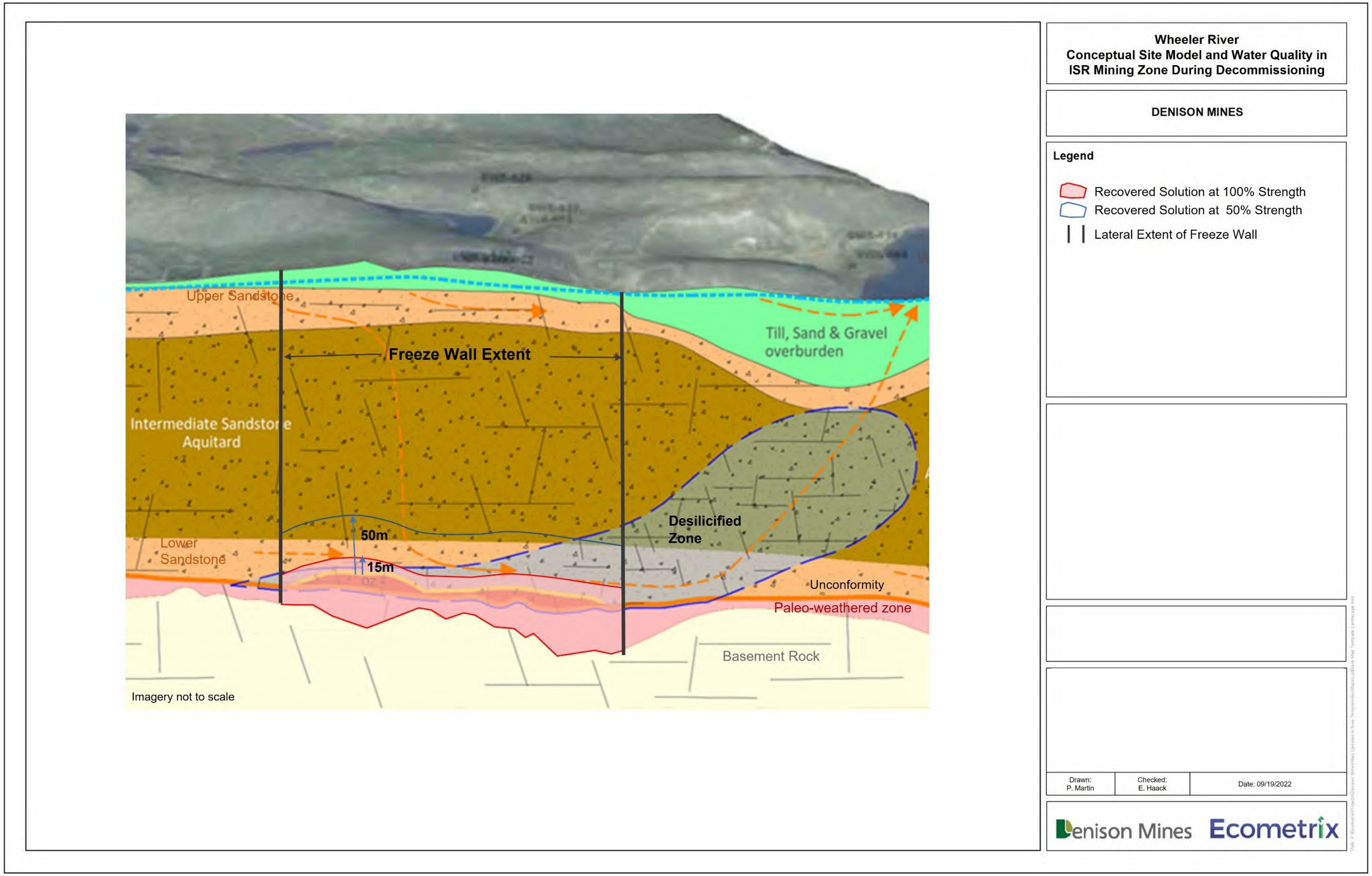

Figure 7.6-1: Conceptual Site Model and Water Quality in the In Situ Recovery Mining Area During Decommissioning

7.6.2.2 Numerical Model

A report has been prepared providing the details of the numerical modelling used to support the EA and the development of the Decommissioning objectives (Appendix 7-C). The following subsections are a summary of what is presented in that report. As such, reference will not be given explicitly to Appendix 7-C from this point forward.

Groundwater flow and geochemical reactive transport modelling were applied to help understand the migration and attenuation of COPCs from the mining area toward Whitefish Lake, the primary surface water receptor (Section 7.6.2.2.2).

There were five steps in the numerical modelling:

1) development of a calibrated 3D groundwater flow model for the LSA for existing/baseline conditions. This model is described in more detail in Section 7.6.2.2.1 and was the basis for evaluating changes in groundwater quantity during Operation (presented in Section 7.4.2.1);
2) modification of the 3D groundwater flow model as required to reflect post-Operation changes to the subsurface (Section 7.6.2.2.3);
3) identification of key geochemical reactions for dissolved groundwater constituents along the groundwater flow path (Appendix 7-C);
4) development of the 3D geochemical reactive transport model (Section 7.6.2.2.3); and
5) demonstration that the Decommissioning objectives are protective of the Surface Water Quality VC. This was done by comparing groundwater quality discharging at Whitefish Lake with screening groundwater quality criteria, and provision of water quality information for further assessment of potential environmental risks (Section 10).

7.6.2.2.1 3D Groundwater Flow

The first stage of numerical modelling was the development of a 3D groundwater flow model for the LSA. The model was calibrated to observed water level and stream baseflow data. Beyond the statistical match achieved between observed and simulated conditions, the groundwater flow patterns in the calibrated groundwater flow model were consistent with the CSM presented in Figure 7.3-7.

The 3D groundwater flow model for the LSA was built using FEFLOW (Diersch 2014). The FEFLOW code offers the flexibility to represent complex spatial features at surface and within the subsurface and can represent saturated and unsaturated flow and transport. The modelling code was applied without any modifications to the processes simulated in the code.

The FEFLOW code is a finite element code whereby the model area (domain) is subdivided horizontally and vertically into a set of triangular prisms called elements that represent a unit of porous media. Each element has specified hydraulic properties, such as hydraulic conductivity and storage values, that are assigned. The FEFLOW code simulates the flow of groundwater using the properties assigned within the elements and water level elevations (hydraulic heads) at known locations, such as surface water features like lakes and rivers.

Groundwater flow observed and simulated in the calibrated groundwater model travelled eastward within the Lower Sandstone Aquifer before moving upward through the Desilicified Zone in the Athabasca Sandstone and overlying overburden deposits toward Whitefish Lake. The Desilicified Zone is better described as a porous media rather than a fractured rock environment and it facilitates the connection between the Upper and Lower groundwater flow systems in the area east of the Phoenix deposit. From a water budget perspective, the calibrated groundwater flow model was used to identify that groundwater discharge to Whitefish Lake is primarily through the Upper Aquifer (overburden and upper sandstone aquifer), with a lesser component flowing from the Lower Sandstone Aquifer through the Desilicified Zone into the base of Whitefish Lake near its eastern shore.

The flow patterns for groundwater discharging to Whitefish Lake are illustrated in plan and cross-section view in Figure 7.6-2, based on backward-tracking particles that were started at the orange dots and tracked backward in time toward their source area. Particle traces illustrate that while Whitefish Lake receives groundwater from all directions, most groundwater starts in areas west of Whitefish Lake. Review of the cross-section illustrates that most of the groundwater flow to Whitefish Lake is sourced from waters flowing through the Upper Sandstone Aquifer and Overburden units, with a lesser contribution flowing from the Lower Sandstone Aquifer through the Desilicified Zone. Downward gradients from the Upper Sandstone Aquifer are found near the western (i.e., upgradient) edge of the Desilicified Zone where flow from the Upper Sandstone Aquifer expands to flow through the permeable Desilicified Zone; the gradient transitions to upward beneath Whitefish Lake. Similarly, slight upward flow paths from the Lower Sandstone Aquifer are experienced near the western (i.e., upgradient) edge of the Desilicified Zone, where flow through the Lower Sandstone Aquifer extends vertically to flow into the overlying Desilicified Zone.

The colours on the particle traces in Figure 7.6-2 illustrate that groundwater discharging to Whitefish Lake through the Upper Sandstone Aquifer requires less than 50 years of travel time for groundwater recharge near the Phoenix site; groundwater recharge west of the Phoenix site would require 50 to 500 years (i.e., groundwater discharge to Whitefish Lake was generated from precipitation hundreds of years earlier). Groundwater travel time from the Lower Sandstone Aquifer through the Desilicified Zone to Whitefish Lake requires 250 to 400 years of travel time.

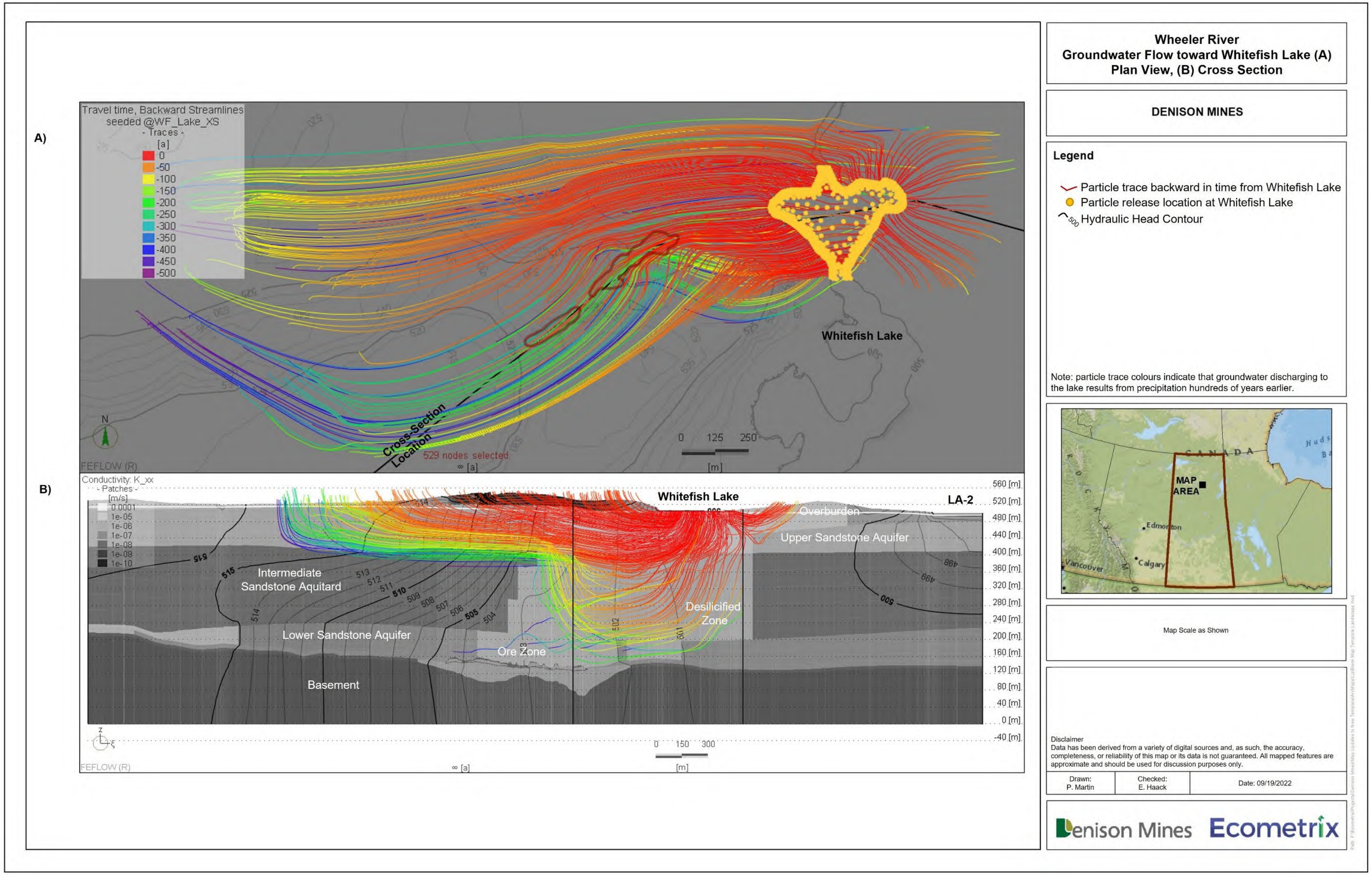

Figure 7.6-2: Groundwater Flow Toward Whitefish Lake – (A) Plan View, (B) Cross Section

7.6.2.2.2 Evaluation of Potential Receiving Bodies

Important during groundwater modelling was gaining an understanding of where groundwater flowing through the mining area will ultimately discharge. Boundary conditions applied in the model, as illustrated in Figure 7.6-3 and Figure 7.6-4, show that within the model, groundwater is permitted to exit/leave the domain at any of the surface lakes or flow further south toward Russell Lake.

Identification of potential receiving bodies involved review of available groundwater level, streamflow, and stream or lake level elevation data. The potential hydraulic gradients and flow rates were also evaluated to identify the potential for groundwater to migrate from the ore zone to each potential receiving body. The observed (and calibrated) groundwater flow patterns identified a primarily west to east groundwater flow direction in the Phoenix ore zone that suggests surface waterbodies east of the site are the most likely downgradient receiving bodies. Waterbodies located east of the ore zone include Whitefish Lake (500 m east), McGowan Lake (2 km southeast), and an unnamed lake (LA-2) east of McGowan Lake (1.9 km east). Russell Lake, located 6 km south of the ore zone (Figure 7.6-3), was also considered a potential regional discharge location.

Hydraulic gradients were estimated in the model based on water level differences between the ore zone and each potential surface water receptor. In addition, calculations of potential groundwater flow rates to each surface water receptor were evaluated for a range of interpreted hydraulic conductivity values. Estimated hydraulic gradients toward McGowan Lake and Lake LA-2 were 50% larger than the gradient toward Whitefish Lake. However, the groundwater flow rate through the Desilicified Zone, where a relatively high hydraulic conductivity is conservatively interpreted to exist, is estimated to be more than ten times greater than other areas where the intermediate sandstone aquitard is unaltered. As a result, the groundwater flow rate potential is estimated to be highest (i.e., by an order of magnitude or more) toward Whitefish Lake than any other surface waterbody in the area. Groundwater flow potential toward Russell Lake is the lowest of any surface water feature evaluated.

The implication of this interpretation is that the primary potential receiving body of COPCs in groundwater associated with the mining area is Whitefish Lake. The potential for groundwater to flow from the ore zone and discharge at other waterbodies in the area is interpreted to be significantly lower than the potential for discharge into Whitefish Lake. Groundwater discharge to Whitefish Lake is also most conservative from a predictive perspective as groundwater flow and discharge into other nearby surface waterbodies, such as McGowan or Russell Lakes, would predict lower concentrations due to greater dispersion along those longer flow paths.

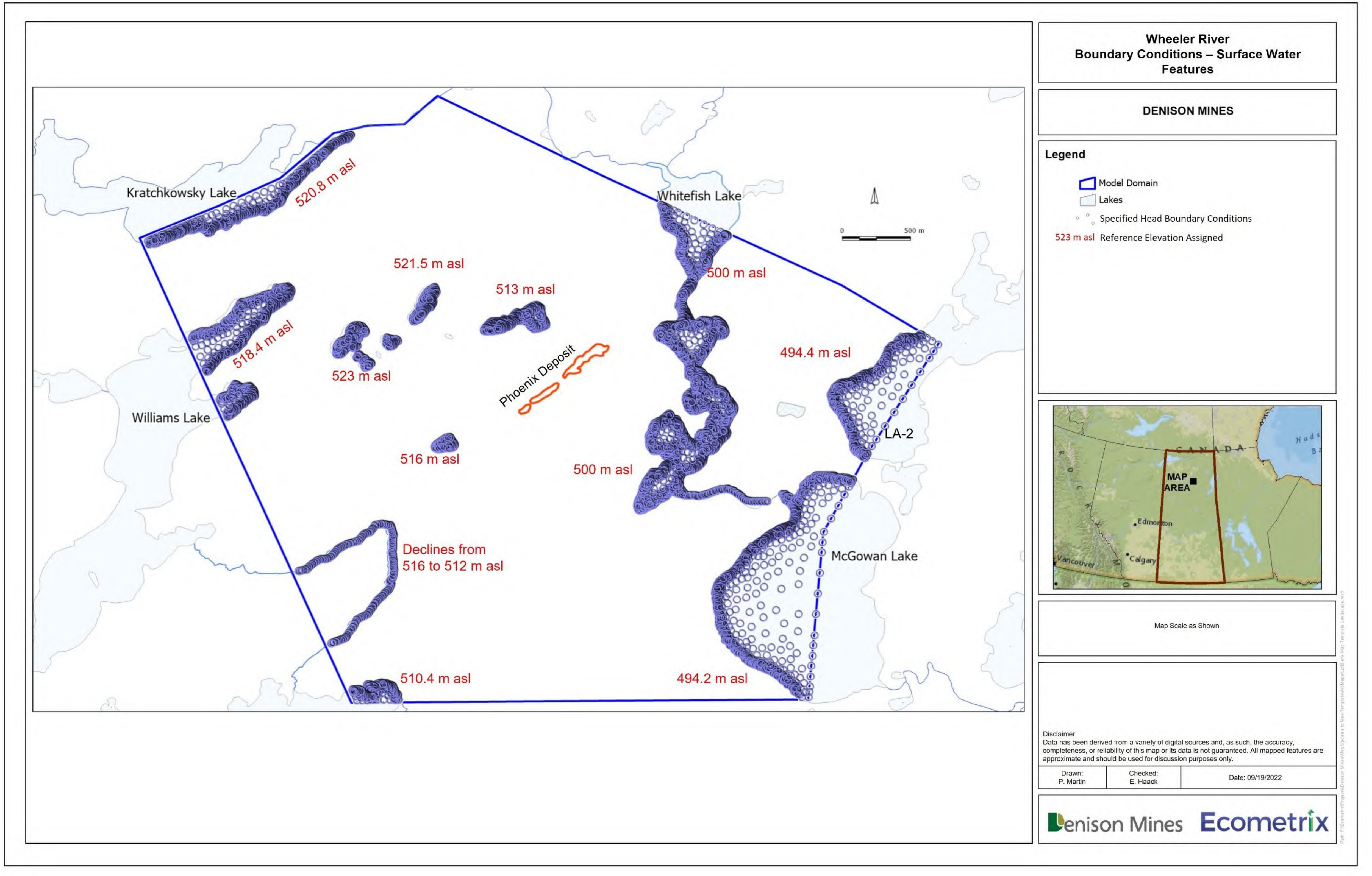

Figure 7.6-3: Boundary Conditions – Surface Water Features

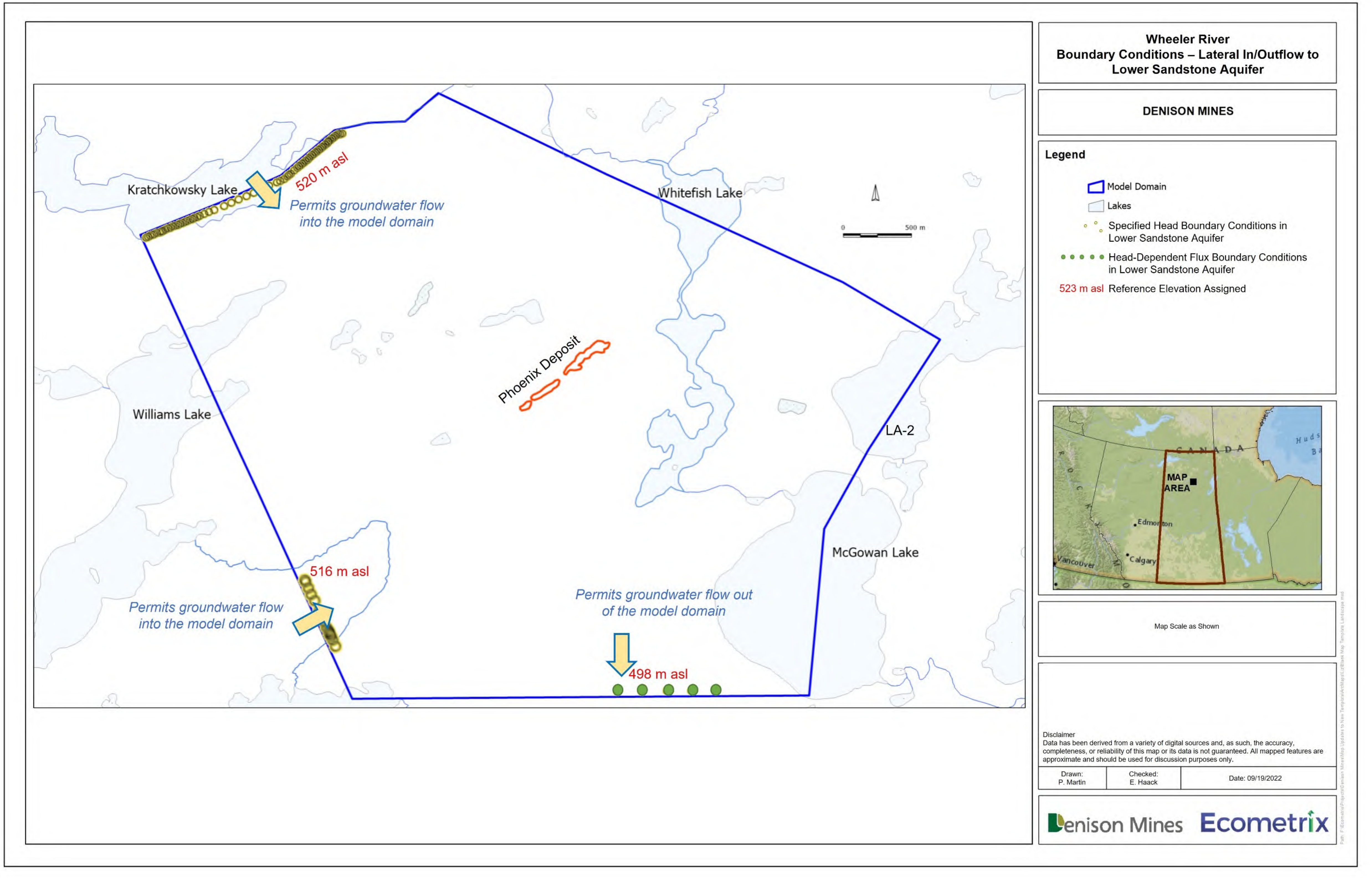

Figure 7.6-4: Boundary Conditions – Lateral In/Outflow to the Lower Sandstone Aquifer

7.6.2.2.3 *Evaluation of Geochemical Reactive Transport*

3D Geochemical Reactive Transport Model

Reactive transport modelling required integrating multi-component, time-varying flow and transport simulations using FEFLOW's simulator with the chemical processes that affect the migration of COPCs along the groundwater flow path. To incorporate the chemical processes, the piChem 'plug-in' option available with the FEFLOW software was used. PiChem (Wissmeier 2016) facilitates the linkage of geochemical reactions simulated using the geochemical code PHREEQC (Parkhurst and Appelo 2013). Reactive transport is simulated using an operator splitting technique, wherein solute transport and geochemical reactions are carried out within the model sequentially in each calculation step.

The computational requirements of a 3D geochemical reactive transport model with multiple constituents far exceeded what was practically achievable within the regional-scale 3D model. As such, a smaller 3D model domain was developed to carry out reactive transport modelling. The 3D sub-domain model for reactive transport modelling is shown in relation to the LSA in Figure 7.6-5. Particle traces showing the groundwater flow path from the mining area to the discharge zone/area in Whitefish Lake in the 3D reactive transport model are shown in Figure 7.6-6.

Changes to hydrogeological conditions within the mining area due to ore extraction were considered during development of the 3D sub-domain model. Dissolution of ore within the active mining area is expected to enhance the interconnected pore space, and thereby enhance (increase) the hydraulic conductivity. As such, one key difference between the sub-domain model input parameters and those assigned in the 3D Regional Model was the assignment of the properties associated with the Upper Barrier Aquitard Zone, the Ore Zone, and the Lower Barrier Aquitard Zones. As there is uranium mineralization contained within the Upper and Lower Barrier Zones, these zones are expected to be removed during Project operations and, as such, the hydraulic conductivity values representing these units were replaced with elevated hydraulic conductivity values relative to those assigned in the regional-scale base case model. Specifically, a hydraulic conductivity value of $5x10^{-6}$ m/s was assigned to represent the area where the uranium mineralization will be removed as part of Project operations. This value ($5x10^{-6}$ m/s) is a factor of five greater than the value assumed for the ore zone in the 3D Regional Model and conservatively simulates that the Upper and Lower Barrier Zones no longer result in effective barriers for mineral transport from the ore zone.

One-dimensional Geochemical Analysis

Chemical processes that may affect COPC concentrations in groundwater reaching Whitefish Lake were evaluated using a 1D reactive transport model. This was done because of the practicality and relative ease (i.e., much less extensive computational demands) of modelling in 1D with PHREEQC in comparison to 3D reactive transport modelling.

Geochemical modelling was used to simulate the behaviour of the COPCs associated with groundwater in the mining area Post-Decommissioning and to support an understanding of:

- which constituents in the Ore Zone restored solution are likely to undergo reactions along the groundwater transport pathway, such as interactions with the solid phase that result in their removal from the solution phase; and
- how these reactions will affect timelines and concentrations of constituents observed in groundwater at the base of the primary receiving body (i.e., Whitefish Lake).

Use of thermodynamic geochemical models for such purposes is precedented for ISR projects (e.g., Johnson et al. 2016; Lagneau et al. 2019; Reimus et al. 2019; de Boissezon et al. 2020). The model was developed using site-specific data for mineralogical assemblages, as well as truthing the conceptualized interactions to measured concentrations of the constituents in the solid phase. The simulations evaluated included the following:

- Sorption (adsorption and ion exchange) of COPCs to reactive sites associated with mineral surfaces – The mineral surfaces selected from available Project information and relevant literature were goethite, clay minerals, and quartz. The sorption process represents the partitioning of a fraction of COPCs dissolved in groundwater to the solid phase through binding at mineral surface(s) chemically (i.e., a new chemical bond is formed) or through ion exchange/electrostatic interactions (i.e., the dissolved constituent is attracted to the mineral surface based on opposite charge). The affinity of a COPC to bind to a mineral surface is specific to the COPC, the surface properties, the concentration of the dissolved COPC, and the composition of the solution phase overall. Constituents of potential concern that are similar in chemical nature (like many cationic metals, for example) compete for binding sites. Sorption was modeled as reversible, meaning constituents were allowed to sorb and desorb to achieve thermodynamic equilibrium conditions. Because minerals found throughout the subsurface are known to provide important sorbing potential, sorption was considered to some extent in all model runs.
- Redox – The influence of redox conditions and potential redox transformations of key constituents was also evaluated. This included transformation of uranium and iron. Groundwater in the hydrostratigraphic units in the LSA is largely anoxic but there is some evidence for the presence of oxygenated conditions within the upper aquifers (within the overburden materials and Upper Sandstone Aquifer). For iron, the potential for oxidation of ferric iron to ferrous iron (Fe(II) to Fe(III)) and subsequent precipitation of iron oxide minerals under oxygenated conditions in the upper hydrostratigraphic units was evaluated because these reactions influence pH. For uranium, the potential for dissolved U(VI) in groundwater from the mining area to be reduced to U(IV) and immobilized as uraninite in association with pyrite present in hydrothermally altered sediments at depth (within the Lower Sandstone Aquifer and Intermediate Sandstone Aquitard) was evaluated.

- Solubility Control – The potential for the precipitation of uranyl (U(VI)) mineral phases and other mineral phases to control the solution-phase concentrations of uranium and other COPCs.
- pH of the plume – Inclusion of proton sorption to, and subsequent desorption from, clays within the mining area. The pH of Solution #1 is acidic (pH 4.3). Assuming equilibrium of the clays with the pH results in protons that are desorbed as circumneutral pH groundwater flows through the mining area during Post-Decommissioning and the 'future centuries' period. This results in the groundwater plume from the mining area being acidic over a longer period of time.

Radioactive decay of radionuclides along the groundwater flow path was not included in the final 3D reactive transport simulations. This was a conservative approach.

Through the 1D evaluation process, sorption to quartz, iron-containing minerals (goethite), and clay minerals (illite) were identified as being an important process for COPC transport and, as such, these processes were carried forward into the 3D reactive transport model. Precipitation of COPCs as solid phases was also carried forward for a subset of COPCs (i.e., Ra, Ba, Al, and, in some simulations, Fe). Redox transformations of U(VI) and Fe(II) were also carried forward for further evaluation in the 3D model.

3D Model Simulations

It is the complexity of groundwater flow conditions and chemical processes previously described in the subsurface that necessitated the use of a sophisticated approach (i.e., PiChem) for the assessment of the 'future centuries' period. This approach was considered necessary to achieve realistic simulation of COPC transport and fate.

The 3D geochemical reactive transport model simulations were run for thousands to tens-of-thousands of years after thawing of the freeze wall (i.e., Post-Decommissioning and beyond). Simulations of up to 100,000 years were performed to make sure that desorption, ion exchange, and other processes reached a stable equilibrium and would not yield additional mass available for transport. However, for base case simulations, the dissolved uranium mass was reduced 90% within the first 5,000 years, and a steady-state uranium plume was achieved within the first 10,000 years. By 25,000 years, the dissolved mass was reduced to 1% of the decommissioning restored solution mass. Some simulations were extended to and beyond 50,000 years (base case simulation was 60,000 years) because that timeframe was required to reduce peak plume concentrations for uranium to 1/100th the initial conditions; note that the plume is most persistent within the low conductivity paleoweathered bedrock. Beyond 60,000 years, where peak concentrations are 1/100th the source concentration, the potential for a continued groundwater plume from the mining area is all but eliminated and conditions have returned to baseline conditions.

Multiple model simulations were run to evaluate the sensitivity of the results (sensitivity analysis) to uncertainties in the model inputs and assumptions. A 'base case' was developed that reflected sorption to mineral phases, with mineral phase concentrations being aligned with the central tendency of measured values. The following uncertainties were evaluated and are reflected in Table 7.6-1:

- (Scenario 1): COPC concentrations at the Decommissioning objectives (i.e., Solution #1) assumed over the whole of the mining area, versus 50% concentrations in the upper portion of the mining area. This extends the source zone vertically; the lateral extent is physically constrained by the freeze walls. This scenario effectively simulates an increase in the total mass of the source.
- (Scenario 2): Proton sorption to clays in the ore zone. As described previously, proton desorption from clays results in a plume of lower pH for a longer period. Because COPC sorption is affected by the pH of the solution, potential effects of lower pH conditions in the plume on migration behaviour of the COPC was important to evaluate.
- (Scenario 3): Transport simulation time was extended to 100,000 years following cessation of mining to evaluate the potential that desorption, ion exchange, and other processes could yield additional mass available for transport.
- (Scenarios 4, 5, 6): Increased hydraulic conductivity values in portions of the flow path between the mining area and Whitefish Lake, and specifically in the Lower Sandstone Aquifer and altered (desilicified) portion of the Intermediate Sandstone Aquitard.
- (Scenario 7): Increased hydraulic conductivity in the active mining area. Higher hydraulic conductivity within the ore zone, representing the potential that the ore zone may have an enhanced flow through rate and thus create a greater mass flux leaving the ore zone.
- (Scenario 8): Higher hydraulic conductivity along the WS Shear within the paleoweathered zone. The WS Shear is interpreted to have an enhanced fracture zone (damaged zone) surrounding the fault plane, with the frequency and apertures of fractures decreasing exponentially away from the fault plane (i.e., typical interpretation for fracturing surrounding a fault). The enhanced fracturing along the WS shear is only expected to be relevant within the paleoweathered portion of the subsurface as the overlying sediments have been desilicified, and thus are more like porous media than fractured media.
- (Scenario 9): Increased hydraulic conductivity along exploration coreholes where grout was only placed in the 15 m above the Ore Zone. The overlying coreholes were simulated to have enhanced hydraulic conductivity through the Intermediate Sandstone Aquitard (Figure 2-6 in Appendix 7-C).
- (Scenario 10): The number of available sorption sites on the mineral surfaces was reduced to $1/10^{th}$ the base case to reflect the potential that the solids in the system will have fewer available sites than what is described/assumed in the literature, for reasons such as particle

size, mineral phase, etc. Consequently, the potential for dissolved mass to adsorb (and thus have transport retarded) was reduced.

- (Scenario 11): Reduction in the number of available reaction sites to 1/10th the base case, as in Scenario 10, but with the full suite of constituents.
- (Scenario 12): The Lower Sandstone Aquifer has relatively low clay and iron concentrations in relation to the overlying hydrostratigraphic units. These minerals were removed altogether from this zone to evaluate the influence on COPC migration.
- (Scenario 13): The longitudinal and transverse dispersivity were reduced by a factor of two to reduce the potential dispersion of the plume along the flow path to values of 5 m and 2.5 m, respectively. This has the effect of increasing the peak concentration along the dominant flow paths.
- (Scenario 14): Oxygenated conditions may be encountered in the upper flow zone. Oxidation of ferrous iron from the mining area to ferric iron and subsequent oxidation to goethite was allowed, and the effect on pH and COPC behaviour was evaluated.
- (Scenario 15): The groundwater is largely anoxic and pyrite is present in the zone of thermal alteration in the Lower Sandstone Aquifer. The potential for U(VI) reduction linked to pyrite oxidation was explored. In this scenario, no sorption was assumed in the Lower Sandstone Aquifer for U(VI) or other COPCs.

In Scenarios 3, 4, and 5, the values for increased hydraulic conductivities in the Lower Sandstone Aquifer and Desilicified Zone of the Intermediate Sandstone Aquitard were developed using a robust uncertainty analysis (i.e., Parameter ESTimation utility, PEST++ IES; Doherty 2015, 2018; White 2018; White et al. 2020). This approach was used in recognition that model calibration is non-unique and that a range of parameter combinations should be evaluated to understand potential environmental predictions.

Results with respect to peak concentration of COPCs in groundwater discharging to Whitefish Lake are summarized in Table 7.6-1, for the multiple model simulations introduced above. Concentrations in groundwater discharging at Whitefish Lake are not simulated to vary appreciably from baseline conditions for the base case or in any of the scenarios that, overall, evaluate the sensitivity of the model predictions to a range of subsurface conditions. Changes in water quality are gradual and will result in an evolution of the groundwater quality reaching Whitefish Lake.

The potential Project-related effect was evaluated in two phases. Concentrations of COPCs in groundwater discharging at the lake were compared to available generic guidelines for the protection of freshwater aquatic life, which were used as groundwater quality screening criteria. The groundwater quality screening criteria are summarized in Table 7.6-1 and the sources of the criteria are provided in Appendix 7-C. COPC concentrations overwhelmingly met the screening guidelines across the scenarios evaluated, including those that were least conservative with respect to attenuation of COPC concentrations. However, to further evaluate potential Project-related effects during the ‘future centuries’ period (mass flux of COPC), inputs from groundwater were evaluated in the ERA using the IMPACT model. This is presented in Section 10.1.4.2.3 in Section 10.

For the COPCs identified in the effluent, the predicted mass flux from groundwater into Whitefish Lake starting 200 years after the Project phases during the ‘future centuries’ period was added into the IMPACT model to predict the water and sediment concentrations over time at the exposed locations. As shown in the ERA (Appendix 10-A in Section 10), predicted water and sediment concentrations at all locations are expected to be below water and sediment quality guidelines. Even though the water and sediment concentrations of COPCs are below their respective guidelines, dose and risk predictions for human receptors were performed using the IMPACT model as part of the ERA to understand what the predicted effects might be during ‘future centuries’ for the same COPCs as during the Project phases. During ‘future centuries’, a permanent resident was included on the former mine site instead of a camp worker. There were no predicted risks to human receptors for all non-carcinogens evaluated during the ‘future centuries’ period, and the cancer risk from arsenic was not predicted to exceed the negligible cancer risk level for any of the receptors assessed during ‘future centuries’ (Section 10.1.6.1.4 in Section 10). Further, the radiation dose estimate was below the public dose limit; thus, no discernable health effects are anticipated due to exposure of the permanent resident receptor to releases from the Project.

Project-related effects from the long-term transport of groundwater solutes to Whitefish Lake during the ‘future centuries’ period were modelled (Appendix 10-A in Section 10) and evaluated with respect to the Surface Water Quality VC (Section 8.2.4.2.5 in Section 8). No residual effects were identified.

Table 7.6-1: Maximum Concentrations in Groundwater Reaching Whitefish Lake

Scenario	MaxTime	pH	Al	As	C	Ca	Cd	Cl	Co	Fe	K	Mg	Na	Ni	Pb	SO_4	Se	Si	U	Ba	Cr	Cu	F	Mn	Mo	P	Ra	Sr	Th	V	Zn
Base	**60000**	**6.45**	**4.00E-2**	**7.82E-4**	**1.34E+1**	**7.01E+0**	**1.07E-5**	**9.98E+0**	**4.23E-4**	**1.94E+0**	**3.05E+0**	**2.76E+0**	**5.12E+0**	**1.92E-3**	**1.18E-4**	**1.26E+1**	**8.35E-4**	**1.22E+1**	**5.50E-4**												
Base+*	8720	6.47	2.98E-2	3.22E-4	1.34E+1	7.02E+0	1.07E-5	9.88E+0	4.22E-4	**1.95E+0**	3.05E+0	2.78E+0	5.13E+0	1.92E-3	1.19E-4	**1.27E+1**	8.36E-4	1.22E+1	5.45E-4	3.94E-2	5.25E-4	7.00E-4	6.14E-2	2.79E-1	3.09E-3	7.43E-2	2.28E-9	1.19E-1	3.16E-8	6.64E-3	4.71E-3
1	50000	6.43	4.01E-2	4.19E-4	1.34E+1	8.36E+0	1.10E-5	1.17E+1	4.33E-4	2.85E+0	3.05E+0	2.87E+0	5.58E+0	1.96E-3	1.18E-4	**1.89E+1**	8.48E-4	1.22E+1	5.50E-4												
2	50870	6.42	4.20E-2	4.11E-4	1.34E+1	7.06E+0	1.07E-5	1.00E+1	4.24E-4	1.95E+0	3.05E+0	2.78E+0	5.14E+0	1.92E-3	1.18E-4	**1.26E+1**	8.35E-4	1.22E+1	5.51E-4												
3	100000	6.45	3.98E-2	1.40E-3	1.34E+1	5.83E+0	1.43E-5	1.03E+1	4.85E-4	2.10E+0	3.42E+0	3.08E+0	6.17E+0	1.90E-3	1.17E-4	**1.37E+1**	1.37E-3	1.22E+1	8.71E-4												
4	35000	6.45	4.01E-2	1.03E-3	1.47E+1	5.03E+0	1.30E-5	1.05E+1	4.19E-4	8.55E-1	3.26E+0	3.20E+0	5.87E+0	1.91E-3	1.21E-4	**5.03E+0**	1.38E-3	1.22E+1	1.70E-3												
5	25450	6.45	4.02E-2	9.82E-4	1.47E+1	5.01E+0	1.42E-5	9.87E+0	4.19E-4	8.13E-1	3.23E+0	3.19E+0	5.47E+0	1.91E-3	1.21E-4	**4.74E+0**	1.28E-3	1.22E+1	1.54E-3												
6	25075	6.45	4.01E-2	1.10E-3	1.46E+1	5.02E+0	1.38E-5	1.10E+1	4.19E-4	1.06E+0	3.28E+0	3.18E+0	6.32E+0	1.91E-3	1.21E-4	**6.46E+0**	1.44E-3	1.22E+1	1.81E-3												
7	10000	6.44	4.02E-2	1.58E-3	1.34E+1	6.10E+0	2.27E-5	1.00E+1	4.16E-4	1.95E+0	3.17E+0	2.94E+0	6.59E+0	1.89E-3	1.18E-4	**1.27E+1**	1.47E-3	1.22E+1	7.69E-4												
8	10000	6.44	4.02E-2	2.00E-3	1.34E+1	6.18E+0	2.59E-5	1.05E+1	4.16E-4	2.02E+0	3.17E+0	2.95E+0	6.92E+0	1.89E-3	1.18E-4	**1.31E+1**	1.57E-3	1.22E+1	7.69E-4												
9	10000	6.45	4.00E-2	3.21E-4	1.34E+1	7.01E+0	1.07E-5	9.95E+0	4.23E-4	1.94E+0	3.05E+0	2.76E+0	5.12E+0	1.92E-3	1.18E-4	**1.26E+1**	8.35E-4	1.22E+1	5.50E-4												
10	50000	6.44	4.02E-2	4.68E-4	1.34E+1	6.61E+0	1.14E-5	9.95E+0	6.33E-4	1.95E+0	2.95E+0	2.71E+0	6.98E+0	1.92E-3	1.18E-4	**1.26E+1**	8.35E-4	1.22E+1	1.40E-3												
11	11175	6.46	4.69E-2	3.33E-4	1.34E+1	6.68E+0	1.18E-5	9.86E+0	4.48E-4	1.95E+0	2.95E+0	2.72E+0	6.66E+0	1.92E-3	1.19E-4	**1.27E+1**	8.36E-4	1.22E+1	1.37E-3	3.93E-2	5.27E-4	7.86E-4	6.17E-2	2.82E-1	9.14E-4	9.41E-2	2.52E-9	1.20E-1	3.80E-8	1.30E-4	4.93E-3
12	8540	6.47	2.98E-2	3.25E-4	1.34E+1	6.95E+0	1.07E-5	9.89E+0	4.22E-4	1.95E+0	3.05E+0	2.78E+0	5.29E+0	1.92E-3	1.19E-4	**1.27E+1**	8.36E-4	1.22E+1	5.45E-4	3.94E-2	5.25E-4	6.99E-4	6.14E-2	2.79E-1	9.12E-4	7.46E-2	2.26E-9	1.20E-1	3.15E-8	1.30E-4	4.70E-3
13	35000	6.43	4.15E-2	1.93E-3	1.49E+1	7.48E+0	3.96E-5	1.20E+1	9.10E-4	2.91E+0	3.27E+0	3.21E+0	8.38E+0	1.92E-3	1.21E-4	**1.93E+1**	2.19E-3	1.22E+1	9.58E-3												
14	50000	6.38	4.21E-2	1.49E-3	1.34E+1	6.14E+0	2.22E-5	1.00E+1	6.62E-4	6.48E-3	3.17E+0	2.94E+0	6.62E+0	1.90E-3	1.17E-4	**1.26E+1**	1.40E-3	1.22E+1	3.15E-3												
15	15000	6.39	3.83E-2	6.97E-4	1.34E+1	6.96E+0	1.07E-5	9.89E+0	4.22E-4	2.00E+0	3.05E+0	2.78E+0	5.30E+0	1.91E-3	1.18E-4	**1.26E+1**	8.34E-4	1.22E+1	5.34E-4	3.94E-2	5.14E-4		6.17E-2	2.89E-1	9.12E-4	7.74E-2	2.61E-9	1.20E-1	3.41E-8	1.30E-4	5.00E-3
Groundwater Quality Screening Criteria		6.5-9	5.00E-2	5.00E-3			4.00E-5	1.20E+2	7.80E-4	3.00E-1				2.50E-2	1.00E-3	1.28E+2	2.00E-3		1.50E-2		8.90E-3	2.00E-3		2.30E-1	3.10E+1		3.00E-9	2.50E+0	1.24E-4	1.20E-1	1.10E-2

Notes:
* Base+ Scenario used to evaluate effects within Whitefish Lake in the ERA (
Exceedances of Groundwater Quality Screening Criteria are shown in red

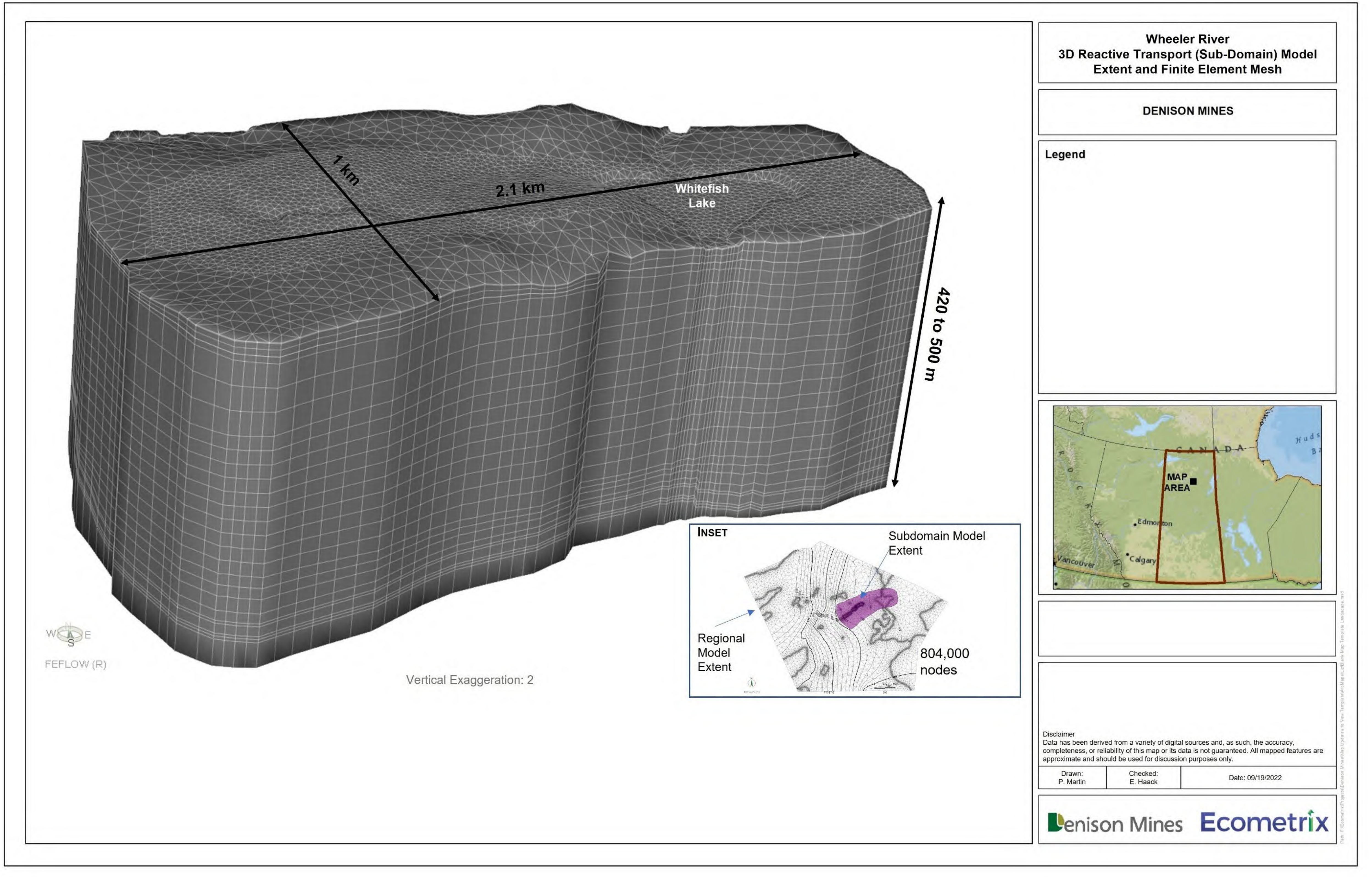

Figure 7.6-5: 3D Reactive Transport (Sub-Domain) Model Extent and Finite Element Mesh

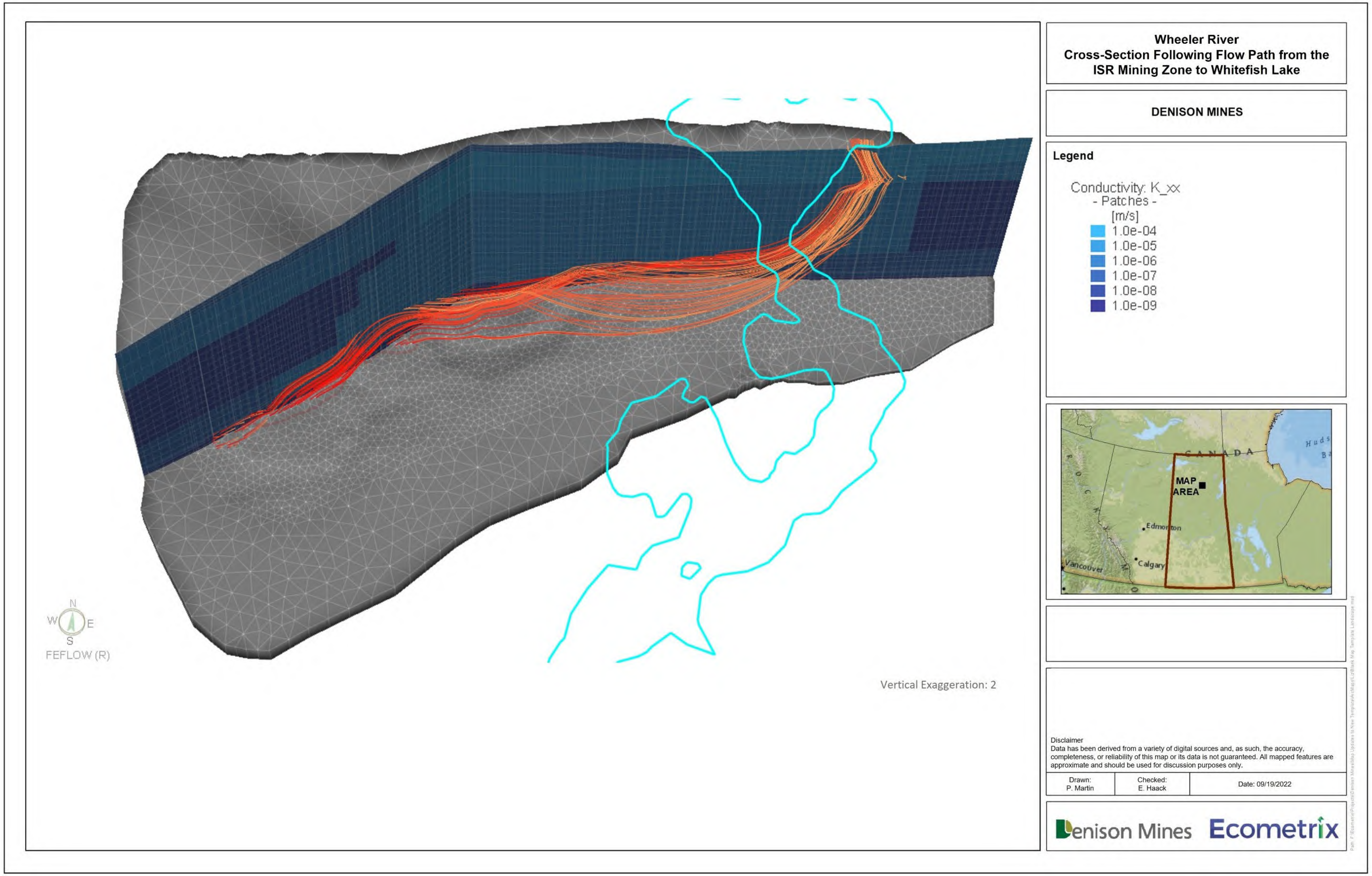

Figure 7.6-6: Cross-section Following Flow Path from the In Situ Recovery Mining Area to Whitefish Lake

Plume Behaviour – Base Case Scenario

Predicted transport of dissolved COPCs was generally found to follow anticipated flow paths with additional spreading due to dispersion. Dispersion reduces the concentrations as time progresses in the model and the dissolved plume spreads, resulting in lower concentrations of COPCs in groundwater reaching Whitefish Lake than those in the remediated mining area (Section 7.6.2.1). This is shown in Figure 7.6-7 for chloride. Chloride is a COPC that acts conservatively in groundwater, meaning that due to its chemical nature, its behaviour will be affected by dispersion and advection but not by chemical reactions with other groundwater constituents or the solid matrix along the groundwater flow path. Chloride and other COPCs that behave conservatively (including sulphate) are simulated to reach their peak concentration in the lake in approximately 400 years; this is consistent with the early arrival particle traces illustrated in Figure 7.6-6.

The area simulated to be a source of contaminant mass Post-Decommissioning includes the Ore Zone, the overlying Lower Sandstone Aquifer (i.e., 50 m above the Ore Zone), and the underlying Paleoweathered bedrock (Section 7.6.2.1). As indicated in Figure 7.6-7, elevated concentrations of even conservative COPCs persist within the Paleoweathered zone due to its lower hydraulic conductivity (i.e., it takes longer for COPCs to be flushed out of this zone).

Several types of chemical reactions can affect the concentrations of COPC along the groundwater flow path. Chemical reactions that can act to retard the velocity of groundwater plumes relative to the average linear velocity of groundwater (i.e., advection) and/or attenuate COPC concentrations in groundwater include precipitation as a mineral phase, sorption, and redox transformation (and subsequent precipitation and/or sorption). Other processes, like radioactive decay and ingrowth, can affect concentrations of radiological constituents along the groundwater flow path.

The transformation of mass from the dissolved to the sorbed state is illustrated in Figure 7.6-8 through Figure 7.6-11. Selenium and uranium are elements that have very different affinities for sorption to the mineral phases in the subsurface across the LSA. Selenium shows a low affinity for the solid phase and selenium migration to Whitefish Lake is retarded to a limited extent in comparison to chloride (conservative constituent) (Figure 7.6-8 and Figure 7.6-9). Concentrations of selenium in groundwater are attenuated primarily from dispersion, as for chloride.

Uranium is very strongly sorbed to the mineral phases. Because of this, migration is very strongly retarded and uranium in the dissolved phase is not predicted to reach Whitefish Lake in 50,000 years or beyond (Figure 7.6-10 and Figure 7.6-11). The distance that the dissolved uranium plume migrates is limited by the adsorption reactions and dispersion. The uranium plume is simulated to grow modestly over the first 5,000 years of the simulation but then start to retract (i.e., shrink) during later times as the source concentration (i.e., dissolved uranium concentrations in remediated groundwater in the mining area) is depleted. Depletion of the source concentration occurs as background water carrying lower uranium (and other constituent) concentrations flows through the source area.

For the uncertainty scenario with lower dispersivity, exceedances of the groundwater quality screening criteria for cobalt (Co) and selenium (Se) were simulated to occur. The exceedances for these two elements represent dissolved concentrations in groundwater 1.2 and 1.1 times their respective groundwater quality screening criteria. Figure 7.6-12 provides an example of the portion of Whitefish Lake which could receive concentrations greater than the groundwater quality screening criteria (in this case for selenium). Note that as the portion of the lake with potential to experience concentrations above the groundwater quality screening criteria is small, the mass flux entering the lake would is simulated to be relatively unchanged from background conditions. The simulated concentrations reaching the base of Whitefish Lake would be further readily reduced during mixing within the lake (Appendix 10-A in Section 10).

By accounting for flow, transport, and chemical reactions, the simulated plumes of dissolved COPCs emanating from the Ore Zone were found to reach a maximum extent within the Lower Sandstone Aquifer and the deeper part of the Desilicified Zone after 5,000 to 10,000 years (depending on the COPC).

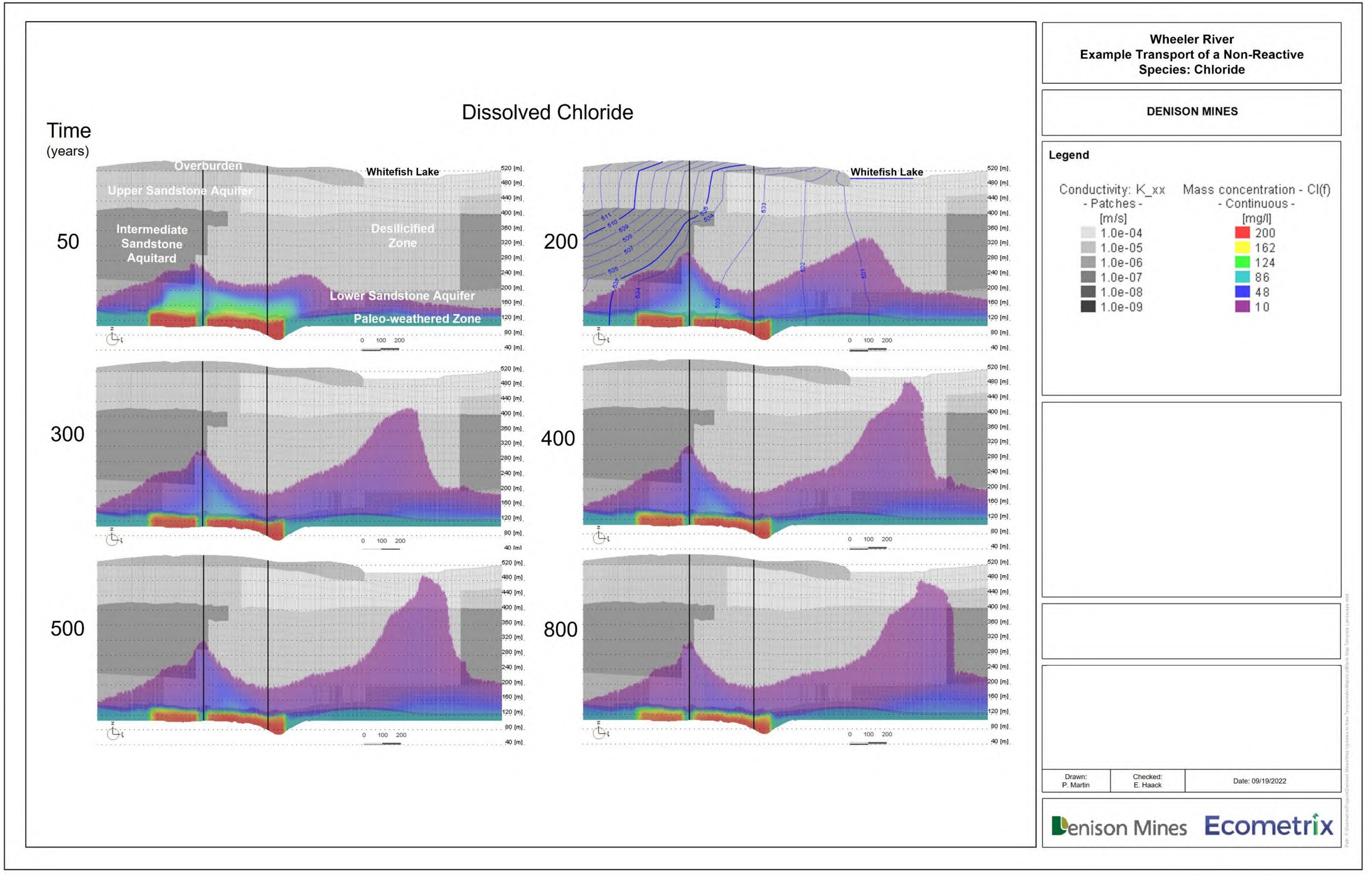

Figure 7.6-7: Example Transport of a Non-Reactive Species – Chloride

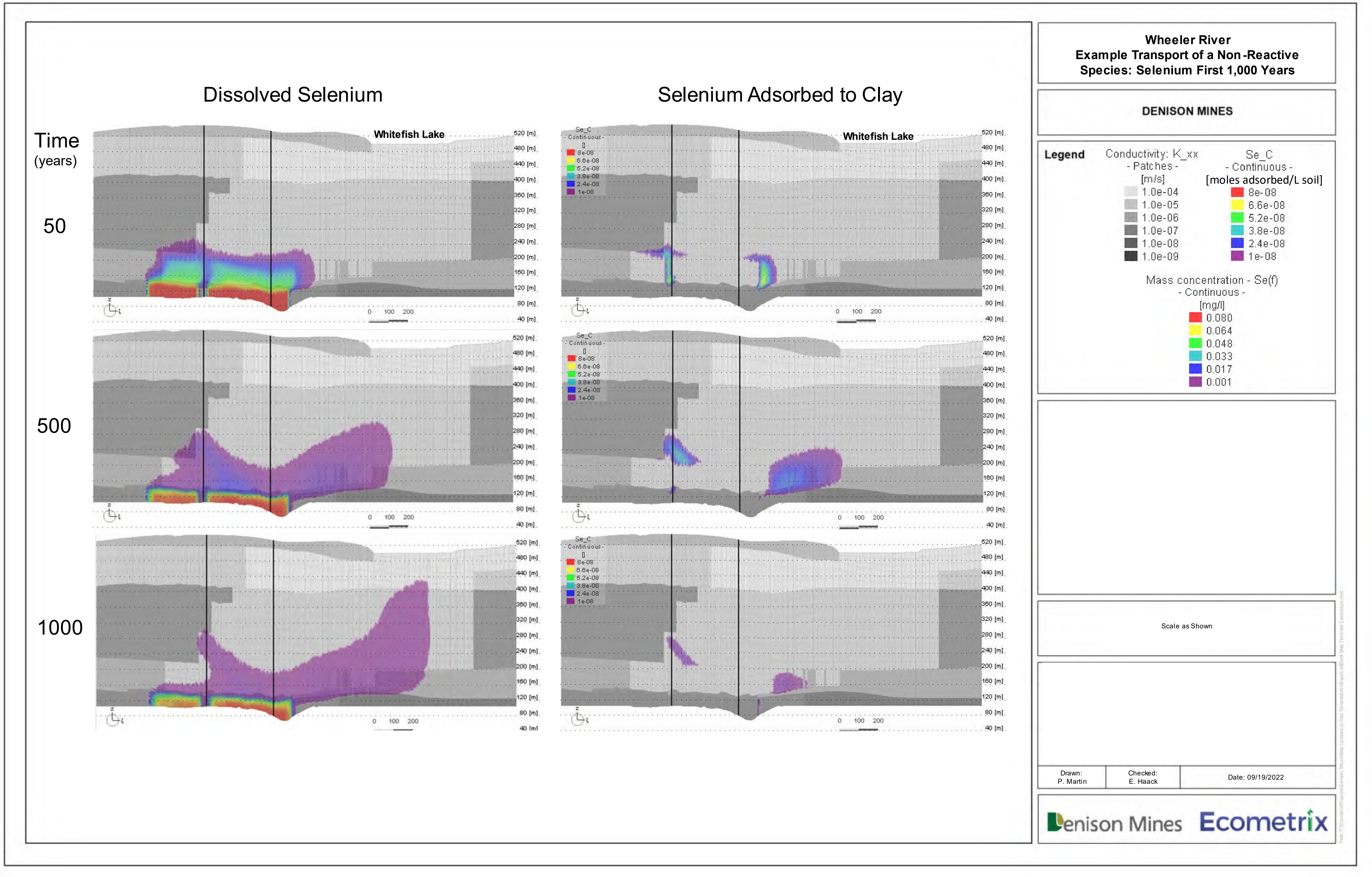

Figure 7.6-8: Example Transport of a Non-Reactive Species – Selenium First 1,000 Years

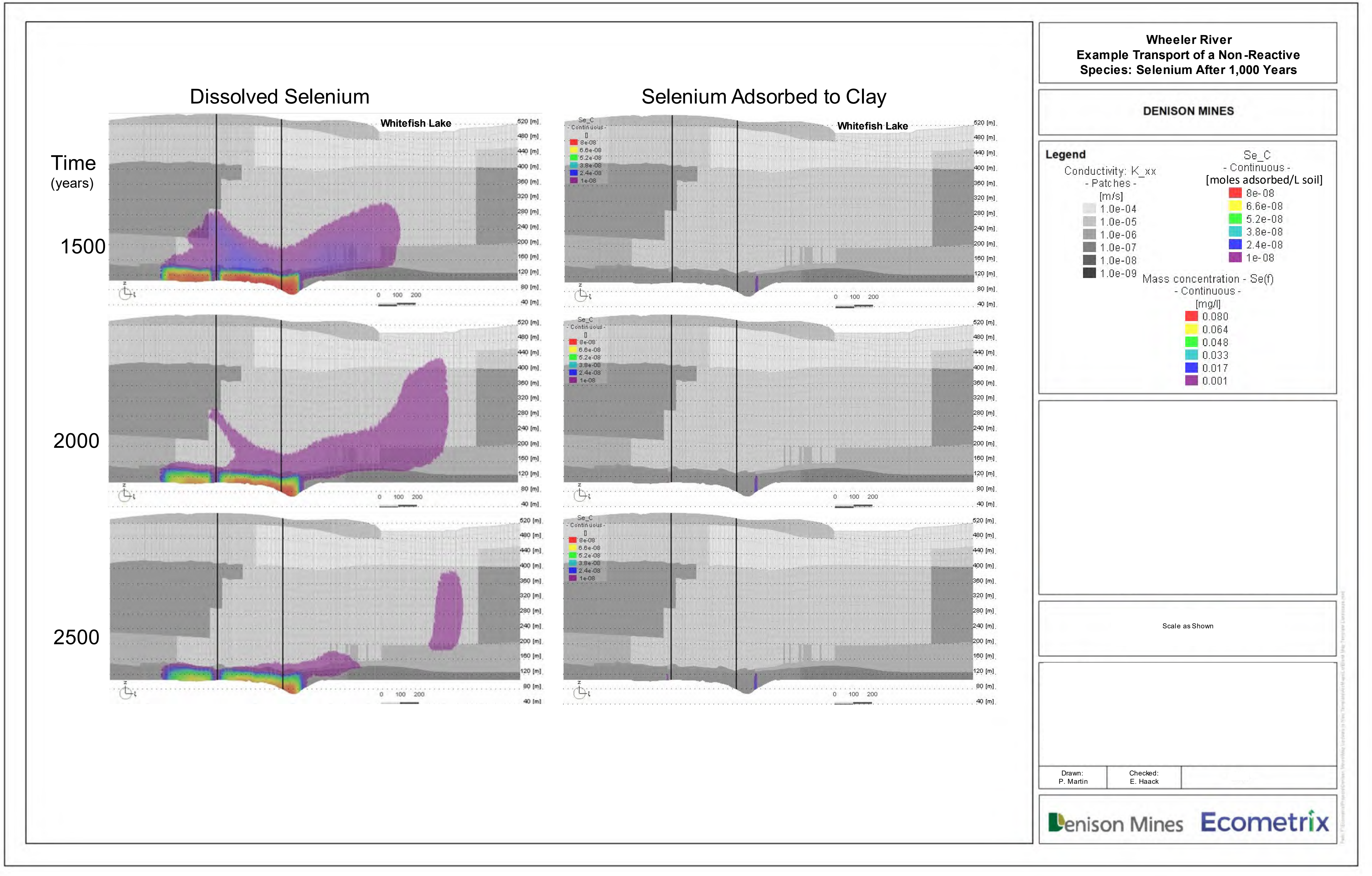

Figure 7.6-9: Example Transport of a Non-Reactive Species – Selenium After 1,000 Years

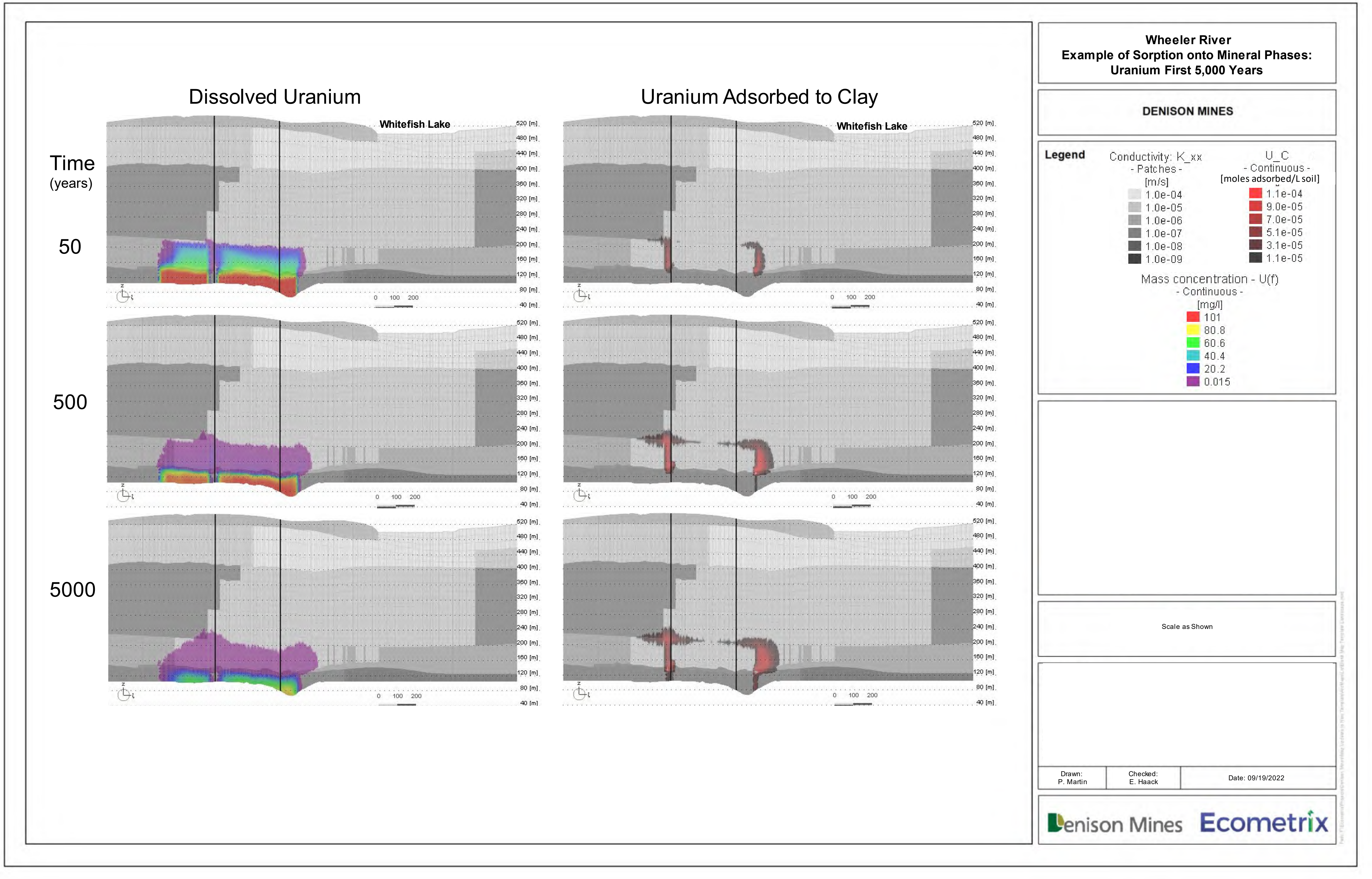

Figure 7.6-10: Example of Sorption onto Mineral Phases – Uranium First 5,000 Years

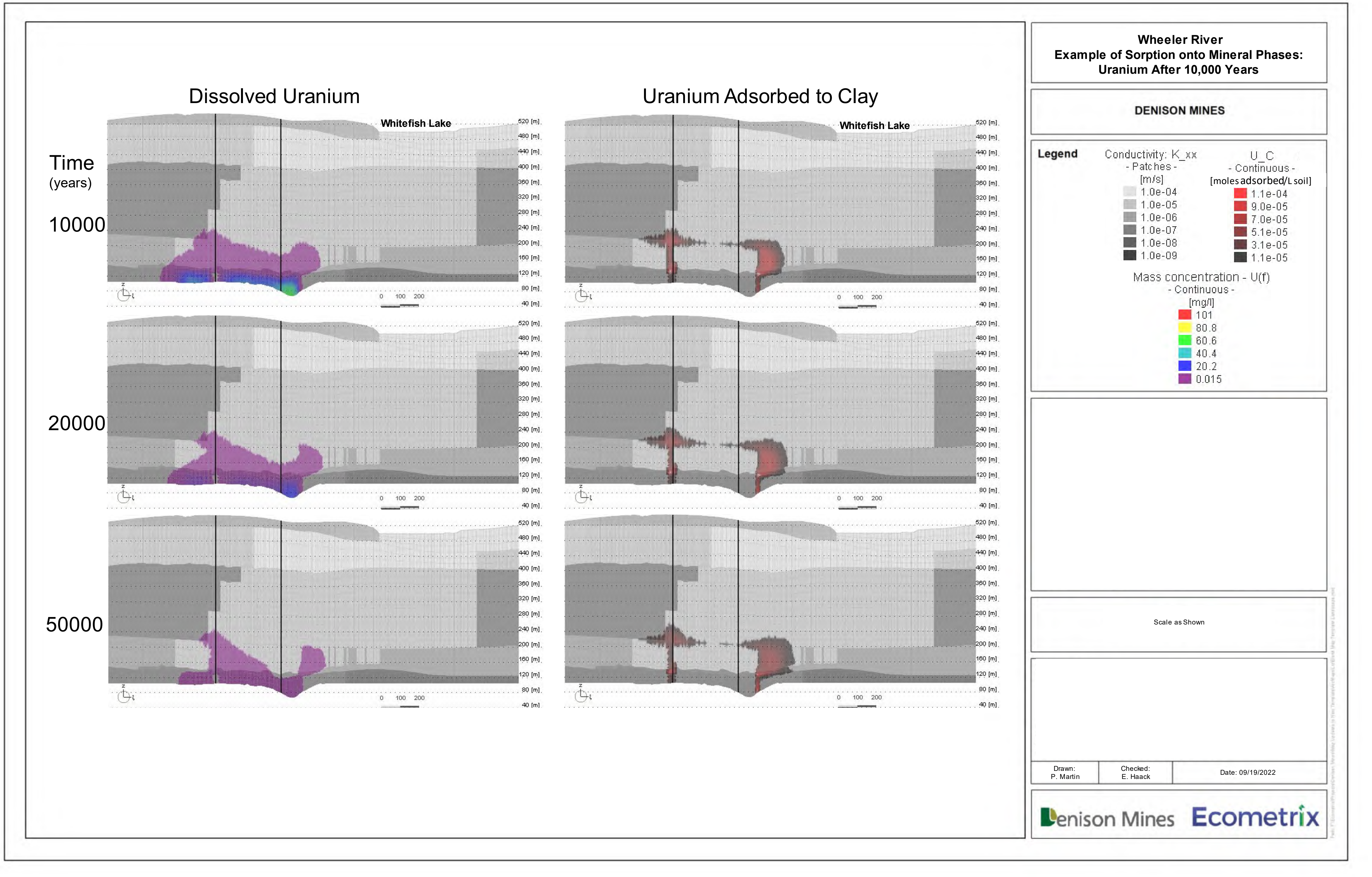

Figure 7.6-11: Example of Sorption onto Mineral Phases – Uranium After 10,000 Years

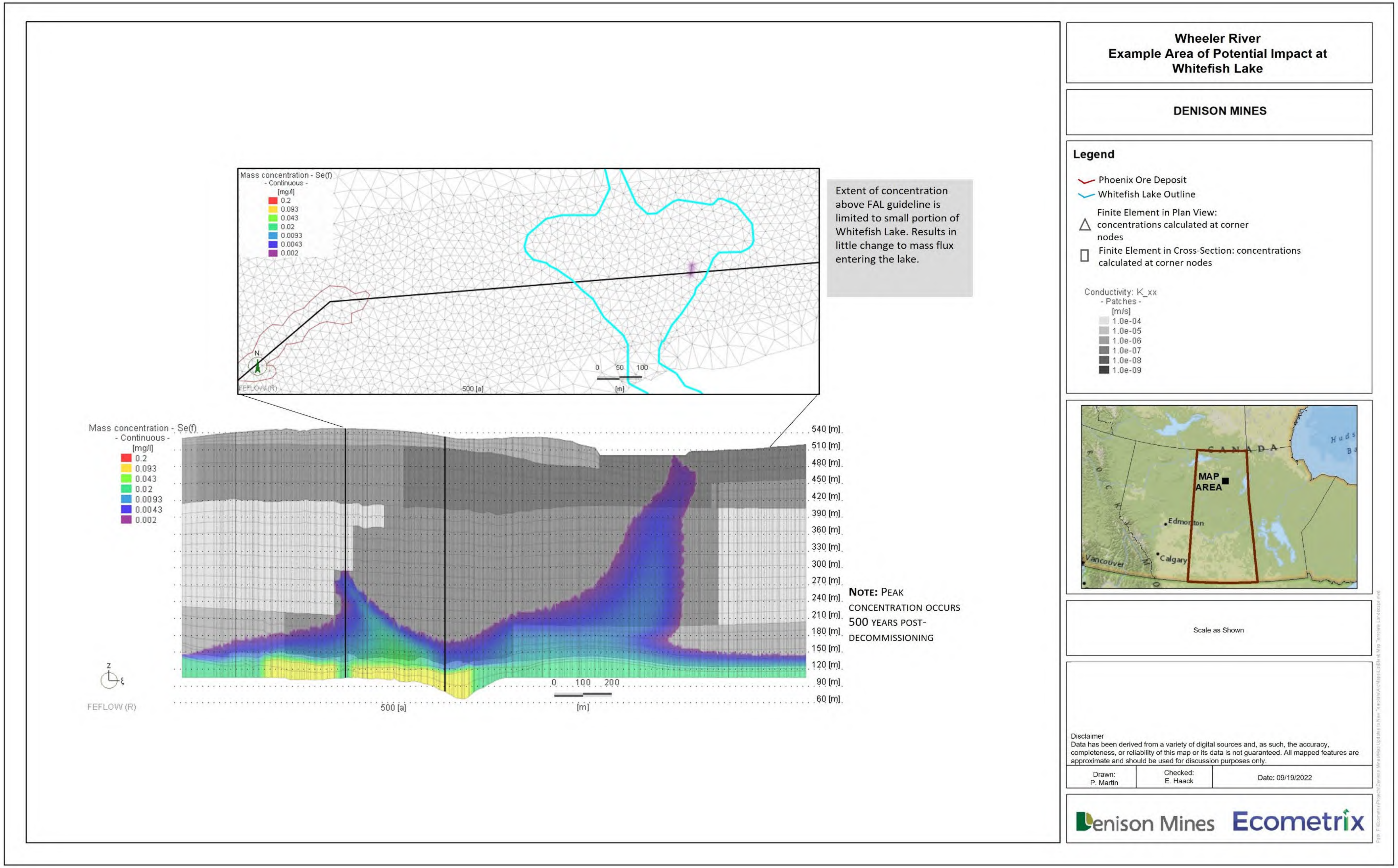

Figure 7.6-12: Example Area of Potential Impact at Whitefish Lake

7.6.2.2.4 Summary of Residual Effects Evaluation

The concentrations and mass loadings of COPCs associated with mining activities reaching Whitefish Lake were simulated to be modest variations from the background concentrations, as shown in Figure 7.6-13 and Figure 7.6-14, respectively. Sulphate is predicted to experience the largest change in concentration at Whitefish Lake, rising from 3 to 12 mg/L (i.e., a factor of four); however, this change in concentration is anticipated to occur over a small portion of the lake and thus results in a mass flux increase of 14%. For most of the constituents, the mass flux to Whitefish Lake raises by less than 5%. As such, the variations predicted to occur at Whitefish Lake are considered modest.

Consequently, future concentrations of COPCs at Whitefish Lake were simulated to be similar to background concentrations. Under the base case scenario (i.e., the best estimate of what will occur), exceedances of groundwater quality screening criteria were only predicted for iron, manganese, and pH. Predicted concentrations/values for these parameters were within baseline concentrations observed in the LSA; iron and manganese concentrations in groundwater are naturally elevated and pH values in groundwater range naturally down to approximately pH 6.

Groundwater monitoring will be completed over the life of the Project to assess trends and compliance with model predictions (Section 7.8).

Results of the residual effect evaluation are provided in the following residual effects characteristic definition and rating summary tables for Geology (Table 7.6-2 and Table 7.6-3), Groundwater Quantity (Table 7.6-4 and Table 7.6-5), and Groundwater Quality (Table 7.6-6 and Table 7.6-7) VCs.

Table 7.6-2: Geology – Definitions for Residual Effect Characteristics

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Negative effect or effect is not desirable.
		Positive – Beneficial effect or effect is desirable.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Low** – Minimal amount of change relative to the range of existing variation.
		Moderate – Moderate amount of change relative to the range of existing variation.
		High – High amount of change relative to the range of existing variation.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area.
		Local – Effect is limited to the VC LSA.
		Regional – Effect extends beyond the VC LSA into the VC RSA.
		Beyond Regional – Effect extends beyond VC RSA.

Residual Effect Characteristic	Definition	Rating
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only).
		Medium-term – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning).
		Long-term – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals.
		Frequent – Effect occurs many times on a regular basis.
		Continuous – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions
		Partially Reversible – A residual effect that partially diminishes to baseline conditions
		Irreversible – A residual effect that will not diminish to baseline conditions
Context	Since Geology is an intermediate VC, the context is best defined in the significance determination of the receptor VCs, specifically Terrain.	
Likelihood	Likelihood that the residual effect will occur including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability that the residual effect will occur.
		Unlikely – A low probability that the residual effect will occur.

Table 7.6-3: Geology – Summary of the Residual Effect Characteristics Ratings

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The possible effect is subsidence, and thus a vertical displacement of soil at ground surface. This is a negative or undesirable effect.
Magnitude	Low	The extent of subsidence is expected to be limited in terms of vertical displacement, to a maximum of 2-3 mm at ground surface. This degree of change is negligible and is likely within the range of ground surface elevation change/disturbance associated with other routine operations at surface.
Geographic Extent	Project Area	The geographic extent of subsidence is expected to be localized to a small portion of the Project Area.
Duration	Long-term	The time period of subsidence was modelled as a single mass loss event. However, the period of subsidence, if it occurs, may extend over a longer period of time, and would extend beyond the lifetime of the Project.
Frequency	Continuous	Subsidence at ground surface, once it occurs, will be continuous.

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Reversibility	Partially Reversible	Subsidence can be integrated with the surrounding natural environment through site reclamation.
Context	Context is described for receptor VCs, being Terrain.	
Likelihood	Likely	Although modelled to be negligible in magnitude, it is likely that subsidence will occur through the course of the Project. The likelihood is expected to be mitigated/lessened by the mining approach whereby mass is removed/ore extracted in multiple phases (versus a single mass loss event in the active mining zone, as modelled).

Table 7.6-4: Groundwater Quantity – Definitions for Residual Effect Characteristics

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Negative effect or effect is not desirable. **Positive** – Beneficial effect or effect is desirable.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Low** – Minimal amount of change relative to the range of existing variation. Defined as a less than 10% change in groundwater discharge (L/s). **Moderate** – Moderate amount of change relative to the range of existing variation. Defined as a change in groundwater discharge (L/s) more than 10% but less than 25%. **High** – High amount of change relative to the range of existing variation. Defined as a change in groundwater discharge (L/s) greater or equal to 25%.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the VC LSA. **Regional** – Effect extends beyond the VC LSA into the VC RSA. **Beyond Regional** – Effect extends beyond VC RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.

Residual Effect Characteristic	Definition	Rating
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions **Partially Reversible** – A residual effect that partially diminishes to baseline conditions **Irreversible** – A residual effect that will not diminish to baseline conditions
Context	Since Groundwater Quantity is an intermediate VC, the context is best defined in the significance determination of the receptor VCs including various VCs in the Aquatic Environment.	
Likelihood	Likelihood that the residual effect will occur including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability that the residual effect will occur. **Unlikely** – A low probability that the residual effect will occur.

Table 7.6-5: Groundwater Quantity – Summary of the Residual Effect Characteristics Ratings

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Groundwater quantity characterized at discharge to Whitefish Lake (LA-5) will be reduced, primarily as a result of water taking and anticipated changes in groundwater recharge, during Construction, Operation and Decommissioning.
Magnitude	Moderate to High	Groundwater discharge is expected to be reduced by as much as 25% in Whitefish Lake during Decommissioning. Discharge is expected to be reduced to a lesser extent during Construction (10%) and Operation (20%).
Geographic Extent	Local	The geographic extent of changes in groundwater quantity is expected to be localized to a Whitefish Lake in the LSA.
Duration	Medium-term	Discharge flows to Whitefish Lake are expected to be most affected (reduced) during Decommissioning. Recovery to baseline (pre-mining) conditions is expected during the early years of Post-Decommissioning (by year 9) when pumping has ceased.
Frequency	Continuous	The effect is expected to occur from Construction through Operation into Decommissioning, and is predicted to revert to baseline conditions by year 9 of Post-Decommissioning.
Reversibility	Fully Reversible	The effect is fully reversible upon cessation of pumping.
Context	Context is described for the Surface Water Quantity VC. Because groundwater discharge to Whitefish Lake is a small component of water flow through the lake, the change in overall water quantity within the lake during all Project phases is predicted to be too small to measure.	
Likelihood	Likely	Changes to groundwater quantity (discharge to Whitefish Lake) are likely to occur due to water taking for Project activities and changes in groundwater recharge in the Project Area.

Table 7.6-6: Groundwater Quality – Definitions for Residual Effect Characteristics

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Negative effect or effect is not desirable. **Positive** – Beneficial effect or effect is desirable.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Low –** A measurable change that is not within the variability of baseline conditions but below groundwater quality screening criteria. The criteria are a compilation of generic guidelines for the protection of aquatic life for constituents of potential concern in groundwater discharging to Whitefish Lake for the Project. **Moderate** – A measurable change that is not within the variability of baseline conditions and not within groundwater quality screening criteria; therefore, it could have an adverse effect on water uses in the LSA. **High** – A measurable change that is not within the variability of baseline conditions and is substantively outside of groundwater quality screening criteria; therefore, it is likely to have an adverse effect on water uses in the LSA.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the VC LSA. **Regional** – Effect extends beyond the VC LSA into the VC RSA. **Beyond Regional** – Effect extends beyond VC RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions **Partially Reversible** – A residual effect that partially diminishes to baseline conditions **Irreversible** – A residual effect that will not diminish to baseline conditions
Context	Since Groundwater Quality is an intermediate VC, the context is best defined in the significance determination of the receptor VCs including various VCs in the Aquatic Environment and the Human Health VC.	
Likelihood	Likelihood that the residual effect will occur including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability that the residual effect will occur. **Unlikely** – A low probability that the residual effect will occur.

Table 7.6-7: Groundwater Quality – Summary of the Residual Effect Characteristics Ratings

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project will cause a change in concentrations of constituents in groundwater, measured as a mass of chemical per unit volume in water (e.g., mg/L). Groundwater quality in the subsurface within the LSA will be changed following the remediation process in the mining area. Groundwater constituents within the remediated groundwater will migrate away from the mining area during a period beginning at Post-Decommissioning. This migration will extend toward Whitefish Lake (the receiving environment) over hundreds to thousands of years ('future centuries') because of the relatively low groundwater velocities between the mining area and Whitefish Lake. Some constituents will require even more time for this migration as they are strongly held back (retarded) in the subsurface relative to the groundwater flow velocity due to interaction with the naturally existing minerals along the flow path. Dispersion (spreading) of constituents along the flow path will reduce constituent concentrations significantly throughout the groundwater migration period.
Magnitude	Low	Under the base case, there were no exceedances of groundwater quality screening criteria except those constituents that are naturally outside of criteria. Under highly conservative sensitivity analysis scenarios, minor exceedances (≤ 1.2 times the groundwater quality screening criteria) occurred for two of the constituents evaluated; because these exceedances were limited to one highly conservative scenario, exceedances are considered unlikely.
Geographic Extent	Local	The geographic extent of the residual effects is predicted to be local as effects are predicted to be confined to a small portion of the waterbody immediately adjacent to the Project (i.e., Whitefish Lake).
Duration	Long-term	In the 'future centuries' period following the remediation process in the mining area, there is the potential for COPCs dissolved in groundwater to migrate as part of natural groundwater flow conditions in the subsurface. Such migration will occur over hundreds to thousands of years.
Frequency	Continuous	Changes to groundwater quality are anticipated over the 'future centuries' period and will require hundreds to thousands of years to migrate through the sub-surface to a receiving water body. As such the effects are considered continuous during that period.
Reversibility	Irreversible	Although the changes to groundwater quality may be reversible within the future centuries period, they are considered irreversible in the context of the EIS.
Context	Context is described for surface water VCs as they will be the receptor of effected groundwater in the future centuries. The significance of the residual effect was evaluated further in the ERA (Section 10) and no risks to the Human Health VC were identified from inputs of constituents of potential concern to Whitefish Lake. No residual effects were identified with respect to the Surface Water Quality VC (Section 8).	
Likelihood	Likely	It is expected that a change in groundwater quality will occur.

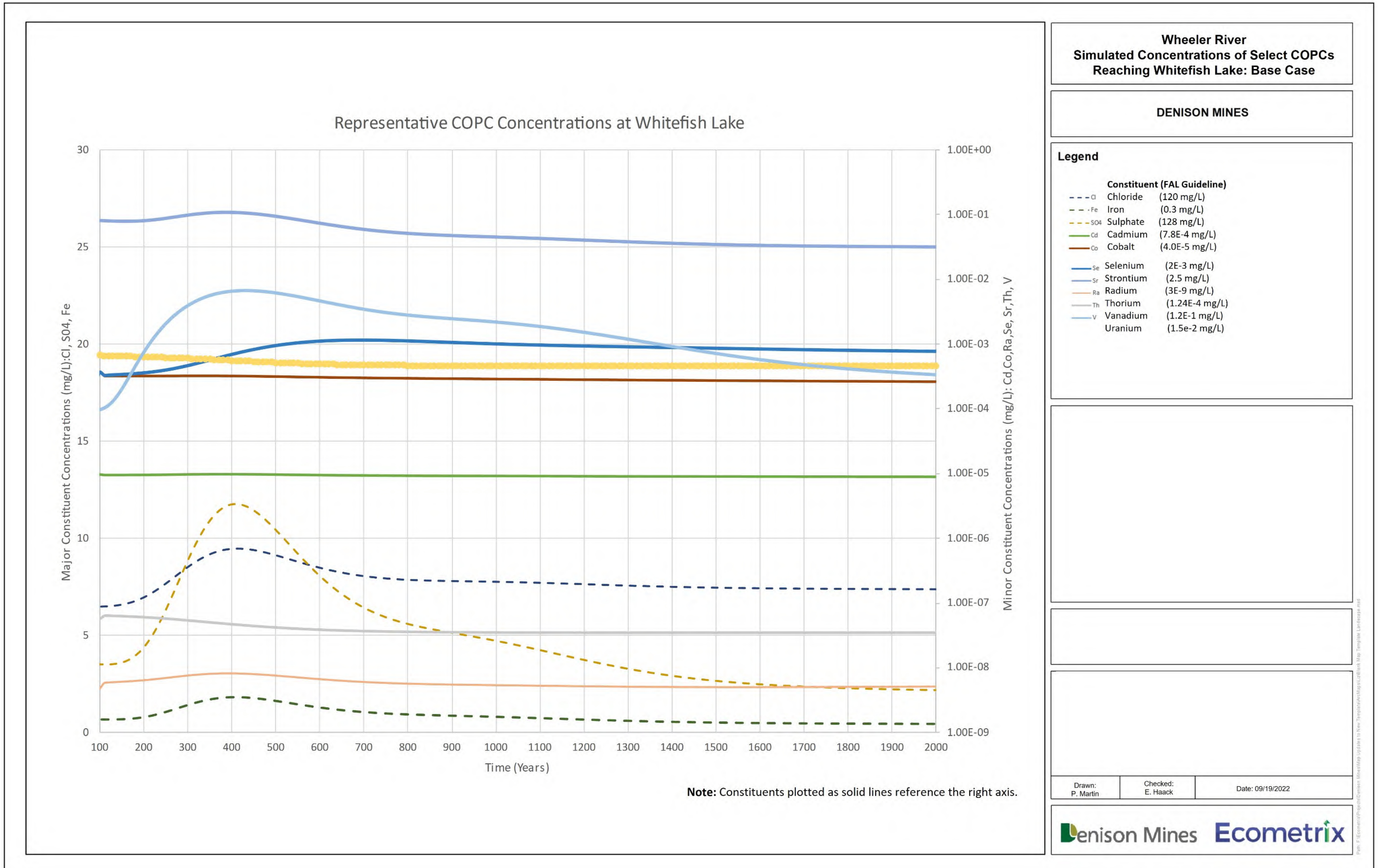

Figure 7.6-13: Simulated Concentrations of Select Constituents of Potential Concern Reaching Whitefish Lake – Base Case

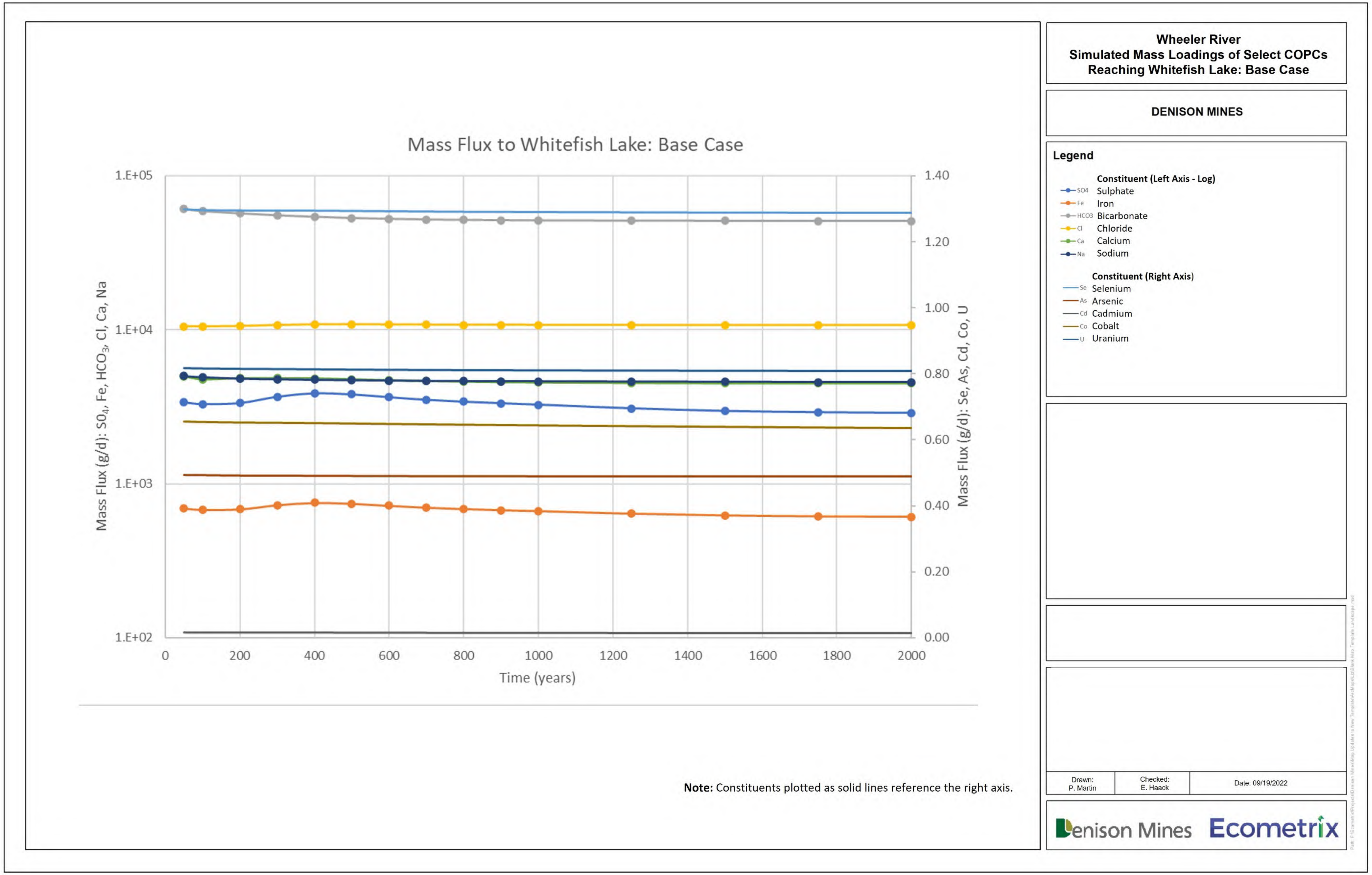

Figure 7.6-14: Simulated Mass Loading of Select Constituents of Potential Concern Reaching Whitefish Lake – Base Case

7.6.2.3 Significance and Confidence

Numerical models are approximations of the real-world environment and generalizations are necessary to take a complex hydrogeologic system and bring it into the numerical model. As such, there is inherent uncertainty associated with groundwater flow and reactive transport modelling presented in the previous sections and Appendix 7-C.

Despite the inherent uncertainty, confidence in the simulated hydrogeologic conditions is provided by the following:

- Model calibration that fits all data to within a tolerance of 2 m, with calibration residuals randomly distributed within the area of interest. The model calibration also includes simulated flow rates through the model that are consistent with observed baseflow estimates. The model calibration was achieved with relatively minor deviation from the conceptualized model parameters. These considerations together illustrate that the model developed provides an excellent representation of observed hydrogeologic conditions.
- A model parameter uncertainty assessment was completed to generate alternative calibrated parameter distributions. The parameter sets with higher hydraulic conductivity values, which are expected to produce higher flow velocities, were carried forward and used to evaluate prediction uncertainty regarding COPC concentrations reaching Whitefish Lake.
- Fifteen uncertainty scenarios were developed to test the implication of assumptions regarding the source condition, hydrogeologic conductivity along the flow path, transport parameter, and geochemical reactions on predicted concentrations reaching Whitefish Lake. All scenarios produced similar COPC plume transport and peak concentrations arriving at Whitefish Lake.

Together, the abovementioned factors provide confidence that the predicted outcomes (i.e., COPC concentrations reaching Whitefish Lake) are representative. The uncertainty analysis provides an understanding of how different the results could be should parameters differ from the best estimate parameters. All simulations indicate that the natural hydrogeologic environment has a high capacity for attenuating concentrations of COPCs from the mining area post-decommissioning.

Despite this confidence, groundwater monitoring planned for during Operation, Decommissioning, and Post-Decommissioning will be used to guide adaptive management. The model predictions will be updated if monitoring data indicate conditions meaningfully different from those simulated and/or if new information becomes available that might affect modelling assumptions. Management approaches will be updated as required to safeguard the environment.

Regarding significance determination, Geology, Groundwater Quality, and Groundwater Quantity are intermediate VCs and the significance of any associated residual effects are assessed within the context as a pathway to effects on receptor VCs. A change in an intermediate VC may lead to an effect on a receptor VC. Receptor VCs are generally biological or integrated assessment endpoints. Significance determination is not completed on intermediate VCs, but integrated into the residual effect evaluation, residual effect characterization, and significance determination for related receptor VCs. The receptor VCs for Geology are Terrain, and the receptor VCs for Groundwater Quality and Groundwater Quantity are carried into the aquatic environment through various VCs.

7.7 Cumulative Effects

The cumulative effects assessment considers whether the residual adverse effects of the Project on the Geology and Groundwater VCs will overlap spatially and/or temporally with the same kind of residual adverse effects on the VC resulting from other past, present, and reasonably foreseeable projects and activities

Existing and reasonably foreseeable projects within the Wheeler River system that have been considered for potential to interact with the Geology and Groundwater VCs include the following existing mines and mills: Cameco Cigar Lake Mine, Cameco Key Lake Operation, and Cameco McArthur River Operation.

No cumulative effects are expected for the Geology VC as a result of the Project. Subsidence is expected to be limited in terms of vertical displacement, if detectable, and localized to a small portion of the Project Area that does not spatially overlap with other project footprints. The Geology VC is not considered further under cumulative effects.

No significant residual effects were determined for the Groundwater VC (quantity) as a result of the Project. Changes to surface water levels and flows are expected to be well below criteria identifying a residual effect during all phases of the Project. Furthermore, Project-related interactions are predicted to be limited spatially and temporally. Spatially, the interactions of the Project with the Surface Water Quantity VC are highly localized to the LSA, and specifically to Whitefish Lake (LA-5), and is not further propagated downstream of this immediate area. Project-related interactions do not extend beyond the LSA into the RSA. This is due to the small footprint of the Project and relatively small change in groundwater discharge, which results in a very small change in surface water levels in Whitefish Lake during all Project phases.

Project residual effects on the Groundwater VC (quality) relate to changes (increases) in constituent concentrations in groundwater during all Project phases, and the associated change in loadings of these constituents to local receiving environments. Such changes are predicted to be negligible to low in magnitude and limited to the LSA. For example, during Construction, there are no activities expected to interact with the Groundwater VC (quality). During Operation, engineering measures will be in place to mitigate any changes to water quality. Following Decommissioning and the restoration of groundwater flow patterns that are similar to pre-mining conditions, changes to groundwater, limited to the LSA, do not extend to the RSA.

The Project is situated approximately 35 km (straight distance) northeast of the Key Lake Operation, 35 km southwest of the McArthur River Operation, and 85 km southwest of the Cigar

Lake Mine. These projects do not spatially overlap with the Project LSA and are not further considered under cumulative effects.

7.7.1 Climate Change Considerations

Climate change was evaluated qualitatively for the Geology and Groundwater VCs. Climate change is not anticipated to affect subsidence; therefore, the Geology VC is not anticipated to be affected. With regards to the Groundwater VC, climate change may affect the overall hydrological water balance for the Project. As discussed in Section 8.1.3.3 in Section 8, several parameters influence the water balance for the Project, including mean annual temperature, surface wind speed, total precipitation, and snow depth. Mean annual temperature and surface wind speed affect evaporation while total precipitation and snow depth affect local runoff. In a scenario of increased precipitation and decreased or constant evaporation, climate change may result in greater flows in the Wheeler River drainage system (see Section 8.1.7.6 in Section 8) and increased recharge to groundwater. The 3D hydrogeological model for the LSA shows 99% of local recharge remains within the shallow groundwater system (Potential Effect #1: Groundwater Quantity – Construction to Decommissioning (General Activities 7.4.2.1). The consequences would be increased discharge to Whitefish Lake, combined with an increase in available water inputs to the lake from additional precipitation, and subsequent runoff with more water available for dilution. Groundwater quality discharging to Whitefish Lake would be similar or improved under this climate change scenario compared to the EA case.

Quantification of the effects of climate change were not specifically addressed because the case of reduced groundwater recharge (i.e., the most relevant parameter which could change within the groundwater flow system), and thus a lower driving force for transport, was considered less conservative than the scenarios tested.

Overall, the cumulative effects on the Groundwater VC from climate change are predicted to be minimal.

7.8 Monitoring and Follow-up

For the purposes of this EIS, monitoring and follow-up are defined as follows:

- monitoring programs are designed to meet regulatory requirements (e.g., permit or license conditions) and/or to demonstrate compliance with environmental commitments made in the EIS; and
- follow-up programs are designed to address any uncertainties identified during the EA process (e.g., to verify predictions made during the EIS; to determine the effectiveness of proposed and implemented mitigation measures) and to determine if and when to implement adaptive management measures.

7.8.1 Monitoring of Surface Terrain

Subsidence at ground surface within the wellfield will be evaluated from Construction through to Decommissioning by monitoring the elevation of collars (top of pipe) for wells within the wellfield.

Additional details include the following:

Initial wellfield construction primarily consisting of earthworks to level the pertinent wellfield phases will be guided by Lidar surveys to provide a consistent datum prior to the installation of any well type (monitoring, injection, recovery, freeze) within the wellfield.

The subsequent installation of any well type is located on a ‘easting’ and ‘northing’ basis guided by a differential global positioning system (DGPS) with accuracy of within 5 cm. Although DGPS systems can measure a point in the vertical or ‘Y’ direction with a comparable level of accuracy to the ‘X’ and ‘Y’, the vertical datum of any installed well will be further validated by use of stadia rods, which have accuracy to within 5 mm.

The top of collar elevation of all newly installed wells will be measured to a known datum located off the wellfield. As part of annual inspections well collar elevations will be measured on a regular basis and recorded relative to the prior years’ measurements to determine the degree (if any) subsidence occurring within the well itself that may be attributable to sloughing or shifting of a well at depth. Measurements of the well collar elevations are a surveying industry standard tool for determination of any vertical movement within a well itself.

Satellite system’s such as InSAR may be utilized to complement the stadia rod measurements on an as needed basis; however, due to the negligible subsidence (<10 mm) anticipated the system is envisioned to have its limitations with emphasis and reliance placed on site specific measurements.

The proposed monitoring program, as conceptually described above, will be documented more formally as part of the overall operations management program prior to establishment of the well field. The monitoring program will include a contingency plan whose objective would be to facilitate the timely identification of, and response(s) to, potentially emerging conditions whereby routine monitoring data indicate performance is not meeting expectations (e.g., levels of subsidence are outside the range of expectations). The contingency plan conceptually would identify performance objectives, key performance indicators and measurement endpoints, triggers that would describe conditions, when met, where a response is required and a tiered-response plan in which an emerging issue would be confirmed (or not), with successive levels of response, including investigation of cause and risk, investigation of strategies to mitigate risk and implementation of preferred risk mitigation.

7.8.2 Groundwater Monitoring

The Project has the potential to directly (through the ISR process) or indirectly influence groundwater quality and/or quantity near the Project Area. Groundwater conditions will be monitored extensively prior to, during, and post Operation. A detailed Groundwater Protection and Groundwater Monitoring Plan will be provided for the Project. The GWMP will be informed by the understanding of existing groundwater conditions at the Project Area (Appendix 7-A), the reactive transport modelling of groundwater COPCs associated with the restored mining area (Appendix 7-C), and the commitments made within the Geology and Groundwater section of the EIS.

Groundwater protection and groundwater monitoring programs are mandatory components of the CSA N288.7:15 standard *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills* (CSA 2015). The GWMP is a 'living document' that will be adapted and updated as required to achieve the level of environmental protection committed to in the EIS, over the life of the Project.

The requirements of the GWMP are to demonstrate, during each Project phase, that:

- excursions are not occurring; if excursions do occur, an early warning/timely signal will be provided of when and where they are occurring such that appropriate further evaluation and actions can be undertaken;
- commitments made in the EA are being achieved; and
- protection of groundwater end use/receiving environment is being achieved.

The groundwater well monitoring network and sampling plan will be flexible and adapted at each stage to identify any changes in groundwater quality and quantity associated with mining activities in a timely fashion. The spatial pattern of monitoring wells (i.e., well locations and density) and the sampling schedule will reflect the spatial and temporal distribution of COPCs, guided by anticipated operational conditions and by the range of constituent behaviours identified in the site-specific COPC fate and transport modelling. The monitoring system will be designed at each phase of the Project to provide adequate coverage of all hydrostratigraphic units.

The chemical and physical constituents to be monitored in groundwater include the COPCs provided in Section 7.6.2.1. Other major ion constituents of groundwater are also recommended (e.g., total alkalinity, bicarbonate, carbonate, sodium, magnesium, potassium, and calcium). Additional COPCs identified in association with surface facilities are nitrogen species (i.e., ammonium, nitrate, and nitrite) and volatile organic compounds.

Not all COPCs will be measured in groundwater at all sampling locations or during each sampling event. Higher priority will be given to some parameters that are KIs of site activity-related changes in water quality. Constituents to be considered as key performance indicators in groundwater are listed in the following bullets. The first three may be considered for continuous measurement.

- Hydraulic response – The mining fluids are injected at operating pressures that exceed ambient subsurface pressures. Changes in hydraulic head (or the hydraulic response) is a very sensitive measure to changes in pressure. A hydraulic response would be interpreted to indicate fluid movement between the mining chamber and the observation point and may indicate that an excursion has occurred.
- Temperature – Ambient groundwater temperatures in the Lower Sandstone Aquifer are expected to be less than 10°C. The temperature of the mining fluids is expected to exceed these temperatures to some extent (on the order of 10°C) due to reactions between the ore and the fluids. An increase in temperature may indicate that an excursion has occurred.
- EC – The mining fluids have high total dissolved solids and associated EC/specific conductance. The specific conductance of the mining fluids is expected to exceed 15,000 µS/cm, whereas the maximum specific conductance in groundwater in the overlying Lower Sandstone Aquifer is approximately 1,000 µS/cm (Appendix 7-A). An increase in EC may indicate an excursion has occurred.
- pH – The mining fluids are expected to have a pH less than 2. Groundwater pH values are circumneutral (pH ranges from 6.3 to 7.5). A change in pH to more acidic values (less than 6) may indicate an excursion has occurred.
- ORP – The mining fluids are expected to have an ORP that is very oxidizing (greater than 400 mV). The groundwater is anoxic and has ORP values that are typically less than 150 mV. An increase in ORP may indicate an excursion has occurred.
- Sulphate – The primary chemical in the injected fluids is sulfuric acid. During metallurgical testing completed for the Project to date, sulphate concentrations in the leachate exceeded 40,000 mg/L. Concentrations of sulphate in groundwater may be influenced by interactions with other groundwater/mining fluid constituents; however, elevated concentrations of sulphate may indicate an excursion has occurred.
- Dissolved uranium – Mobilized uranium in the injected fluids may reach concentration orders of magnitude higher than in groundwater. Should an excursion occur, it is important to understand the associated dissolved uranium concentration.

One additional parameter, chloride, has been included as a key parameter. It is possible that mobilized chloride concentrations are higher in the injected fluids than in groundwater; however, this is not the primary intent of including this parameter in the routine monitoring. Rather, calcium chloride brine makes up fluids that maintain the freeze wall. Thus, a change in the concentration of chloride - and EC - may indicate that a loss of freezing capacity has occurred in the freeze wall, representing an excursion, and delineate the extent of brine migration. However, loss of freezing is considered as an accident and malfunction, and loss of freezing is expected to be signaled much earlier by operational monitoring (e.g., pressure changes in the cooling circuit) than through monitoring of water quality.

In addition to the above parameters, tritium concentrations will also be measured in groundwater to further analyze the potential to age groundwater in the subsurface.

The list of parameters being analyzed at any given location and time will be rationalized in the GWMP for each Project phase and each Project area (e.g., surface facilities versus mining area versus freeze wall perimeter).

7.8.2.1 Surface Facilities

Excursions associated with surface facilities are changes in groundwater flow conditions or groundwater quality that represent Project design failure. Such failures include spills, leaks, or uncontrolled leachate from ponds and landfills that may cause changes to the shallow groundwater flow conditions and/or groundwater quality.

A groundwater monitoring network will be developed to monitor groundwater conditions upgradient, on the perimeter, and downgradient of the surface facilities outlined in Table 7.4-7. Surface facilities do not extend more than approximately 4 metres below ground surface (mbgs); thus, groundwater wells associated with the surface facilities will be shallow wells installed for the most part in the overburden materials. The monitoring well network can be built up over time in alignment with construction and operation of the facilities. Sufficient time will be given prior to Operation to collect baseline samples at each location. Because baseline conditions in shallow groundwater have been established (Appendix 7-A), the objective of collecting baseline samples from wells in the surface infrastructure groundwater monitoring well network is to confirm that conditions are aligned with those understood from baseline conditions. Samples collected from the surface facilities groundwater monitoring wells prior to Operation should be collected on two occasions, and preferably in two seasons.

During Operation, groundwater will be monitored across the monitoring network and samples submitted to an accredited laboratory for analysis of the full suite of COPCs or for KI parameters. Sampling frequency will be at least semi annually, and may be more frequent in wells surrounding specific facilities.

During Decommissioning, shallow monitoring wells associated with decommissioned surface facilities will be abandoned in accordance with provincial well abandonment legislation. Facilities retained on site, and their decommissioned configurations, include:

- the industrial landfill containing low-level (as defined by the Canadian Nuclear Safety Commission) radiological waste contamination, which will have an engineered cover installed to limit water infiltration into the industrial wastes; and
- the material (primarily gypsum) in the Industrial Wastewater Treatment Plant precipitate pond, which will be covered and decommissioned in place.

Monitoring wells upgradient, on the perimeter, and downgradient of these facilities will be retained to demonstrate chemical stability of groundwater surrounding and downgradient of these facilities after the covers have been placed. Groundwater quality associated with these facilities will have been sampled relatively extensively during Operation. Thus, there will be a good understanding of the chemical stability prior to cover placement. It is expected that long-term chemical stability, post cover placement, will be demonstrated in two to three years of sampling on a seasonal (spring, summer, fall/winter) basis. Monitoring of these wells may extend into early Post-Decommissioning.

Response to potential excursions will follow the Excursion Contingency Plan provided in Section 7.8.2.3.

7.8.2.2 In Situ Recovery Mining area

7.8.2.2.1 Pre-Construction and Construction

The groundwater monitoring network for the Operation phase will be installed during pre-construction and Construction. Existing monitoring wells will be used as much as possible, but it is anticipated that several new wells will be installed to meet monitoring needs. During pre-construction and Construction, existing/baseline conditions will be established in each well under pre-Operation conditions. As such, data collected are supplemental to the baseline conditions understood for the Project (Appendix 7-A). Supplemental data are anticipated to include:

- additional spatial coverage of baseline conditions within the active mining area; and
- additional data for water quality within the Desilicified Zone Aquifer.

A follow-up study is recommended to supplement the available data on hydraulic conductivity in the Desilicified Zone. Pumping tests, minimally 48-hours long, are recommended in wells on the freeze wall perimeter that are completed within desilicified sediments of the Lower Sandstone Aquifer and Intermediate Sandstone Aquitard. Additional commitments related to the Desilicified Zone include:

- assessment of vertical hydraulic conductivity;
- quantification of horizonal and vertical flow gradients; and
- identification and mapping of any structures with the potential to influence groundwater flow in the DSZ, such as fractures/fault zones.

7.8.2.2.2 Operation

The groundwater monitoring network during Operation will focus on groundwater conditions within and on the outside perimeter of the freeze wall, and evaluation of changes in groundwater quality including detection of excursions from potential loss of freezing capacity. The monitoring well network within and surrounding the freeze wall is shown at a conceptual level in Figure 7.8-1.

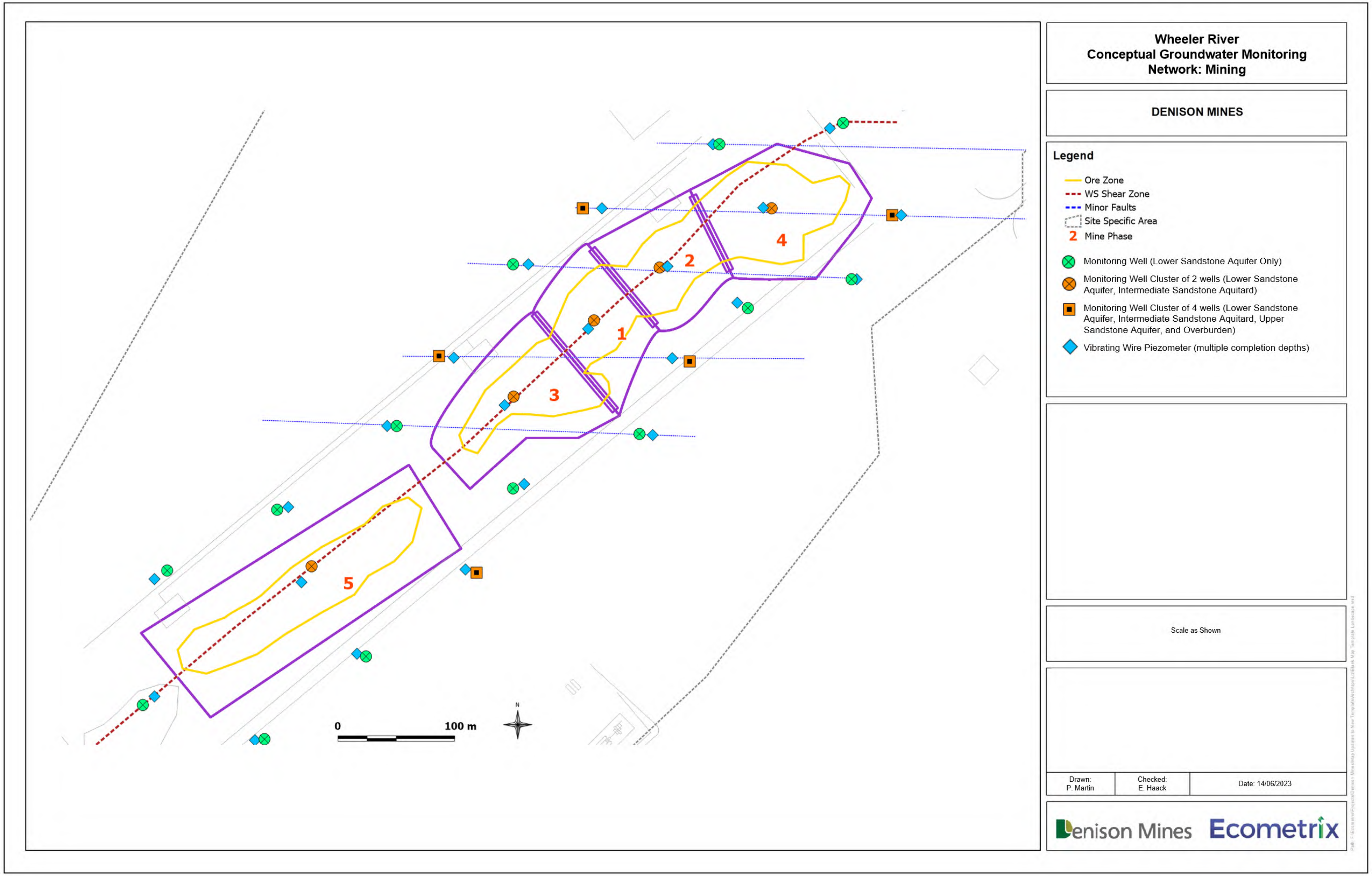

Figure 7.8-1: Conceptual Groundwater Monitoring Network – Mining

Positioning of wells for the conceptual groundwater monitoring network within and surrounding the freeze wall during the Project phases will reflect precedent from other ISR mining projects (NRC 1997, 2006; Mackin et al. 2001), which includes one well per 1.2 to 2 ha (1 ha = 10,000 m^2) within the mining area. A frequency of one well per Project phase, as shown in Figure 7.8-1, is aligned with this and results in a greater number of wells than the precedent. The maximum spacing between monitoring wells around the freeze wall perimeter will be no more than 125 m (as proposed) and will not exceed 150 m.

The wells around the perimeter of the freeze wall will be positioned 20 m from the expected outside perimeter of the freeze wall. This distance was selected because:

- a response to changes in water quality from the mining area/freeze wall in the perimeter wells will be dependent on the effective porosity but is reasonably expected to occur within 8 to 10 years (this estimation reflects the geomean hydraulic conductivity of the Lower Sandstone Aquifer and Desilicified Zone [i.e., 2.2×10^{-6} m/s and 4.8×10^{-6} m/s, respectively; Appendix 7-A]); and
- it is as close to the freeze wall as is considered advisable to represent undisturbed/ambient conditions.

The conceptual monitoring network consists of four types of installations:

- vibrating wire piezometers (VWP);
- multi-level wells or well nests/clusters of four groundwater monitoring wells;
- multi-level wells or well nests/clusters of two groundwater monitoring wells; and
- single interval groundwater monitoring wells.

Around the outside perimeter of the freeze wall, monitoring wells will generally target the Lower Sandstone Aquifer (single interval groundwater monitoring wells) as this is the most likely unit through which mobilized COPCs may migrate laterally from the mining area. In all monitoring locations, monitoring/sampling wells will be coupled with adjacent vibrating wire piezometers. The VWPs are intended to provide early warning of potential excursions by signaling any pressure changes outside the freeze wall. Adjacent to each mining Phase, the monitoring well plan also includes a cluster of four monitoring wells, wherein multiple elevations will be monitored at discrete intervals to observe any changes vertically above or below the elevations of the active mining area.

Within the footprint of each Project phase, vertical sets of wells (i.e., well clusters) and VWPs will be utilized to monitor vertical pressure changes and potential upward COPC migration. Vibrating wire piezometers will be designed to have multiple completions with depth to monitor pressure variability between the active mining area and the overlying strata.

The proposed monitoring network does not include wells installed within the ore zone within the basement aquitard, including the upper paleoweathered zone. The underlying basement rock has very low hydraulic conductivity (Table 7.3-2) that will act to limit the downward vertical migration, but severely limit the capacity of the rock to yield water for sampling. Despite the low hydraulic conductivity, the fluids injected during mining are characterized by a high density and specific gravity (greater than sea water) and have the potential to migrate downward to the base of the paleoweathered zone. Vibrating wire piezometers will delineate the pressure front in the aquitard. Should the potential for an excursion be identified through monitoring of the pressures, the process for excursions (Section 7.8.2.3) will be followed.

Per the monitoring wells and VWPs proposed in the mining area and the freeze wall perimeter are, for the most part, located along the WS Shear zone or minor faults. The placement of these wells along these features will make sure that changes in groundwater flow conditions and water quality along possible preferential pathways are being monitored.

Sampling will focus on KI parameters. Some key parameters, including hydraulic response, temperature, and EC, have been selected for continuous measurement. The VWPs measure hydraulic response and temperature. Electrical conductivity probes are proposed to be deployed at least within a subset of wells within the freeze wall and on the freeze wall perimeter. Groundwater samples will be collected at least monthly and semi-annually in the wells within the freeze wall and on the freeze wall perimeter, respectively.

7.8.2.2.3 Decommissioning

The focus of the groundwater monitoring network during Decommissioning is demonstrating groundwater remediation within the mining area to meet Decommissioning objectives and continued monitoring on the outside perimeter of the freeze wall. The groundwater monitoring network inside the freeze wall during Decommissioning has been developed conceptually and is shown in Figure 7.8-2. Outside of the freeze wall, the network of freeze wall perimeter wells and the sampling schedule will be similar to that established during Operation.

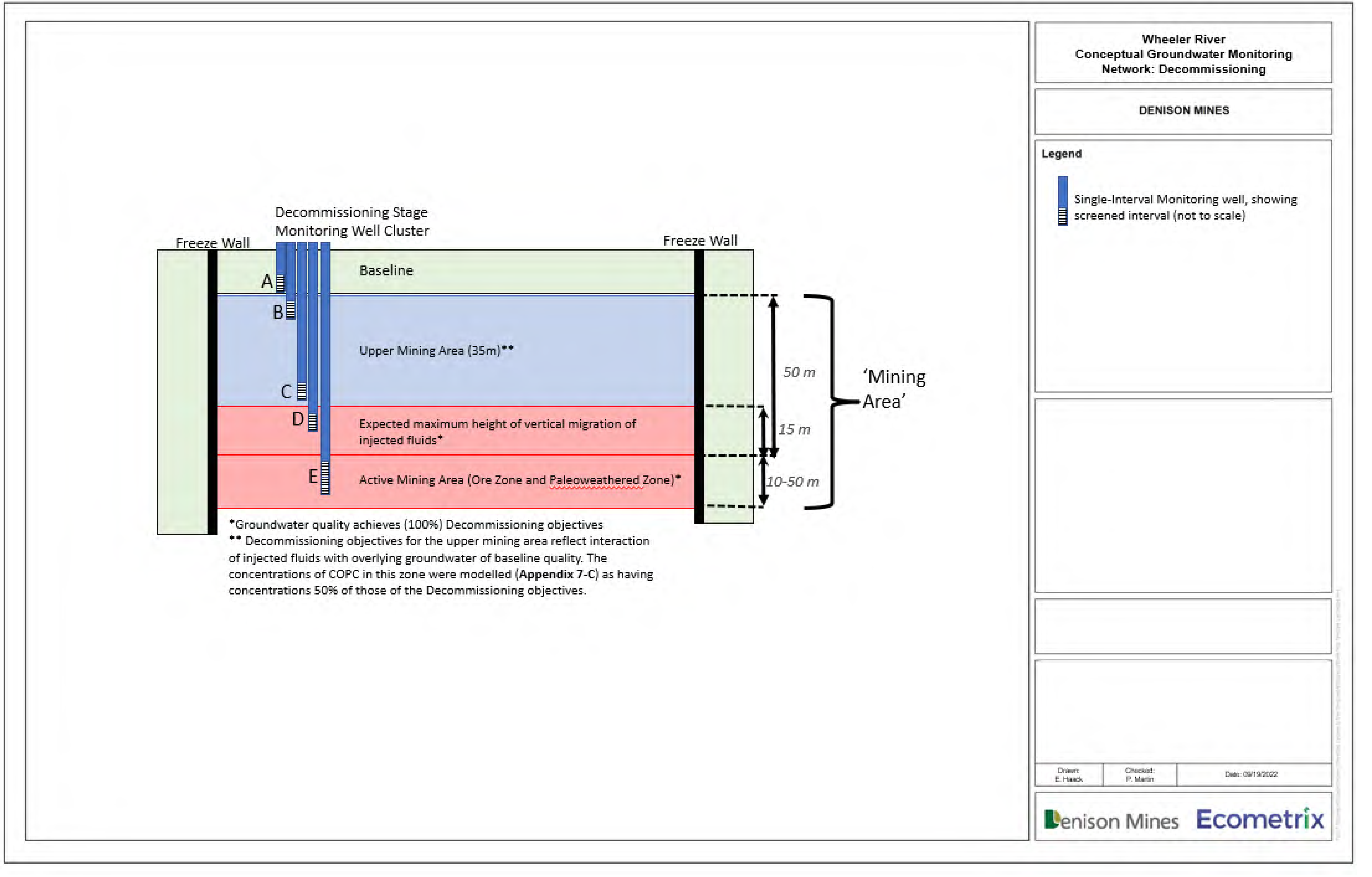

Figure 7.8-2: Conceptual Groundwater Monitoring Network – Decommissioning

At least five to seven multi-well clusters are proposed across the mined area (Figure 7.8-2). Sampling will include KI parameters or the full suite of COPCs at different times in the remediation process.

Within the freeze wall, two wells will be positioned within the active mining area to monitor conditions towards the base (well 'E') and towards the upper extent of the active mining area (well 'D'). Two wells will be positioned within the upper mining area towards the base (well 'C') and the upper extent of the zone (well 'B'). A well will also be positioned immediately above the upper mining area (well 'A') to confirm baseline water quality above the mining area.

Sampling of water quality of the water produced in the active mining area over the entire remediation process will be frequent (at least weekly) to allow the remedial approach to be adapted as required on a spatial-temporal basis. Sampling of the wells in the upper mining area and overlying Athabasca Sandstones will be seasonally during the first three years of Decommissioning and potentially more frequent during the later two years of Decommissioning to demonstrate chemical stability.

Groundwater quality is not expected to be uniform across the monitoring wells installed in the same area; for example, groundwater quality in 'D' wells across the mining area will not be uniform. As such, meeting the acceptable Decommissioning objectives will be based on statistically demonstrating that the water quality in each zone meets acceptable target values with associated levels of uncertainty (i.e., central tendency and 95% confidence intervals) and is stable over sufficient time for there to be confidence that conditions will not change.

Where possible, groundwater monitoring wells installed above the ore zone during Operation will be used for monitoring during Decommissioning. New wells will be installed as needed.

7.8.2.2.4 Post-Decommissioning

After groundwater remediation within the mining area has been completed, the freeze wall will be turned off and allowed to thaw. This will allow the eventual re-establishment of the pre-operational groundwater flow regime in the former mining area. The post-decommissioning period will extend from the end of physical decommissioning until transfer of the site into the provincial Institutional Control Program (Government of Saskatchewan 2009) or direct release of the land back to the Crown.

The primary objectives during Post-Decommissioning are to demonstrate that:

- the pre-operational flow conditions have been re-established; and
- chemical stability has been achieved.

During Post-Decommissioning, the monitoring well network will be developed (within and outside the freeze wall) and will require an augmented well network beyond the outer perimeter of the freeze wall. The highest density of wells will continue to be within the mining area, reflecting the extensive monitoring in that area during Decommissioning. The density of the freeze wall perimeter wells may need to be augmented to increase the number of clusters/multi-levels, such that there is adequate coverage of the Intermediate Sandstone Aquitard. Furthermore, a small number of additional clusters will be required in the inferred downgradient direction (i.e., to the northeast) beyond the freeze wall perimeter wells. These wells will be completed primarily in desilicified sediments of the Lower Sandstone Aquifer and Intermediate Sandstone Aquitard.

To the southwest of the freeze wall perimeter wells and further downgradient to the northeast, there will be a zone of intermediate density wells where well clusters will be positioned no more than 200 m apart along the predicted plume path, and plume delineation wells will be offset from that path in both directions. Numerical groundwater modelling simulations (Appendix 7-C) suggest that lateral migration will be limited, such that monitoring 100 m beyond the plume path will be sufficient to delineate the plume. In the upgradient direction, well clusters in the intermediate density zone will be completed in the Lower Sandstone Aquifer and Intermediate Sandstone Aquitard. In the downgradient direction, well clusters will be completed in desilicified sediments of the Lower Sandstone Aquifer and Intermediate Sandstone Aquitard, and in the Upper Sandstone and Overburden Aquifers.

Further southwest and beyond Whitefish Lake in the downgradient (northeast) direction will be low density (regional) groundwater monitoring zones. Existing regional (GWR-series) wells will be used where possible. Well clusters will monitor the Lower Sandstone Aquifer, Intermediate Sandstone Aquitard, Upper Sandstone Aquifer, and Overburden Aquifer. Well clusters will be positioned to delineate any influence of mining activities on water quality.

The groundwater constituents being measured and the frequency of sampling of wells in the Post-Decommissioning groundwater network will be identified in future iterations of the GWMP. Over the life of the Project, predictions of the assimilative capacity of the subsurface and associated migration potential for COPCs will be refined through updated reactive transport modelling. These will guide the specific details of the Post-Decommissioning GWMP.

7.8.2.3 Excursion Contingency Plan

The overall objective of the Excursion Contingency Plan as part of the GWMP is to facilitate the timely identification of, and response(s) to, potentially emerging conditions (excursions) whereby routine monitoring data indicate environmental performance is not meeting expectations.

During each mining stage, excursions signal that performance expectations are not being met.

- Mining and Decommissioning Stages:
  - Excursions are signaled by a change in water quality in specific wells compared to baseline conditions. These include wells on the perimeter and downgradient of surface facilities, the freeze wall perimeter wells, and wells within the freeze wall overlying the mining area.

  - A change in water quality is defined as an upward trend in a COPC concentration (or KI value) over a meaningful period above that statistically established as the background or baseline concentration. The upward trend is identified based on a suitable statistical test, such as the Mann Kendall Test.
- Post-Decommissioning Stage:
  - Excursion are signaled by a change in water quality that is outside of that bounded by modelling predictions.
    - The model predictions spatiotemporally bound COPC concentrations in the subsurface that do not pose a risk to the receiving environment. Water quality that is outside of this bounding is defined as representing a material increase over a meaningful period compared to the predicted values either in rate of change or magnitude of change of COPC concentrations.

In the previous statements, a meaningful period refers to an appropriate number of sampling intervals. The number of sampling intervals defining a trend above control limits (baseline conditions or modelling predictions) that is considered appropriate will depend on the frequency of sampling and the location of the wells, and will be defined in the GWMP.

An excursion, signaled in the manner previously described, triggers a response. The response plan is tiered and involves confirmation of an excursion with successive levels of response, including:

- investigation of cause and risk;
- investigation of strategies to mitigate risk; and
- implementation of preferred risk mitigation.

The GWMP will provide details regarding the aforementioned investigative and mitigative actions. The actions are summarized in the following levels:

Level 1 – Confirmation of Validity of the Sample Results

In Level 1, the objective is to confirm the validity of the results signaling the excursion. This will be done through review of QA/QC information that was collected coincident with the results signaling the excursion. These data are assessed to determine whether there are issues with the sample result, such that the result is considered to be accurate or not. The laboratory would also be consulted in order to confirm the accuracy of reporting.

In instances where sample results are validated, Level 2 actions are implemented; conversely, if the data cannot be validated, it may be appropriate to re-sample and increase sampling frequency to confirm the results, or to end the inquiry and return to routine sampling.

For reference, validation of the results for individual sampling events will be carried out upon receipt of those data since follow-up activities associated with validation may be time sensitive, and also to make sure that implementation of Level 2 actions, when appropriate, is done in a timely manner. Such follow-up activities could include, beyond confirmation of sampling and laboratory QA/QC, the re-analysis of samples by the laboratory or re-sampling.

Level 2 – Investigation of Cause and Risk

An investigation to confirm that the observations signalling an excursion are related to Project activities and to determine the potential cause will be initiated. The investigation could take many forms but ultimately the investigation should identify a causal mechanism to confirm that the sample results are related to mining activities or surface facilities. In addition, consideration of the results within a temporal context will be undertaken to understand the extent to which future change might be expected. Such an analysis supports the assessment of risk, as described below.

Risk associated with the confirmed Excursion Contingency Plan trigger should be described. Risk in this context is risk to surface water quality and biota. The characterization of risk is meant to contribute to decision making for next steps, with respect to both scope and timing.

The nature of the Level 2 response is likely to vary depending on the result and level of investigation required; as such, the response times may vary (e.g., one to several months) but will be conducted in a timely manner. By way of example, in the instance that the investigation process identifies that the trigger exceedance is in fact site-related, follow up would be appropriate (see Level 3). Alternatively, enhanced monitoring or targeted studies could be recommended to reduce uncertainties, or in the case that the trigger exceedance is not site-related, it may be appropriate to return to routine monitoring.

Level 3 – Development of Strategies for Mitigation

Alternatives to mitigate the identified trigger exceedance will be considered. Mitigation measures associated with the protection of groundwater quality and quantity are outlined in Section 7.5. Other mitigation measures, likely to be primarily focused on reduction of constituent loadings and/or concentrations reporting to the environment, may also be developed and implemented. It is expected that the effectiveness of any mitigation alternative under consideration will be assessed quantitatively (to the extent possible), and that the assessment will include predictions about the degree of risk reduction expected. Criteria should be developed to assist in the selection of the preferred alternative.

The response time for a Level 3 response will be agreed upon in collaboration with appropriate stakeholders, including all applicable government ministries and regulatory authorities.

Level 4 – Implementation of a Preferred Mitigation Strategy

A plan to implement a preferred mitigation strategy would be developed in consultation with regulatory authorities and Interested Parties, as appropriate, pending the outcomes of Levels 1 to 3 of the Response Plan. Any regulatory permits/approvals that may be required will be obtained and any stakeholder and/or Indigenous consultation obligations will be fulfilled.

Monitoring plans will be developed to track the environmental response in relation to the implementation of the preferred mitigation strategy. In many cases, the monitoring needed to track environmental response following mitigation will already be in place as part of routine monitoring programs. In some cases, minor revisions to routine monitoring programs may be required, whereas in other cases, it may not be possible to adequately assess the success of abatement actions through routine monitoring. In these cases, additional special studies will be needed. The details of these special studies will be documented.

The response time for a Level 4 response will be agreed upon in collaboration with appropriate stakeholders, including all applicable government ministries and regulatory authorities.

7.9 Geology and Groundwater Summary

This subsection of the EIS was completed to understand and characterize the potential residual effects of the Project and foreseeable developments on the physical aspects of the Geology and Groundwater VCs. The spatial and temporal boundaries for the Geology and Groundwater VCs were similar and were chosen as they permitted the description of existing and potential future conditions in sufficient detail to allow potential Project-VC interactions and potential effects to be identified, understood, and evaluated.

Geology

Geology includes bedrock, soils, and geomorphology (i.e., the study of physical features on the earth and their relationship to underlying geological structures). The Geology VC is recognized as an important component of the environment that may be affected by the Project, and changes to Geology could in turn lead to effects on other VCs selected for assessment. For example, terrain morphology dictates landscape function, such as surface drainage patterns, and reflects the underlying surficial (geological) materials. Changes to terrain morphology can affect and use economic activity and biological functions in proximity to the Project.

Acknowledging that changes to Geology are important aspects of the natural and human environment, the Geology VC was referred to as an intermediate VC (i.e., it does not have an assessment endpoint). Changes to this intermediate VC were evaluated to facilitate the assessment of Project interactions with links to other disciplines for inclusion in their assessments, including Groundwater, Terrestrial Environment, and Land and Resource Use.

Geological conditions, in terms of rock and mineral composition stratigraphy (i.e., how geological materials are arranged in sequence with depth/spatially) and structural components (i.e., faulting and fracturing), are well understood based on Project-specific and regional information. The overall Project Area and Operation have been designed to limit disturbance to the natural geological environment outside of the immediate mining area. One component of the Geology VC assessment focused on subsidence at ground surface associated with consolidation of rock mass (ore) at significant depth (approximately 400 m) below ground, from within the mining chamber. The assessment predicted negligible change in ground elevation of 2-3 mm within a discrete and localized area of the Project Area. This minor change is likely not to be measurable and is likely within the bounds of other routine operational surface disturbances. Beyond subsidence, changes in hydraulic conductivity localized to the mining area anticipated to be associated with ISR mining were evaluated as part of the assessment of potential effects on groundwater quantity and quality (Section 7.6.2.2.3).

As part of mining operations, detailed monitoring activities will be completed to assess the performance of various components of the Project associated with engineering mining designs, subsidence, performance, and infrastructure designs to protect the Geology VC. Subsidence at ground surface within the wellfield will be evaluated from Construction through to Decommissioning by monitoring the elevation of collars (top of pipe) for wells within the wellfield. Monitoring will be undertaken to evaluate any vertical displacement at ground surface, and the monitoring program will include a contingency plan should conditions with respect to subsidence not meet expectations (e.g., levels of subsidence are outside of range of expectations) (Section 7.8.1).

Groundwater

Groundwater is an integral component of the hydrologic cycle and is considered an important environmental component and pathway to the Surface Water Quality VC. Groundwater was selected as a VC for assessment because it is important in maintaining ecological habitats through its influence on the hydrology and water quality of surface waterbodies, including wetlands. Indigenous Knowledge and engagement activities clearly identified the importance Interested Parties place on groundwater as a pathway to surface water, and the associated potential for changes in groundwater inputs to surface water to influence fish and fish habitat, sediment quality, vegetation, wildlife, human health, and Indigenous land and resource use (Section 7.2). Groundwater includes domestic, commercial, and industrial water supplies, and the groundwater component of freshwater ecosystems, including stream flow, wetlands, and surface waterbodies. As supported by comments and concerns provided by Interested Parties and informed by IK, maintaining groundwater quality and quantity is important for maintenance of surface water quality and health and the shared value of water and its life sustaining properties (see Section 7.2).

Within the LSA, the Groundwater VC was considered an intermediate VC as it is a pathway to the aquatic environment. As an intermediate VC, the Groundwater VC does not have an assessment endpoint.

The overall Project Area and Operation have been designed to limit disturbance to the natural groundwater environment outside of the immediate mining area. Specific and standard mitigation measures will be employed to eliminate, reduce, or control the potential residual effects of the Project on groundwater quantity and quality and protect discharges to local surface waterbodies. Examples of mitigation measures include the use of liners and effluent collection systems at landfills and pads; the establishment of freeze walls before mining operations to hydraulically isolate the mining area; and remediation of groundwater quality within the mining area during Decommissioning to appropriate levels (i.e., Decommissioning objectives).

To carefully evaluate how residual mass of COPCs dissolved in groundwater may interact with the environment after remediation of groundwater in the mining area, a rigorous numerical model of groundwater flow and chemical COPC behaviour along the groundwater flow path was used as a predictive tool. The model is founded on proven scientific principles and processes (e.g., groundwater flow, contaminant transport, and geochemical reaction processes) and allowed future conditions to be evaluated. The results of the numerical model support the conclusion that with the implementation of appropriate mitigation, the potential effects of the Project on the Groundwater VC are not expected to cause adverse residual effects. Dissolved COPCs are predicted to migrate varying extents along the groundwater path between the mining area and Whitefish Lake, with constituents that do not interact with the solid matrix predicted to arrive within approximately 400 years. Concentrations of COPCs were predicted to remain at levels that would not result in environmental risk.

Over the life of the Project, groundwater quantity and quality monitoring activities will be completed to assess the performance of various components of the Project associated with engineering mining designs and performance and infrastructure designs to protect the Groundwater VC. A groundwater monitoring plan, including an Excursion Contingency Plan, and measures for adaptive management will be implemented for the Project.

7.10 References

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Appendix 7-A Baseline Geology and Hydrogeology Report

See file “S7_App 7-A Baseline Geology & Hydrogeology Report_Wheeler River.pdf”

Appendix 7-B Engagement Database Summary – Geology and Groundwater

See file "S7_App 7-B Geo&Groundwater Engagement_Wheeler River.pdf"

Appendix 7-C Numerical Modelling: Post-Decommissioning Evaluation

See file “S7_App 7-C Modelling_Post-Decommissioning Evaluation_Wheeler River.pdf”

Denison Mines

Wheeler River Project

Final Environmental Impact Statement

July 2024

Powering
PEOPLE, PARTNERSHIPS AND PASSION.

Wheeler River Project

Final Environmental Impact Statement

Section 8 – Aquatic Environment

October 2024

Denison Mines

Denison Mines Corp.

345 4th Avenue South

Saskatoon, SK, S7K 1N3

Roadmap

This roadmap of the Wheeler River Project Environmental Impact Statement (EIS) has been provided to summarize the main document sections and appendices of the EIS.

Wheeler River Project
Environmental Impact Statement

Executive Summary

PART I: INTRODUCTION AND CONTEXT
- Section 1: Project Introduction and Overview
- Section 2: Project Description
- Section 3: Indigenous and Local Knowledge
- Section 4: Engagement
- Section 5: Approach and Methodology of the Assessment

PART II: BIOPHYSICAL ENVIRONMENTAL ASSESSMENTS
- Section 6: Atmospheric and Acoustic Environment
- Section 7: Geology and Groundwater
- Section 8: Aquatic Environment
- Section 9: Terrestrial Environment

PART III: HUMAN ENVIRONMENT ASSESSMENTS
- Section 10: Human Health
- Section 11: Land and Resource Use
- Section 12: Quality of Life
- Section 13: Economics

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Abbreviations, Acronyms, and Units

Abbreviation / Acronym	Definition
CCME	Canadian Council of Ministers of the Environment
COPC	Constituents of potential concern
CWQG	Canadian Water Quality Guidelines
Denison	Denison Mines Corp.
DFO	Department of Fisheries and Oceans
EA	Environmental assessment
EIS	Environmental Impact Statement
ERFN	English River First Nation
HADD	Harmful alteration, disruption, or destruction
HQ	Hazard quotient
IDF	Intensity duration frequency
IK	Indigenous Knowledge
ISR	In situ recovery
IWWTP	Industrial Wastewater Treatment Plant
KI	Key Indicator
LK	Local Knowledge
LSA	Local Study Area
MDMER	Metal and Diamond Mining Effluent Regulations
MP	Measurable Parameter
PMP	Probable maximum precipitation
Project	Wheeler River Project
RCP	Representative concentration pathway
REF	Reference
RSA	Regional Study Area
SEQG	Saskatchewan Environmental Quality Guidelines
SVS	Shared Value Solutions
TOC	Total organic carbon
TSS	Total suspended solids
VC	Valued component
WTP	Water treatment plant

Units	Definition
°C	degrees Celsius
%	percent
Bq/g	becquerel per gram
Bq/s	becquerel per second
cm	centimetre
ha	hectare
kg	kilogram
km	kilometre
km^2	square kilometre
L	litre
L/s	litre per second
m	metre
m^2	square metre
m^3	cubic metre
mm	millimetre
m/s	metre to second
m^3/hr	cubic metre per hour
m^3/s	cubic metre per second
m^3/s/km^2	cubic metre per second per square kilometre
mg/kg	milligram per kilogram
mg/L	milligram per litre
mg/s	milligram per second
mGy/d	milligray per day
µg/g	microgram per gram
µm	micrometre
µs/cm	microsiemen per centimetre
y	year

Glossary

Term	Definition
Bathymetry	Measurement of the depth of water in rivers, lakes, or oceans.
Beach seine	A net deployed by hand or boat that, when retrieved, forms a tightening “U” that corrals fish to a common point.
Bedload movement	Granular particles at the sediment-water interface that are moved if the flow velocity is great enough to overcome gravity and resistance.
Benthic invertebrates	Organisms that lack an internal skeleton and inhabit the bottom of a waterbody, either on or in the sediment.
Braided streams	Multiple channels that branch and merge to form a characteristic braided pattern.
Canopy cover	Percentage of a study area shaded by riparian vegetation.
Effluent	Liquid waste discharged into a waterway.
Electrofishing	A fishing technique that produces a current of electricity at a set voltage between a submerged anode and cathode. This current generates an electric field and attracts fish; when fish enter the field, they become temporarily stunned.
Flat	Calm, level, or a slow-flowing water channel.
Gill net	A panel of vertical netting that traps fish.
Hydrology	Study of the distribution and movement of water.
Instream cover	Sheltered areas in a stream that could provide protection or refuge to aquatic organisms.
Macrophyte	A plant, typically aquatic, that is large enough to be seen by the naked eye.
Major earthworks	Engineering works created through processing parts of the earth’s surface (excluding ore extraction) that causes major disturbance to the land, or to the bed or subsoil under water.
Minnow traps	Small fish traps, usually composed of a mesh box or cylinder with two funnel-shaped entrances at either end.
Mixing Zone	An area of water contiguous to a point source or definable non-point source where the water quality does not comply with one or more of the Water Quality Objectives.
Overprinting	When a project is constructed on or over existing terrestrial or aquatic habitat.
Plankton	A diverse group of organisms that exist suspended in marine or freshwaters and are incapable of swimming against the current.
Pool	Deeper and wider area of a stream with a slower rate of flow.
Riffle	A shallow area in a stream with fast flowing water over rocks.
Riparian	Area located at the junction between land and a natural watercourse.
Run	Deep, faster flowing stream water with little to no turbulence.
Stream gradient	The slope of a stream’s channel measured by the vertical drop of a stream over a horizontal distance.
Thermocline	Thin but distinct layer between the warmer mixed surface water and the cooler deep water below.
Total Suspended Solid	Undissolved suspended particles, typically greater than 2 microns, in a water sample.
Voucher specimen	Preserved specimen serving as a record of and organism.
WGS84 datum	The World Geodetic System 1984 is a datum featuring coordinates that change over time.
Young-of-year	All fish of a species in a population that are less than one year of age.
Zone of influence	Spatial area receiving water flow within which some degradation or water quality or use impairment is anticipated to occur as a result of discharge.

8 Aquatic Environment

Section 8 of the Environmental Impact Statement (EIS) for the Wheeler River Project (the Project) is focused on the Aquatic Environment. The integrated biophysical and human environment assessment approach is illustrated in Figure 8-1. As a guide for EIS reviewers, Figure 8-2 provides a preview of the Valued Components (VC) associated with the assessments completed in this section of the EIS.

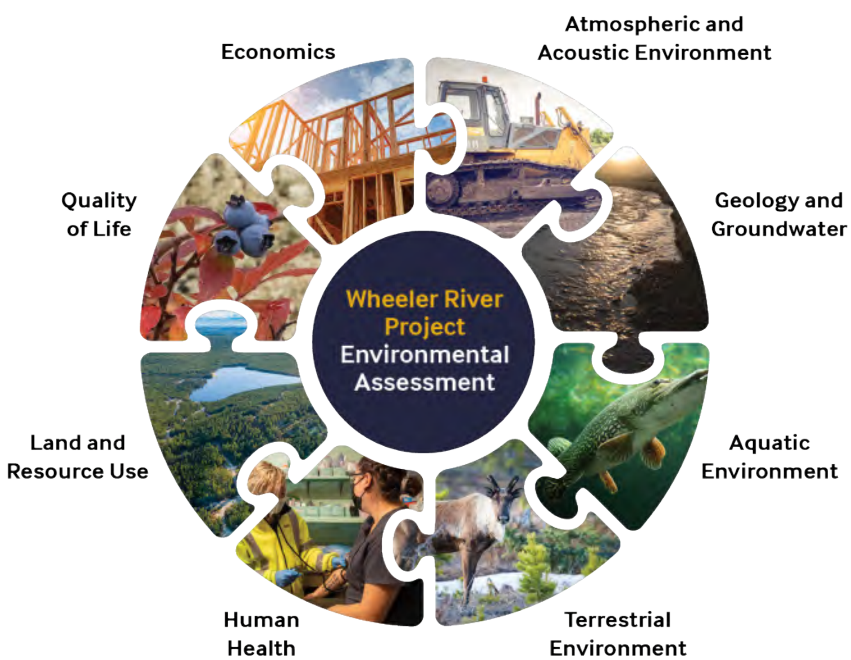

Figure 8-1: Biophysical and Human Environment Assessments for the Wheeler River Project Environmental Assessment

Figure 8-2: Aquatic Environment – Valued Components

8.1 Surface Water Quantity

This section addresses the potential effects of the Project on Surface Water Quantity (i.e., surface water hydrology) as a VC. The following are discussed herein as part of the environmental assessment EA:

- scope of the assessment;
- summary of existing conditions relevant to the Surface Water Quantity VC;
- identification and description of potential interactions between the Project and the Surface Water Quantity VC;
- identification and description of mitigation measures applicable to the Surface Water Quantity VC to eliminate, reduce, or control the potential adverse Project-related effects;
- identification and characterization of predicted Project-related residual effects on the Surface Water Quantity VC after mitigation;
- characterization of significance and assignment of the level of confidence in the predictions; and
- identification and characterization of potential cumulative effects.

Figure 8.1-1 is a graphic representation of the assessment process used in this EIS.

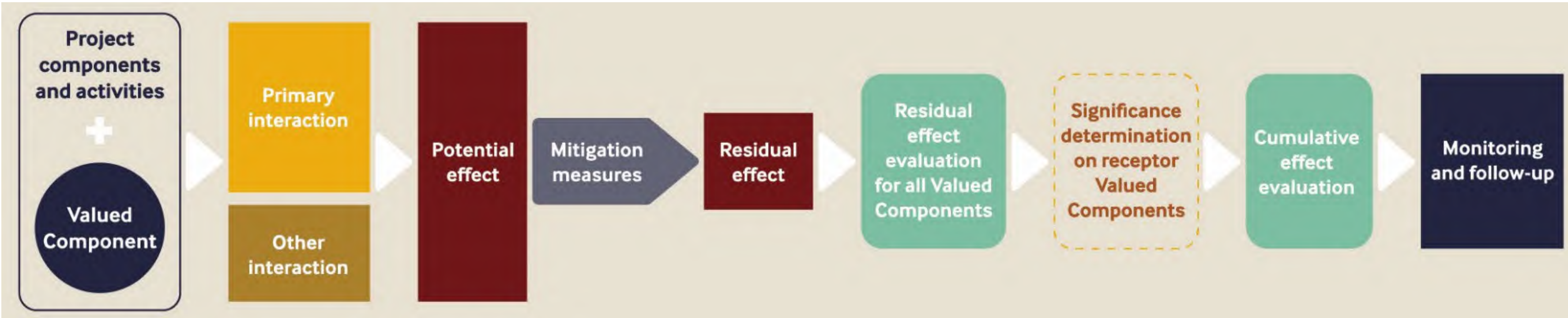

Figure 8.1-1: Environmental Assessment Process for the Wheeler River Project

8.1.1 Scope of the Assessment

The purpose of this assessment is to assess potential changes to hydrological conditions (as represented by the Surface Water Quantity VC) for all Project phases at the Project, local, and regional study areas scales. The Surface Water Quantity VC concerns hydrological parameters of interest, including flow regimes and water levels in watercourses and waterbodies within defined study areas. Key considerations of the assessment are associated with how Project activities such as, but not limited to, water taking activities, water discharges, and changes to drainage patterns could result in changes to hydrological conditions.

8.1.1.1 Valued Component Selection

The process and rationale for selection of VCs and establishment of Key Indicators (KIs) and associated Measurable Parameters (MPs) is described in Section 5 Approach and Methodology of the Assessment. Section 5.8.1.1 defines intermediate VCs and receptor VCs. This section addresses the Surface Water Quantity (hydrology) VC which is identified as an intermediate VC as it represents a physical medium and pathway of influence to biological and ecological receptor VCs. This section addresses the Surface Water Quantity VC, which was selected for inclusion as Project activities have the potential to affect existing surface drainage patterns. Potential changes to water, from both a quantity and quality perspective, are key considerations within the EA process, as demonstrated by previous uranium mining development proposals in the Athabasca Basin, and draw a high level of concern from Interested Parties (see Section 8.1.2). Changes to existing surface drainage patterns are directly and indirectly linked to several VCs and have the potential to influence water quality, biodiversity, and biological function (i.e., Fish and Fish Habitat, Benthic Invertebrates) and the cultural values of Indigenous groups, the public, and other stakeholders. In this context, Surface Water Quantity is interrelated or linked, to varying extents, to other VCs that are considered in this effects assessment, including:

Intermediate Valued Components

Surface Water Quality: Surface water flow volumes and periodicity directly influence the interface of waterbodies with their riparian zones (inundation) and the available assimilative capacity of water features, which can directly influence Surface Water Quality.

Groundwater Quantity and Groundwater Quality: Surface hydrology can influence hydrologic connectivity with groundwater sources, and vice versa.

Receptor Valued Components

Terrestrial Environment: Surface water interacts with various VCs to shape ecosystem form, function, and biodiversity, including Vegetation and Ecosystems and Wetlands (i.e., riparian and wetland vegetation); Terrain, Soils, Organic Matter/Peat; Ungulates, Furbearers and Woodland Caribou as well as Raptors, Migratory Breeding Birds, and Bird Species at Risk.

Fish and Fish Habitat: Surface water flows (i.e., water level [depth] and velocity) directly influence fish life histories and behaviours (i.e., spawning, migration, and overwintering) and food availability and health (i.e., benthic invertebrates, zooplankton, and phytoplankton).

Land and Resource Use: Indigenous Land and Resource Use and Other Land and Resource Use are influenced by seasonal flow regimes of surface waters and water levels with respect to navigation and fish harvest.

Figure 8.1-2 is a graphic representation of the main linkages among the Surface Water Quantity VC and other VCs, illustrating the flow of assessment information into and from the Surface Water Quantity VC.

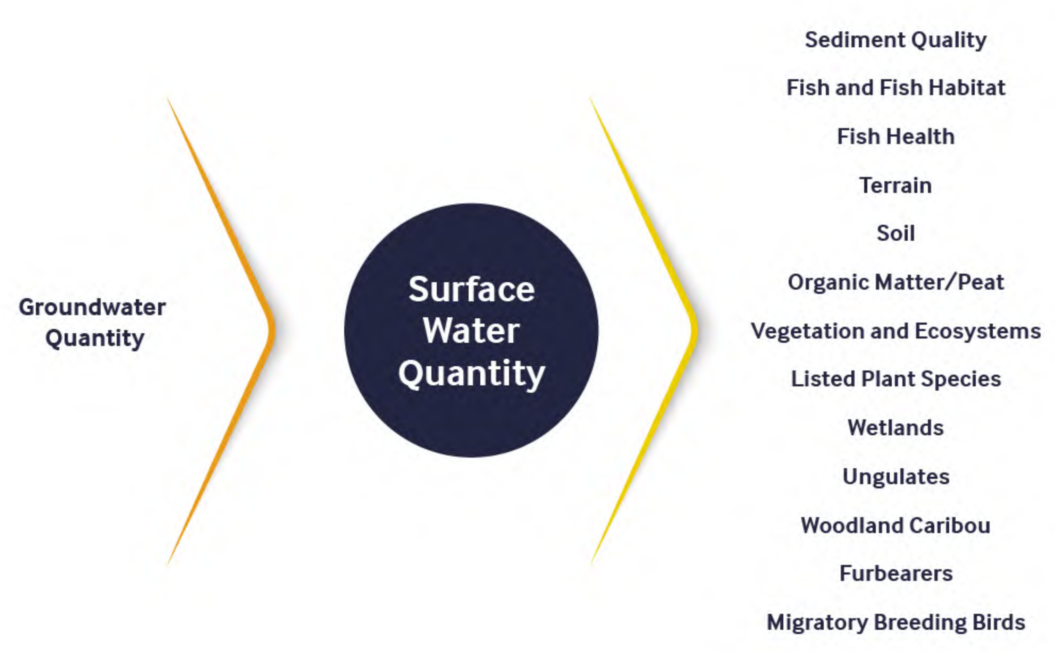

Figure 8.1-2: Integrated Assessment Approach - Key Connections between Surface Water Quantity and Other Valued Components

8.1.1.2 Key Indicators and Measurable Parameters

Key Indicators of change for the Surface Water Quantity VC include hydrometric metrics of surface water discharge (flow) and water level. Assessment of potential changes to discharge is investigated at average conditions and low flow conditions (i.e., the 5th percentile condition flow). The KIs and MPs for the Surface Water Quantity VC are summarized in Table 8.1-1.

Table 8.1-1: Key Indicators and Measurable Parameters for Surface Water Quantity

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Water level	Assesses the change in water level of waterbodies as a function of Project development. Water level is important as it is tied to discharge, water taking, and/or redistribution of natural flow patterns and is directly measurable in lake environments. Maintenance of water levels facilitates continued habitat for aquatic biota and navigation for resource users.	Water level in metres
Average monthly discharge (flow) (m^3/s)	Project activities will result in changes to the local hydrology. A reduction or increase in flows may result due to the elimination or redirection of subwatershed area and through Project water management (i.e., water taking, storage and effluent discharge). Changes to the average monthly discharge represents the typical effect that may be realized.	Percentage change to average condition flow (%)
5^{th} percentile monthly discharge (flow) (m^3/s)	Project activities will result in changes to the local hydrology. A reduction or increase in flows may result due to the elimination or redirection of subwatershed area and through Project water management (i.e., water taking, storage and effluent discharge). Changes to the low flow monthly discharge represents the bounding effect that may be realized with respect to environmental flows.	Percentage change to 5^{th} percentile condition flow (%)

8.1.1.3 Spatial and Temporal Boundaries

Generic considerations associated with the establishment of the spatial boundaries of the assessment are described in Section 5.3.3 in Section 5. As it pertains to the Surface Water Quantity VC, the following is noted.

- The **Project Area** is the direct footprint of the Project. The Project Area represents the area within which Project activities and components may occur and, as such, represents the area within which direct physical disturbance may occur as a result of the Project, either temporary or permanent (i.e., the area of maximum physical disturbance). This area is not VC-specific, but consistent throughout the EIS for all VCs.
- The **Local Study Area (LSA)** is the area that surrounds the Project Area where both direct and indirect effects resulting from Project activities can be reasonably measured. The LSA was established to assess the potential, largely direct effects of the Project and represents the extent to which there is a reasonable potential for the Project or Project-related activities to interact with and potentially adversely affect the VC. For the Surface Water Quantity VC, the LSA was derived from watershed boundaries within proximity of the Project Area, including portions of watersheds that overlap the Project site, as well as areas directly downstream that may be influenced by the Project site or effluent discharge/water withdrawal effects (Figure 8.1-3). The subwatersheds within the LSA are presented in Figure 8.1-4. This area was selected based on important waterbodies (notably Whitefish and McGowan Lakes) downstream of the Project where effects may occur through all Project phases. The LSA extends from those waterbodies down to their inflows to Russell Lake. The downstream extent

of the Surface Water Quantity LSA is at the confluence with Russell Lake. This location was chosen since, cumulatively, the drainage areas associated with the subwatersheds in the LSA represent a very small portion of the larger Russell Lake watershed at that node., As such, the potential for Project-specific effects on the Surface Water Quantity VC can be assessed within this area.

- The **Regional Study Area (RSA)** is the area that surrounds and includes the LSA, and was established to assess the potential, largely indirect effects of the Project, as well as other activities, in a regional context. The RSA is large enough to capture the extent of potential effects (i.e., zone of influence) on a VC and defines the area within which cumulative effects may occur (i.e., cumulative effects assessment boundary). The RSA for the Surface Water Quantity VC is bounded by the regional watershed area in which the Project Area is located. The RSA for this assessment is based on the whole watershed within which the Project is located and extends downstream to include Russell Lake (Figure 8.1-3).

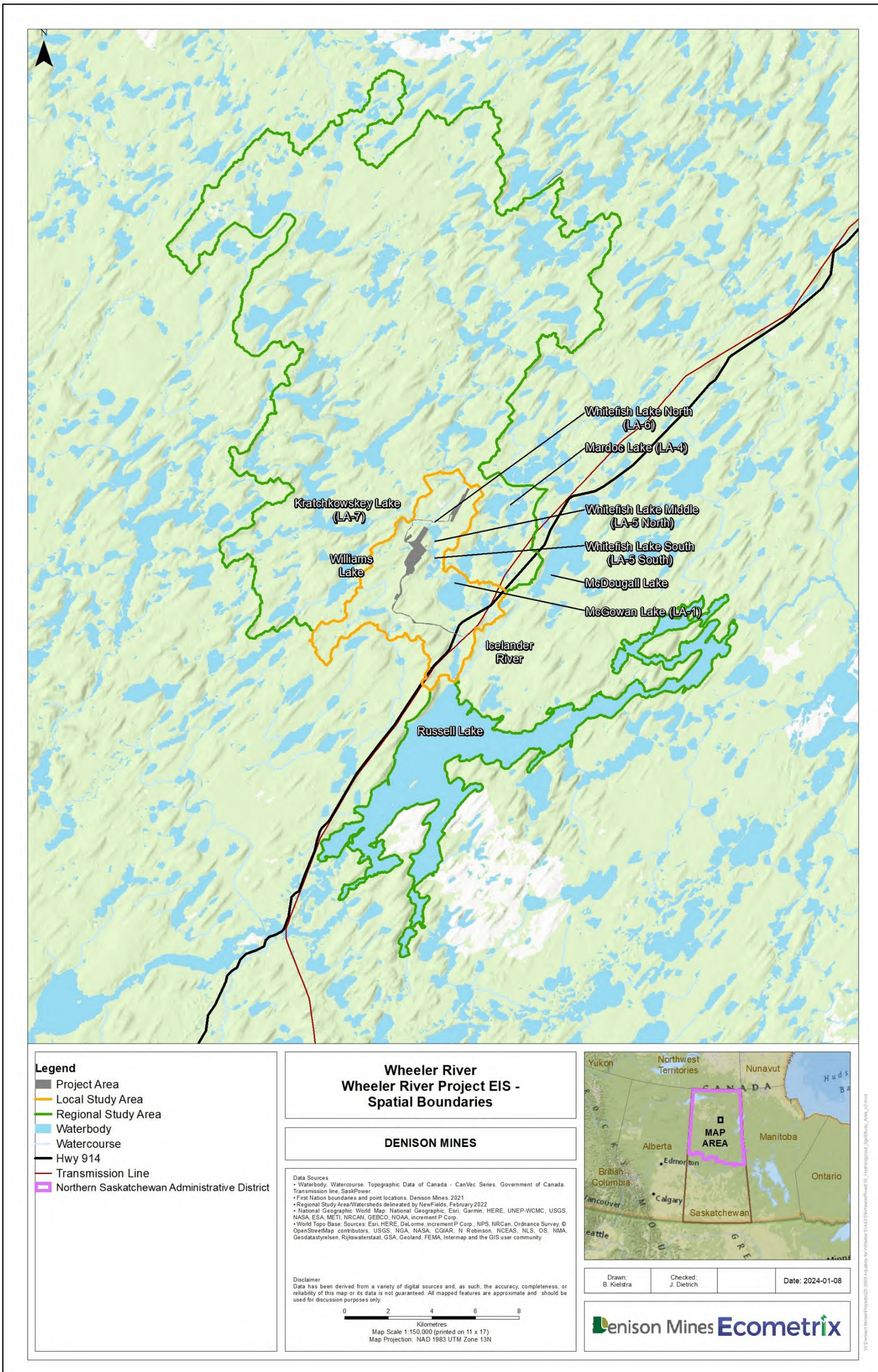

Figure 8.1-3: Study Area Boundaries

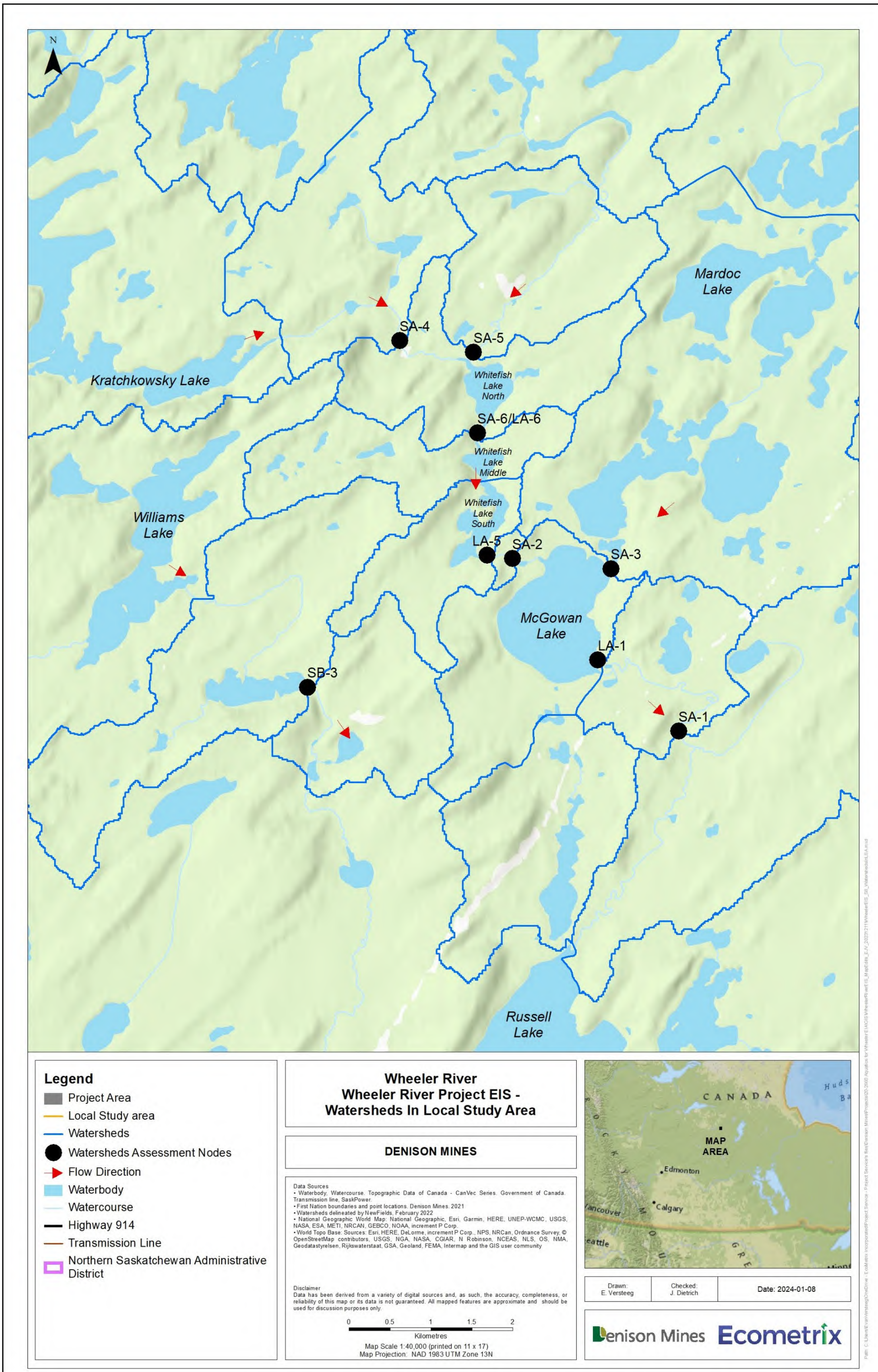

Figure 8.1-4: Watersheds Within the Local Study Area

Temporal boundaries for the EIS are defined in Table 5.3-3 in Section 5.3.4. The temporal boundaries applicable to and considered in the EIS include the following Project phases:

- Construction (Year 1 to 3);
- Operation (Year 3 to 18);
- Decommissioning (Year 18 to 23); and
- Post-Decommissioning (Year 23 to 38).

Additionally, a "future centuries" scenario is considered to assess the potential effects post-restoration (i.e., beyond the Project timeline of 0-38 years) and to reflect the time period over which the highest constituent concentrations in groundwater are predicted to migrate towards and interact with surface water.

This period represents the time where the highest constituent concentrations in groundwater are predicted to interact with surface water based on groundwater modeling. In this context, the future centuries scenario is considered with respect to the interaction of groundwater migration from the Project site and its potential influence on surface water in local water bodies. The future centuries projection encompasses the long-term period during which slow migration of groundwater from the Phoenix Ore Zone area to the surface water environment is anticipated and constitutes a bounding scenario of maximum concentrations of constituents of potential concern (COPC).

8.1.2 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

At its broadest level, Indigenous Knowledge (IK) can be understood as the unique and collective knowledge of Indigenous peoples that may include, but is not limited to, the environmental, cultural, economic, political, and spiritual conditions of a community or region. In this section, IK and Local Knowledge (LK) are viewed as complementary and influential alongside western science to produce a full understanding of the potential effects of the Project, whether measurable or perceived. Both forms of information have been given full and fair consideration.

Denison Mines Corp. (Denison) has recorded and stored information regarding IK, LK and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 21-EN-BNFN-479.6). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment. Appendix 8-A provides a summary of unique identification numbers referenced within Section 8.1.

Indigenous Knowledge and LK quotes and citations were included herein to provide readers with the information considered as the Project advanced throughout the EA process. Since 2016, Denison has been engaging with Interested Parties (i.e., local and Indigenous communities, residents, businesses, organizations, land users, and various regulatory authorities) to support the development of positive relationships and a mutual commitment to collaboration.

The influence of IK, LK, and engagement on the assessment of the Surface Water Quantity VC has first and foremost shaped the shared value of water and its life-sustaining properties.

> *"The lands and waters, we are definitely connected as peoples of English River. If we don't have the lands, we are not connected. If we don't have the water... Water is life to us"* (ERFN and SVS 2022).

Comments associated with water management and discharge to the environment were not directly specific to potential effects on Surface Water Quantity[1]; however, these were considered within the context of community interest regarding surface waters remaining supportive of natural function for biota and existing and future water uses. To this end, Project-related water management is important to maintaining surface water hydrology within the LSA.

Based on engagement (21-EN-BNFN-479.6), it is understood that additional detail is expected with respect to the potential effects of the Project on Surface Water Quantity because Denison proposes to discharge effluent into the local environment and take water from the local environment to support uranium bearing solution processing. This section directly meets this request.

Comments from Indigenous peoples regarding the potential role of climate change are further acknowledged in this assessment as a result of engagement (21-EN-VPL-444.3 and 21-EN-VPL-444.4).

8.1.3 Existing Environment

Denison initiated baseline hydrological monitoring in 2011, which has continued up to the present. Data are reported in Appendix 8-B for the period 2011 to 2019. The baseline flow record is robust and the duration of monitoring is sufficient to establish long-term streamflow trends at the Project site through relationships to long-term operating hydrometric gauging stations in the same watershed. As such, these records can be used to estimate long-term potential effects for the temporal phases and spatial study areas for the Project.

Baseline monitoring for the Project included streamflow monitoring, lake level monitoring, and installation of stage dataloggers at various locations throughout two main watersheds (identified as Watersheds A and B) reporting to Russell Lake (Appendix 8-B). Hydrometric monitoring at the Project site has been carried out by several organizations since 2011. Recently, the focus of each program has shifted to Watershed A stations, predominantly in the vicinity of the Project site. Hydrometric monitoring at streamflow stations has included measurement of stream discharge and water levels, and maintenance of in-stream dataloggers. The discussion of methodology used to develop baseline hydrologic characterization is provided in Appendix 8-B.

[1] 19-EN-MN-SR3-1.2, 19-EN-ML82-1.3, 19-EN-MOE-1.4, 18-EN-VILX-3.33, 18-EN-VILX-3.35, 18-EN-VILX-3.39, and 18-EN-VILX-3.84.

Critical locations of interest for this assessment include the following nodes, which are coincident with baseline monitoring stations and/or watersheds of interest for the assessment (Table 8.1-2; Figure 8.1-4). The assessment nodes represent the collective watershed.

- SA-1 – Streamflow monitoring station on the stream colloquially known as the Icelander River, which is located downstream of LA-1 (McGowan Lake).
- SA-2 – Streamflow monitoring station situated downstream of the outflow from LA-5 (Whitefish Lake) and upstream of the inflow to LA-1 (McGowan Lake).
- SA-3 – Streamflow monitoring station situated upstream of the inflow to LA-1 (McGowan Lake).
- SA-4 – Streamflow monitoring station situated upstream of the inflow to LA-6 (Unnamed Lake).
- SA-5 – Streamflow monitoring station situated upstream of the inflow to LA-6 (Unnamed Lake).
- SA-6 – Stream flow monitoring station situated downstream of the outflow from LA-6 (Whitefish Lake North) and upstream of the inflow to LA-5 (Whitefish Lake South).
- LA-6 – Lake level monitoring station at LA-6 (Whitefish Lake North).
- SB-3 – South Project drainage basin flowing to Russell Lake.
- LA-1 – McGowan Lake.
- LA-5 – Whitefish Lake South.

Gross drainage areas for the above-mentioned locations are presented in Table 8.1-2.

Table 8.1-2: Drainage Areas for Assessment Nodes

Location	Description	Gross Drainage Area (km^2)
SA-1	Icelander River flowing from McGowan Lake	280.6
SA-2	Inflow to McGowan Lake from Whitefish Lake	257.4
SA-3	Inflow to McGowan Lake	15.5
SA-4	Inflow to LA-6 (Unnamed Lake) from Kratchkowski Lake	80.5
SA-5	Inflow to LA-6	167.3
SA-6/LA-6	Flow from LA-6 to Whitefish Lake	251.7
SB-3	Southern Project drainage basin flowing to Russell Lake	24.9
LA-1	McGowan Lake	277.5
LA-5	Whitefish Lake	257.2

Notes:

Gross drainage is the total area of the watershed that would generate runoff to a contributing point.

8.1.3.1 Baseline Stream Flow

Available baseline streamflow data for the Project covered a sufficient time period to support the assessment. To make sure seasonable variability in hydrology was adequately captured as part of the dataset used to assess potential effects, an additional step in data preparation was undertaken to fill in seasonal gaps in the long-term record. This was accomplished by additional modelling (pro-rating) using a known continuous data source. Environment and Climate Change Canada operates hydrometric gauging stations across the country, including one station located approximately 32 km downstream of the Project (i.e., the Project Area and RSA lie within the watershed at this gauge). Environment and Climate Change Canada monitors flow rates on the Wheeler River below Russell Lake (station 06DA005) and has reported historical data from 1973 to 2019 (ECCC 2021). Data prior to 1977 have frequent missing records and were not used for this assessment. Daily average discharge data from station 06DA005 were used, extending from 1977 to 2019, for modelling purposes.

Extending the discharge records from station 06DA005 to other assessment nodes required correlation through unit area runoff relationships or same day discharge best fit correlation. The methodology used is discussed in Appendix II of Appendix 8-C-B. The extended discharge records for each station were then processed to obtain monthly average discharge for each assessment node for the purposes of the effect assessment for the Project. These data are presented in Appendix 8-B, with summary statistics presented in Table 8.1-3.

Table 8.1-3: Summary of Hydrological Statistics for Project Relevant Nodes

Station	Gross Drainage Area (km²)	Statistic	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Monthly Average	Monthly Average Yield (m³/s/km²)
SA-1 – Correlated from Water Survey Canada Wheeler River Station	280.55	Max (m³/s)	3.076	3.182	2.782	2.659	3.507	4.075	4.037	3.436	3.393	4.114	3.497	2.753	3.376	0.012
		Average (m³/s)	1.589	1.518	1.474	1.692	2.398	2.382	2.1	1.888	1.82	1.884	1.823	1.659	1.852	0.0066
		25th Percentile (m³/s)	1.2	1.167	1.152	1.445	2.103	2.11	1.719	1.499	1.288	1.394	1.429	1.275	1.482	0.0053
		5th Percentile (m³/s)	1.067	0.982	0.9	1.211	1.786	1.469	1.273	1.093	0.984	0.986	1.075	1.065	1.158	0.0041
		Min (m³/s)	1.007	0.901	0.875	1.106	1.679	1.414	1.133	1.054	0.945	0.87	0.893	1.028	1.075	0.0038
SA-2 – Adjusted Unit Area Runoff from SA-6	257.36	Max (m³/s)	2.84	2.999	2.446	2.312	3.532	4.554	4.485	3.41	3.346	4.632	3.522	2.379	3.372	0.0131
		Average (m³/s)	1.147	1.089	1.04	1.221	1.972	1.972	1.658	1.442	1.394	1.463	1.376	1.199	1.414	0.0055
		25th Percentile (m³/s)	0.799	0.778	0.77	0.991	1.592	1.613	1.22	1.023	0.862	0.942	0.969	0.852	1.034	0.004
		5th Percentile (m³/s)	0.712	0.66	0.613	0.81	1.278	1.008	0.852	0.734	0.663	0.663	0.716	0.71	0.785	0.003
		Min (m³/s)	0.675	0.613	0.598	0.755	1.177	0.956	0.759	0.705	0.638	0.596	0.609	0.688	0.731	0.0028
SA-3 – Adjusted Unit Area Runoff from SA-1	15.537	Max (m³/s)	0.721	0.746	0.652	0.624	0.822	0.956	0.947	0.806	0.796	0.965	0.82	0.646	0.792	0.051
		Average (m³/s)	0.373	0.356	0.346	0.397	0.562	0.559	0.493	0.443	0.427	0.442	0.428	0.389	0.434	0.028
		25th Percentile (m³/s)	0.282	0.274	0.27	0.339	0.493	0.495	0.403	0.352	0.302	0.327	0.335	0.299	0.348	0.0224
		5th Percentile (m³/s)	0.25	0.23	0.211	0.284	0.419	0.345	0.299	0.256	0.231	0.231	0.252	0.25	0.271	0.0175
		Min (m³/s)	0.236	0.211	0.205	0.259	0.394	0.332	0.266	0.247	0.222	0.204	0.209	0.241	0.252	0.0162
SA-4 – Correlated from SA-6	80.498	Max (m³/s)	0.662	0.695	0.579	0.55	0.803	1.008	0.994	0.779	0.765	1.023	0.801	0.566	0.769	0.0096
		Average (m³/s)	0.298	0.285	0.274	0.315	0.478	0.478	0.41	0.363	0.352	0.367	0.348	0.31	0.357	0.0044
		25th Percentile (m³/s)	0.221	0.216	0.214	0.264	0.398	0.402	0.316	0.272	0.235	0.254	0.26	0.233	0.274	0.0034
		5th Percentile (m³/s)	0.2	0.188	0.177	0.223	0.329	0.268	0.233	0.205	0.189	0.189	0.201	0.2	0.217	0.0027
		Min (m³/s)	0.192	0.177	0.174	0.21	0.307	0.257	0.211	0.199	0.183	0.173	0.176	0.195	0.204	0.0025
SA-5 – Unit Area Runoff from SA-6	167.32	Max (m³/s)	1.802	1.901	1.557	1.474	2.232	2.866	2.823	2.156	2.116	2.915	2.226	1.516	2.132	0.0127
		Average (m³/s)	0.751	0.715	0.684	0.797	1.263	1.263	1.068	0.934	0.904	0.947	0.893	0.783	0.917	0.0055
		25th Percentile (m³/s)	0.535	0.522	0.517	0.654	1.027	1.04	0.796	0.674	0.574	0.624	0.64	0.568	0.681	0.0041
		5th Percentile (m³/s)	0.481	0.448	0.419	0.541	0.832	0.664	0.568	0.495	0.451	0.45	0.484	0.48	0.526	0.0031

Station	Gross Drainage Area (km²)	Statistic	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Monthly Average	Monthly Average Yield (m³/s/km²)
		Min (m³/s)	0.458	0.419	0.41	0.508	0.769	0.632	0.51	0.476	0.435	0.409	0.417	0.466	0.492	0.0029
SA-6/LA-6 – Correlated from SA-1	251.69	Max (m³/s)	2.711	2.859	2.343	2.218	3.357	4.312	4.247	3.243	3.183	4.384	3.348	2.28	3.207	0.0127
		Average (m³/s)	1.129	1.075	1.029	1.199	1.9	1.9	1.607	1.405	1.36	1.425	1.343	1.178	1.379	0.0055
		25th Percentile (m³/s)	0.805	0.785	0.778	0.984	1.545	1.565	1.198	1.014	0.864	0.939	0.963	0.854	1.024	0.0041
		5th Percentile (m³/s)	0.724	0.675	0.631	0.814	1.252	0.999	0.854	0.744	0.678	0.677	0.728	0.722	0.791	0.0031
		Min (m³/s)	0.689	0.631	0.617	0.764	1.157	0.951	0.767	0.717	0.655	0.615	0.627	0.701	0.741	0.0029
SB3 – Unit Area Runoff from SA-1	24.87	Max (L/s)	0.273	0.282	0.247	0.236	0.311	0.361	0.358	0.305	0.301	0.365	0.31	0.244	0.299	0.012
		Average (L/s)	0.141	0.135	0.131	0.15	0.213	0.211	0.186	0.167	0.161	0.167	0.162	0.147	0.164	0.0066
		25th Percentile (L/s)	0.106	0.103	0.102	0.128	0.186	0.187	0.152	0.133	0.114	0.124	0.127	0.113	0.131	0.0053
		5th Percentile (L/s)	0.095	0.087	0.08	0.107	0.158	0.13	0.113	0.097	0.087	0.087	0.095	0.094	0.103	0.0041
		Min (L/s)	0.089	0.08	0.078	0.098	0.149	0.125	0.1	0.093	0.084	0.077	0.079	0.091	0.095	0.0038
LA-1 – Unit Area Runoff from SA-1	277.52	Max (m³/s)	3.043	3.148	2.752	2.63	3.469	4.031	3.993	3.399	3.356	4.069	3.459	2.724	3.339	0.012
		Average (m³/s)	1.572	1.502	1.458	1.674	2.372	2.356	2.078	1.868	1.8	1.863	1.803	1.641	1.832	0.0066
		25th Percentile (m³/s)	1.187	1.155	1.14	1.429	2.08	2.087	1.7	1.483	1.275	1.379	1.414	1.262	1.466	0.0053
		5th Percentile (m³/s)	1.055	0.971	0.89	1.198	1.767	1.453	1.26	1.082	0.974	0.975	1.063	1.053	1.145	0.0041
		Min (m³/s)	0.996	0.891	0.865	1.094	1.661	1.399	1.121	1.043	0.935	0.861	0.883	1.017	1.064	0.0038
LA-5 – Unit Area Runoff from SA-1	257.18	Max (m³/s)	2.82	2.917	2.55	2.437	3.215	3.735	3.701	3.15	3.11	3.771	3.205	2.524	3.095	0.012
		Average (m³/s)	1.456	1.391	1.351	1.551	2.198	2.184	1.925	1.731	1.668	1.727	1.671	1.521	1.698	0.0066
		25th Percentile (m³/s)	1.1	1.07	1.056	1.324	1.928	1.934	1.576	1.374	1.181	1.278	1.31	1.169	1.358	0.0053
		5th Percentile (m³/s)	0.978	0.9	0.825	1.11	1.638	1.347	1.167	1.002	0.902	0.904	0.985	0.976	1.061	0.0041
		Min (m³/s)	0.923	0.826	0.802	1.014	1.539	1.296	1.039	0.966	0.866	0.798	0.819	0.943	0.986	0.0038

8.1.3.2 Low Flow Statistics

Low flow assessment statistics are important for gaining an understanding of the bounding scenario for effluent discharge (i.e., low flow scenario water quality modelling) when a proposed discharge is anticipated for a Project (Section 8.2). The statistic required for the assessment, as required by the Saskatchewan Water Security Agency, is the seven-day average 1:10 year low flow return period (7Q10). This assessment requires tabulation of flow data series into one-week intervals, with summary statistics of the low flow return periods generated from the Log Pearson III analysis. The 7Q10 estimates are presented in Table 8.1-4 for assessment nodes LA-1 and LA 5.

Table 8.1-4: 7Q10 Estimated Discharge

Assessment Node	7Q10 Low Flow Rate (m^3/s)
LA-1	0.874
LA-5 (upstream)	0.626
LA-5 (downstream)	0.810

8.1.3.3 Climate Change

8.1.3.3.1 Water Balance Influenced Parameters

Climate change is recognized as a growing issue facing future developments. The Canadian Centre for Climate Services provides an online tool that identifies potential changes to mean annual temperature, surface wind speed, total precipitation, and snow depth, among other parameters, based on location and timeframes within Canada (CCCS 2021). The four aforementioned parameters influence the water balance at the Project, with mean annual temperature and surface wind speed affecting evaporation, and total precipitation and snow depth affecting local runoff. The climate change parameter estimates presented in Table 8.1-5 are based on projected time intervals and emission scenarios referred to as representative concentration pathways (RCPs), as well as the predicted change referenced to the average of the period 1986 to 2005. The RCP scenarios represent projected plausible emissions based on potential future anthropogenic activity.

Table 8.1-5: Climate Change Parameter Estimates

Parameter	Units	Time Period	Emission Scenario Representative Concentration Pathway (RCP)		
			Low (RCP 2.6)	Moderate (RCP 4.5)	High (RCP 8.5)
Mean Temperature	°C	2021–2040	+1.3	+1.4	+1.6
		2041–2060	+1.7	+2.3	+3.2
		2061–2080	+1.7	+2.8	+4.8
		2081–2100	+1.7	+3.1	+6.2
Surface Wind Speed	% change	2021–2040	-1.4	-1.3	-1.2

Parameter	Units	Time Period	Emission Scenario Representative Concentration Pathway (RCP)		
			Low (RCP 2.6)	Moderate (RCP 4.5)	High (RCP 8.5)
		2041–2060	-0.9	-1.3	-2.6
		2061–2080	-1.3	-0.9	-2.8
		2081–2100	-1.4	-1.6	-2.6
Total Precipitation	% change	2021–2040	+3.6	+2.7	+5.0
		2041–2060	+5.7	+7.3	+8.1
		2061–2080	+5.3	+8.0	+9.4
		2081–2100	+5.7	+7.9	+10.7
Snow Depth	% change	2021–2040	-9.0	-7.1	-9.7
		2041–2060	-7.6	-11.8	-16.0
		2061–2080	-7.5	-14.3	-30.5
		2081–2100	-12.0	-19.5	-38.6

8.1.3.4 Climate Change Influenced Extreme Events

8.1.3.4.1 Intensity Duration Frequency Events

Intensity duration frequency (IDF) curves are used to estimate the size of water management structures around a site. Typically, the 1:100 year, 24-hour precipitation event is the design event used in analyses for water management. Intensity duration frequency curves are often specific to climate monitoring stations; however, the online tool IDF_CC Tool 5.0 developed by the Institute for Catastrophic Loss Reduction (2021) is available for presentation of IDF curves at ungauged locations and includes the ability to estimate future IDF curve values under influences of climate change.

Baseline IDF curve data (Table 8.1-6) are based on a gridded data set extracted from the online tool. The climate change influenced IDF curve data (Table 8.1-7) are based on the time window of 2020 to 2050 under a climate condition scenario yielding the largest magnitude storm fall. The 1:100 year, 24-hour return period rainfall events for the baseline and climate change influenced IDF curves are 79.9 mm and 88.6 mm, respectively (Appendix 8-C).

Table 8.1-6: Baseline of Intensity Duration Frequency Curve Data

Duration	Return Period (Years)						
	2	5	10	20	25	50	100
5 minutes	4.3	6.7	8.8	11.5	12.4	16	20.7
10 minutes	6.4	9.8	12.8	16.7	17.9	23	29.3
15 minutes	7.7	11.9	15.8	21	22.7	29.8	39.1
30 minutes	9.8	14.8	19.1	24.6	26.4	33.6	42.8

Duration	Return Period (Years)						
	2	5	10	20	25	50	100
1 hour	12.3	17.9	22.8	29	31	39.1	49.7
2 hours	15.7	21.7	26.8	33.4	35.5	44.4	56.4
6 hours	24.1	31.7	37.5	43.8	45.8	52.9	60.7
12 hours	31.7	42.4	49.9	57.5	59.7	67.3	75.1
24 hours	38.3	50.7	58.4	65.6	67.5	73.9	79.9

Table 8.1-7: Climate Change Influenced Intensity Duration Frequency Curve Data

Duration	Return Period (Years)						
	2	5	10	20	25	50	100
5 minutes	4.7	7.1	9.5	12.4	13.4	17.6	22.9
10 minutes	6.9	10.5	13.8	17.9	19.3	25.1	32.5
15 minutes	8.3	12.7	17	22.6	24.5	32.7	43.3
30 minutes	10.5	15.8	20.6	26.5	28.4	36.8	47.5
1 hour	13.3	19.2	24.6	31.3	33.4	42.9	55.1
2 hours	16.9	23.2	28.9	36	38.2	48.6	62.5
6 hours	26	33.9	40.4	47.2	49.4	57.9	67.3
12 hours	34.2	45.4	53.8	61.9	64.4	73.8	83.3
24 hours	41.3	54.3	63	70.7	72.8	81	88.6

8.1.3.4.2 Probable Maximum Precipitation Events

The probable maximum precipitation (PMP) event is a design standard value for an extreme rainfall event. The PMP event does not have an estimated return period but is instead based on the theoretical maximum amount of water that a storm could produce based on the maximum persisting dew point (Atmospheric Environment Branch 1999). An assessment completed by the Atmospheric Environment Branch (1999) indicated that a trend in the maximum persisting dew point was not shifting appreciably; however, no formal analysis of projected climate change effects has been completed. Based on data presented by the Atmospheric Environment Branch (1999), the estimated PMP event for the Project is 489.3 mm (Appendix 8-C).

8.1.4 Assessment of Project-related Effects

8.1.4.1 Potential Interactions Between the Project and Valued Component / Key Indicators

The Project will require the construction, operation, and decommissioning of several components (as described in Section 2 Project Description). Potential interactions between Project activities and the Surface Water Quantity VC are summarized by Project phase in Table 8.1-8 and are categorized as:

- Primary Interaction (✓): Project activity is expected to interact with the VC/KI, which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- Other Interaction (✓): Project activity is expected to interact with the VC/KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- No Interaction**:** Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

Based on professional judgment and understanding of the nature of Project activities and their sequencing, the Project activity list was reviewed and the type of interactions determined. Potential Project-related effects are then discussed in Section 8.1.4.2. Primary Project activities with the potential for adverse effects on Surface Water Quantity (i.e., flagged as 'Primary Interactions') are expected to involve surface land clearing, major earthworks, surface/grading preparations, changes to land cover, water management feature construction and operation, and water taking and effluent discharge. Other Project activities (i.e., flagged as 'Other Interaction') refer to those activities that may be associated with hydrogeological influences on local waterbodies and are expected to be secondary contributors to potential adverse effects. The remaining activities (e.g., power generation and supply) were deemed to have no interaction and were not carried forward in the assessment as they are not expected to result in detectable changes in the MPs associated with Surface Water Quantity. Activities during Post-Decommissioning (e.g., site inspections; monitoring and on-site engagement with Interested Parties) were deemed to have no interaction because they do not involve any land clearing, surface preparations, or major earthworks.

Table 8.1-8: Potential Project Interactions for Surface Water Quantity

Project Phase/Activity	Surface Water Quantity
Construction Activities	
Development of access roads and air strip	✓
Site preparation and earthworks; clearing, levelling, and grading of the Project Area	✓
Power generation – generators	
Installation of main substation and distribution of power around site	
Wellfield and freeze hole drilling; ground freezing	✓
Batch plant operation (concrete); crusher at borrow area	
Development of surface infrastructure (camp, operations centre, plants, ponds, pads, and support facilities)	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	

Project Phase/Activity	Surface Water Quantity
Water management (including treatment and site runoff)	✓
Groundwater supply	✓
Surface water withdrawal	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	
On-site and off-site operation of vehicles and transport of materials	
Air transportation for workers	
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Operation Activities	
Operation of the in situ recovery (ISR) wellfield	✓
Wellfield and freeze wall drilling	✓
Operation and expansion of freeze wall	✓
Batch plant operation (grout and cement); crusher in borrow area	
Expansion of pond and pads	✓
Operation of the processing plant and production of uranium concentrate	✓
Water withdrawal from groundwater or surface waterbody	✓
Management of surface water (including seepage and site runoff)	✓
Water treatment, both domestic and industrial	✓
Water release to surface waterbody	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	
Hazardous waste management (temporary storage, handling, and off-site transportation)	
Storage and disposal of drill waste rock, process precipitates, and industrial wastewater treatment plant precipitates	
On-site and off-site operation of vehicles and transport of materials	
Power supply – primarily power from the grid, also generators and back-up generators	
Package and transport of nuclear substances	
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	
Air transportation for workers	
Progressive decommissioning and reclamation	✓
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Decommissioning Activities	
Site water management, treatment, and release	✓
Mining horizon remediation and thawing of freeze wall	✓
Process water treatment and release	✓
Closure of ISR and freeze wells and related infrastructure	✓

Project Phase/Activity	Surface Water Quantity
Decontamination of surface facilities and injection, recovery, and monitoring wells	✓
Asset removal (including site power transmission lines and electrical infrastructure)	
Demolition and disposal of non-salvageable surface infrastructure and materials	
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	✓
Generators	
Waste management (composting and landfill operation)	
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)	
On-site and off-site operation of vehicles and transport of materials	
Reclamation of disturbed areas	✓
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Post-Decommissioning Activities	
Environmental monitoring	
Regulatory site inspections	
Engagement – site visit from Interested Parties	

Interactions between the Project and Surface Water Quantity during the future centuries phase were considered an indirect (secondary) interaction associated with changes in groundwater migration from the restored mining horizon to the surface water environment.

8.1.4.2 Potential Project-related Effects

Denison does not intend to include constant freshwater withdrawal or effluent discharge throughout Operation; however, for the purpose of assessing the scenario of greatest potential effects, the Project was assessed as having a continuous freshwater withdrawal rate of 40.5 m^3/hr and a continuous effluent discharge rate of 36.5 m^3/hr. The withdrawal and discharge rates were assessed independently, despite withdrawal from and discharge to being associated with the same waterbody, to exaggerate the projected effects. In addition, the withdrawal and discharge rates were assessed cumulatively with the Project Area and estimated changes to groundwater contributions through different temporal phases of the Project.

Flows and water levels under pre-development conditions were used as the baseline against which Project-related changes during Construction, Operation, Decommissioning, and Post-Decommissioning were assessed. Pre-disturbance watershed areas are presented in Table 8.1-2. Expected changes to these watersheds were estimated for subsequent phases of the Project (Table 8.1-9). Changes in watershed areas will be primarily a result of construction of mine infrastructure and implementation of the Surface Water Management Program. Two scenarios were considered separately for water withdrawal and treated effluent discharge to LA-5, relevant to Operation and Decommissioning. Changes in monthly and annual streamflow rates were projected based on effects predicted for assessment nodes SA-1, SA-2, SA-6/LA-6, LA-1, LA-5, and SB-3. Changes in flow rates were assessed for the mean and 5th percentile low flow statistics. These statistics were selected as being most representative of potential effects given the relatively small withdrawal/discharge rates with respect to baseline flow rates in the area. The Project is expected to have the greatest effect on baseline flow rates during very low flow conditions. It was noted that these low flow conditions have not been observed in the measured record. Groundwater received in LA-5 under natural conditions and estimates of the changes to this contribution were evaluated for Operation and Decommissioning. The following sections discuss each Project-related effect.

Table 8.1-9: Project Effect Scenarios

Temporal Stages	Scenario Number	Project Influence
Construction	1	Fully developed Project Area
Operation and Decommissioning with water withdrawal	2	Fully developed Project Area Freshwater withdrawal from LA-5 Change in groundwater contribution to LA-5
Operation and Decommissioning with effluent discharge	3	Fully developed Project Area Effluent discharge to LA-5 Change in groundwater contribution to LA-5

8.1.4.2.1 Project Overprinting of Drainage Areas

Construction

For the purpose of this assessment, the full measure of site clearing, grading, and infrastructure construction and commissioning was assumed (175 ha). Please note this value was obtained from Denison early in the assessment process. Subsequent revisions to the site layout has further reduced this footprint to (169.6 ha) and as such, this analysis is overly conservative. As such, the total overprinted area by the Project, including access roads and the airstrip, were assessed with respect to changes in functional drainage areas that would have reported to surface water features in the LSA. The overprinting of the landscape by the Project Area will directly change the surface drainage patterns in the area. This will occur via physical change in the landscape and as a result of redirection of surface flows to catchment features (ponds) for the purpose of water collection for mine processing and site water balance.

The Project Area consists of an access road from Highway 914 that extends northwest to the main facilities and northeast to the proposed airstrip. The road and airstrip were not considered to affect hydrology materially. Both may potentially redirect some flow and have a small influence on the timing of concentration of runoff and infiltration rates; however, in general, they are anticipated to have a very small influence and are not expected to change runoff volumes at assessment nodes. Project facilities will influence runoff to assessment nodes as Denison intends to collect all runoff local to Project facilities, reuse where possible, and treat and discharge this water Whitefish Lake (LA-5). The assessment nodes affected by the Project Area are presented in Table 8.1-10.

Table 8.1-10: Site Footprint Effects

Affected Assessment Node	Decrease in Drainage Area (km²)	% of Drainage Area (km²)
SA-5	0.273	0.2
SA-6	0.566	0.2
SB-3	0.214	0.9

Analysis of the Project effects during Construction with a fully developed Project Area indicated that waterbodies LA-1, LA-5, and LA-6 were within affected assessment nodes for the Project. In all cases, the reduction in surface water flow at each hydrology node is expected to be less than 1% of baseline (Table 8.1-11) based on the reduced surface drainage area reporting to the local waterbodies because of Project land use and infrastructure.

Operation

A loss of functional drainage area reporting to local waterbodies, as realized during Construction, is expected during Operation. Collection of surface drainage in on-site storage and treatment ponds will reduce surface drainage to local waterbodies which report to the Icelander River thereby effecting surface water quantity. If considering Scenario 1, which is exclusive of water taking and discharge, the reduction in surface water flow at each hydrology node is expected to be less than 1% of baseline (Table 8.1-11).

Decommissioning/Post-Decommissioning

Decommissioning of the Project is intended to create a safe, stable, and self-sustaining landscape. This will include remediation of on-site storage and effluent ponds and re-establishment of drainage patterns to local surface waterbodies.

Reclamation activities involving earthworks (i.e., cut/fill, infilling/backfilling, and re-grading/recontouring) and other landscape preparations may result in similar Project-related effects previously described, but to a lesser extent. Project-related effects may include discrete/isolated slope failures, minimal surface subsidence (specific to the area above the mining area), and changes in surface drainage patterns. Areas with exposed/unconsolidated surficial materials will constitute roughness coefficients that are not reflective of naturalized conditions until vegetation re-establishment.

In all cases, the reduction in surface water flow at each hydrology node is expected to be less than 1% of baseline (Table 8.1-11) based on the reduced surface drainage area reporting to the local waterbodies because of Project land use and infrastructure. Surface water flows are expected to move toward pre-development levels following Decommissioning and Post-Decommissioning.

Table 8.1-11: Scenario 1 – Construction Effects on Surface Water Quantity

Station	Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Monthly Average
SA-1	Baseline Scenario Average (m^3/s)	1.589	1.518	1.474	1.692	2.398	2.382	2.1	1.888	1.82	1.884	1.823	1.659	1.852
	Affected Scenario Average (m^3/s)	1.585	1.514	1.47	1.688	2.392	2.376	2.095	1.884	1.815	1.879	1.819	1.655	1.848
	Percentage Change to Average Condition Flow (%)	**-0.24**	**-0.24**	**-0.23**	**-0.24**	**-0.26**	**-0.27**	**-0.26**	**-0.25**	**-0.25**	**-0.25**	**-0.25**	**-0.24**	**-0.25**
	Baseline Scenario 5th Percentile (m^3/s)	1.067	0.982	0.9	1.211	1.786	1.469	1.273	1.093	0.984	0.986	1.075	1.065	1.158
	Affected Scenario 5th Percentile (m^3/s)	1.064	0.98	0.898	1.208	1.782	1.466	1.27	1.091	0.982	0.984	1.072	1.062	1.155
	Percentage Change to 5th Percentile Condition Flow (%)	**-0.23**	**-0.23**	**-0.23**	**-0.22**	**-0.23**	**-0.23**	**-0.22**	**-0.23**	**-0.23**	**-0.23**	**-0.23**	**-0.23**	**-0.23**
SA-2	Baseline Scenario Average (m^3/s)	1.147	1.089	1.04	1.221	1.972	1.972	1.658	1.442	1.394	1.463	1.376	1.199	1.414
	Affected Scenario Average (m^3/s)	1.143	1.085	1.036	1.217	1.966	1.966	1.653	1.437	1.389	1.459	1.371	1.195	1.41
	Percentage Change to Average Condition Flow (%)	**-0.33**	**-0.33**	**-0.33**	**-0.33**	**-0.32**	**-0.32**	**-0.32**	**-0.32**	**-0.33**	**-0.32**	**-0.33**	**-0.33**	**-0.33**
	Baseline Scenario 5th Percentile (m^3/s)	0.712	0.66	0.613	0.81	1.278	1.008	0.852	0.734	0.663	0.663	0.716	0.71	0.785
	Affected Scenario 5th Percentile (m^3/s)	0.71	0.657	0.611	0.807	1.274	1.004	0.849	0.732	0.661	0.661	0.714	0.708	0.782
	Percentage Change to 5th Percentile Condition Flow (%)	**-0.34**	**-0.34**	**-0.34**	**-0.34**	**-0.33**	**-0.33**	**-0.33**	**-0.34**	**-0.34**	**-0.34**	**-0.34**	**-0.34**	**-0.34**
SA-6/ LA-6	Baseline Scenario Average (m^3/s)	1.129	1.075	1.029	1.199	1.9	1.9	1.607	1.405	1.36	1.425	1.343	1.178	1.379
	Affected Scenario Average (m^3/s)	1.128	1.074	1.028	1.197	1.898	1.898	1.605	1.403	1.359	1.424	1.342	1.177	1.378
	Percentage Change to Average Condition Flow (%)	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**
	Baseline Scenario 5th Percentile (m^3/s)	0.724	0.675	0.631	0.814	1.252	0.999	0.854	0.744	0.678	0.677	0.728	0.722	0.791

Station	Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Monthly Average
	Affected Scenario 5th Percentile (m³/s)	0.723	0.674	0.63	0.814	1.251	0.998	0.853	0.743	0.677	0.677	0.727	0.721	0.791
	Percentage Change to 5th Percentile Condition Flow (%)	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**
LA-1	Baseline Scenario Average (m³/s)	1.572	1.502	1.458	1.674	2.372	2.356	2.078	1.868	1.8	1.863	1.803	1.641	1.832
	Affected Scenario Average (m³/s)	1.568	1.498	1.455	1.67	2.366	2.35	2.072	1.863	1.795	1.859	1.799	1.637	1.828
	Percentage Change to Average Condition Flow (%)	**-0.24**	**-0.24**	**-0.24**	**-0.24**	**-0.27**	**-0.27**	**-0.26**	**-0.25**	**-0.25**	**-0.25**	**-0.25**	**-0.24**	**-0.25**
	Baseline Scenario 5th Percentile (m³/s)	1.055	0.971	0.89	1.198	1.767	1.453	1.26	1.082	0.974	0.975	1.063	1.053	1.145
	Affected Scenario 5th Percentile (m³/s)	1.053	0.969	0.888	1.195	1.763	1.45	1.257	1.079	0.972	0.973	1.061	1.051	1.142
	Percentage Change to 5th Percentile Condition Flow (%)	**-0.23**	**-0.23**	**-0.24**	**-0.23**	**-0.24**	**-0.23**	**-0.23**	**-0.23**	**-0.23**	**-0.23**	**-0.23**	**-0.23**	**-0.23**
LA-5	Baseline Scenario Average (m³/s)	1.146	1.088	1.039	1.22	1.971	1.971	1.657	1.441	1.393	1.462	1.375	1.198	1.413
	Affected Scenario Average (m³/s)	1.142	1.085	1.036	1.216	1.964	1.964	1.652	1.436	1.388	1.458	1.37	1.194	1.409
	Percentage Change to Average Condition Flow (%)	**-0.33**	**-0.33**	**-0.33**	**-0.33**	**-0.32**	**-0.32**	**-0.32**	**-0.33**	**-0.33**	**-0.32**	**-0.33**	**-0.33**	**-0.33**
	Baseline Scenario 5th Percentile (m³/s)	0.712	0.659	0.612	0.809	1.277	1.007	0.851	0.734	0.663	0.662	0.716	0.71	0.784
	Affected Scenario 5th Percentile (m³/s)	0.709	0.657	0.61	0.806	1.273	1.004	0.849	0.731	0.66	0.66	0.714	0.707	0.782
	Percentage Change to 5th Percentile Condition Flow (%)	**-0.34**	**-0.34**	**-0.34**	**-0.34**	**-0.33**	**-0.33**	**-0.33**	**-0.34**	**-0.34**	**-0.34**	**-0.34**	**-0.34**	**-0.34**
SB-3	Baseline Scenario Average (m³/s)	0.141	0.135	0.131	0.15	0.213	0.211	0.186	0.167	0.161	0.167	0.162	0.147	0.164
	Affected Scenario Average (m³/s)	0.14	0.133	0.13	0.149	0.211	0.209	0.185	0.166	0.16	0.166	0.16	0.146	0.163
	Percentage Change to Average Condition Flow (%)	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**

Station	Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Monthly Average
	Baseline Scenario 5th Percentile (m^3/s)	0.095	0.087	0.08	0.107	0.158	0.13	0.113	0.097	0.087	0.087	0.095	0.094	0.103
	Affected Scenario 5th Percentile (m^3/s)	0.094	0.086	0.079	0.106	0.157	0.129	0.112	0.096	0.087	0.087	0.094	0.094	0.102
	Percentage Change to 5th Percentile Condition Flow (%)	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**

8.1.4.2.2 Surface Water Taking

Site water management is described in Section 2, with water block flow diagrams for each phase of the Project provided in Figure 2.2-14, Figure 2.2-15, and Figure 2.2-16. It is important to note that Denison plans to recycle process water to the greatest extent possible, thereby reducing both the demand for freshwater supply and the need for discharge to the receiving water environment.

Construction

Water taking is expected to occur from both groundwater and surface water sources during construction at a volume of 35 m^3/hr to support activities such as operation of the concrete batch plant, wash station, drilling activities, and the potable water plant (Figure 2.2-14 in Section 2). The main source of water taking for operation of the mine and to maintain water balance will be from groundwater sources. However, to supplement these volumes, surface water taking from Whitefish Lake (LA-5) was considered as part of the Surface Water Quantity assessment. As the total volume of water taking from surface water is expected to be lower during Construction (35 m^3/hr) compared to Operations (40.5 m^3/hr), discussion of impacts of surface water taking for the bounding scenario (Operation) is provided below.

Operation

Water taking is expected to occur from both groundwater and surface water sources during Operation. Groundwater taking may have an indirect effect on surface water quantity during phases of maximum taking for the purposes of ISR mining.

The main source of water taking for operation of the mine and to maintain water balance may be from groundwater sources. However, to supplement these volumes and to provide a conservative assessment of potential effects, surface water taking from Whitefish Lake (LA-5) at a rate of 40.5 m^3/hr was considered as part of the Surface Water Quantity assessment.

Potential hydrogeological effects are discussed in more detail in Section 7 Geology and Groundwater. However, Whitefish Lake (LA-5) was estimated under baseline conditions to receive 40 L/s from groundwater sources. Modelling for the Project estimated a decrease in this input to 36 L/s during Operation and Decommissioning. As such, this slight reduction in baseflow contribution to LA-5 was incorporated into the estimates of flow reduction at that node (LA-5).

In all cases, the reduction in surface water flow at each hydrology node was less than 3% of baseline (Table 8.1-12) based on the reduced surface drainage area reporting to the local waterbodies because of Project land use and infrastructure. Under natural conditions studied during the baseline survey period (2011 to 2019), the difference between the minimum and maximum water levels at LSA lakes was typically in the order of 0.4 m (Ecometrix 2020). The potential Project-related change in water level in LA-1 (McGowan Lake), LA-5 (Whitefish Lake), and LA-6 (Unnamed Lake) was estimated from the difference in flow rates between the baseline and affected scenarios (Appendix 8-B). For LA-1, the largest predicted change in water level was

0.0037 m under average conditions for May and June during withdrawal. At LA-5, the largest predicted change in water level in a withdrawal scenario was -0.0041 m during March of the 5th percentile dataset. All expected water level effects on other lakes within the vicinity of the Project, including LA-6, were expected to be negligible, with magnitudes also in the sub-centimeter range.

Decommissioning/Post-Decommissioning

Water taking from groundwater and surface water sources is expected through some portion of Decommissioning during remediation of the ore zone well field and treatment prior to discharge to surface waterbodies. The expected volume of water taking will be similar during the Decommissioning (35.5 m^3/hr) period as during Construction (35 m^3/hr) and Operation (40.5 m^3/hr). The water balance during this phase will be consistent with the cessation of drilling and ore extraction followed by mining area remediation, and finally the gradual thawing of the freeze wall (Figure 2.2-16 in Section 2).During this phase, water taking will mainly be used by the processing plant and wellfield remediation and to support the potable water plant and wash bay. The assessment of the potential impacts of water taking described above for Operation remains consistent for the Decommissioning phase. Groundwater and surface water flows will move toward pre-development levels following in Post-Decommissioning.

Table 8.1-12: Scenario 2 – Operation and Decommissioning – Water Withdrawal – Effects on Surface Water Quantity

Station	Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Monthly Average
SA-1	Baseline Scenario Average (m^3/s)	1.589	1.518	1.474	1.692	2.398	2.382	2.1	1.888	1.82	1.884	1.823	1.659	1.852
	Affected Scenario Average (m^3/s)	1.568	1.497	1.454	1.671	2.375	2.359	2.078	1.867	1.798	1.862	1.802	1.638	1.831
	Percentage Change to Average Condition Flow (%)	**-1.3**	**-1.35**	**-1.38**	**-1.23**	**-0.97**	**-0.97**	**-1.06**	**-1.14**	**-1.18**	**-1.15**	**-1.17**	**-1.25**	**-1.16**
	Baseline Scenario 5th Percentile (m^3/s)	1.067	0.982	0.9	1.211	1.786	1.469	1.273	1.093	0.984	0.986	1.075	1.065	1.158
	Affected Scenario 5th Percentile (m^3/s)	1.047	0.963	0.881	1.191	1.765	1.449	1.254	1.074	0.965	0.967	1.055	1.046	1.138
	Percentage Change to 5th Percentile Condition Flow (%)	**-1.81**	**-1.95**	**-2.11**	**-1.62**	**-1.18**	**-1.38**	**-1.55**	**-1.77**	**-1.94**	**-1.94**	**-1.8**	**-1.81**	**-1.69**
SA-2	Baseline Scenario Average (m^3/s)	1.147	1.089	1.04	1.221	1.972	1.972	1.658	1.442	1.394	1.463	1.376	1.199	1.414
	Affected Scenario Average (m^3/s)	1.126	1.068	1.019	1.2	1.949	1.949	1.636	1.42	1.372	1.442	1.355	1.178	1.393
	Percentage Change to Average Condition Flow (%)	**-1.8**	**-1.88**	**-1.95**	**-1.71**	**-1.18**	**-1.18**	**-1.34**	**-1.5**	**-1.54**	**-1.48**	**-1.55**	**-1.74**	**-1.52**
	Baseline Scenario 5th Percentile (m^3/s)	0.712	0.66	0.613	0.81	1.278	1.008	0.852	0.734	0.663	0.663	0.716	0.71	0.785
	Affected Scenario 5th Percentile (m^3/s)	0.693	0.641	0.594	0.79	1.257	0.987	0.832	0.715	0.644	0.644	0.697	0.691	0.765
	Percentage Change to 5th Percentile Condition Flow (%)	**-2.71**	**-2.9**	**-3.1**	**-2.42**	**-1.65**	**-2.01**	**-2.32**	**-2.64**	**-2.89**	**-2.89**	**-2.69**	**-2.72**	**-2.49**
SA-6/ LA-6	Baseline Scenario Average (m^3/s)	1.129	1.075	1.029	1.199	1.9	1.9	1.607	1.405	1.36	1.425	1.343	1.178	1.379
	Affected Scenario Average (m^3/s)	1.128	1.074	1.028	1.197	1.898	1.898	1.605	1.403	1.359	1.424	1.342	1.177	1.378
	Percentage Change to Average Condition Flow (%)	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**
	Baseline Scenario 5th Percentile (m^3/s)	0.724	0.675	0.631	0.814	1.252	0.999	0.854	0.744	0.678	0.677	0.728	0.722	0.791

Station	Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Monthly Average
	Affected Scenario 5th Percentile (m^3/s)	0.723	0.674	0.63	0.814	1.251	0.998	0.853	0.743	0.677	0.677	0.727	0.721	0.791
	Percentage Change to 5th Percentile Condition Flow (%)	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**
LA-1	Baseline Scenario Average (m^3/s)	1.572	1.502	1.458	1.674	2.372	2.356	2.078	1.868	1.8	1.863	1.803	1.641	1.832
	Affected Scenario Average (m^3/s)	1.551	1.481	1.438	1.653	2.349	2.333	2.055	1.846	1.779	1.842	1.782	1.62	1.811
	Percentage Change to Average Condition Flow (%)	**-1.31**	**-1.36**	**-1.39**	**-1.25**	**-0.98**	**-0.99**	**-1.07**	**-1.15**	**-1.19**	**-1.16**	**-1.18**	**-1.27**	**-1.17**
	Baseline Scenario 5th Percentile (m^3/s)	1.055	0.971	0.89	1.198	1.767	1.453	1.26	1.082	0.974	0.975	1.063	1.053	1.145
	Affected Scenario 5th Percentile (m^3/s)	1.036	0.952	0.871	1.178	1.746	1.433	1.24	1.062	0.955	0.956	1.044	1.034	1.126
	Percentage Change to 5th Percentile Condition Flow (%)	**-1.83**	**-1.97**	**-2.13**	**-1.64**	**-1.19**	**-1.39**	**-1.57**	**-1.79**	**-1.97**	**-1.96**	**-1.82**	**-1.83**	**-1.7**
LA-5	Baseline Scenario Average (m^3/s)	1.456	1.391	1.351	1.551	2.198	2.184	1.925	1.731	1.668	1.727	1.671	1.521	1.698
	Affected Scenario Average (m^3/s)	1.436	1.371	1.331	1.53	2.175	2.16	1.903	1.71	1.647	1.705	1.65	1.5	1.676
	Percentage Change to Average Condition Flow (%)	**-1.42**	**-1.47**	**-1.5**	**-1.35**	**-1.06**	**-1.06**	**-1.15**	**-1.25**	**-1.28**	**-1.25**	**-1.28**	**-1.37**	**-1.26**
	Baseline Scenario 5th Percentile (m^3/s)	0.978	0.9	0.825	1.11	1.638	1.347	1.167	1.002	0.902	0.904	0.985	0.976	1.061
	Affected Scenario 5th Percentile (m^3/s)	0.958	0.881	0.806	1.09	1.617	1.326	1.147	0.983	0.883	0.885	0.966	0.957	1.042
	Percentage Change to 5th Percentile Condition Flow (%)	**-1.97**	**-2.12**	**-2.3**	**-1.77**	**-1.29**	**-1.5**	**-1.69**	**-1.93**	**-2.12**	**-2.12**	**-1.96**	**-1.98**	**-1.84**
SB-3	Baseline Scenario Average (m^3/s)	0.141	0.135	0.131	0.15	0.213	0.211	0.186	0.167	0.161	0.167	0.162	0.147	0.164
	Affected Scenario Average (m^3/s)	0.14	0.133	0.13	0.149	0.211	0.209	0.185	0.166	0.16	0.166	0.16	0.146	0.163
	Percentage Change to Average Condition Flow (%)	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**

Station	Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Monthly Average
	Baseline Scenario 5th Percentile (m^3/s)	0.095	0.087	0.08	0.107	0.158	0.13	0.113	0.097	0.087	0.087	0.095	0.094	0.103
	Affected Scenario 5th Percentile (m^3/s)	0.094	0.086	0.079	0.106	0.157	0.129	0.112	0.096	0.087	0.087	0.094	0.094	0.102
	Percentage Change to 5th Percentile Condition Flow (%)	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**

8.1.4.2.3 Surface Water Discharge

Construction

Discharge to the environment is not expected during Construction. Site contact water will be collected and held in the Clean Waste Rock Pond (Figure 2.2-14 in Section 2). Therefore, potential effects of discharge on the Surface Water Quantity VC are not expected because there is no planned discharge during this phase of the Project.

Operation

Discharge to the surface water environment is expected during Operation. For the purpose of this assessment, a continuous discharge was assumed into Whitefish Lake (LA-5) (Table 8.1-13). As a result, this Scenario (3) indicated a potential increase in surface water flow and water levels to LA-5. During a discharge scenario, the maximum predicted change in water level was 0.0032 m in March of the 5th percentile dataset. All expected water level effects on other lakes within the vicinity of the Project, including LA-6, were expected to have negligible effects, with magnitudes also in the sub-centimeter range.

Decommissioning/Post-Decommissioning

Discharge to the aquatic environment of Whitefish Lake during some portion of Decommissioning is expected. Effluent rates during this phase (36.5 m^3/hr) are expected to be the same as during Operation. Therefore, the analysis of potential effects on the Surface Water Quantity VC during Operation provided above and summarized in Table 8.1-13 is considered the bounding scenario for Decommissioning as well. Surface water flows will move toward pre-development levels in Post-Decommissioning.

Table 8.1-13: Scenario 3 – Operation and Decommissioning – Effluent Discharge – Effects on Surface Water Quantity

Station	Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Monthly Average
SA-1	Baseline Scenario Average (m^3/s)	1.589	1.518	1.474	1.692	2.398	2.382	2.1	1.888	1.82	1.884	1.823	1.659	1.852
	Affected Scenario Average (m^3/s)	1.603	1.532	1.488	1.706	2.409	2.393	2.113	1.901	1.833	1.897	1.836	1.673	1.865
	Percentage Change to Average Condition Flow (%)	**0.88**	**0.93**	**0.97**	**0.81**	**0.47**	**0.48**	**0.59**	**0.69**	**0.72**	**0.69**	**0.72**	**0.83**	**0.71**
	Baseline Scenario 5th Percentile (m^3/s)	1.067	0.982	0.9	1.211	1.786	1.469	1.273	1.093	0.984	0.986	1.075	1.065	1.158
	Affected Scenario 5th Percentile (m^3/s)	1.082	0.997	0.915	1.226	1.8	1.483	1.288	1.109	1	1.001	1.09	1.08	1.173
	Percentage Change to 5th Percentile Condition Flow (%)	**1.43**	**1.57**	**1.73**	**1.24**	**0.76**	**0.98**	**1.16**	**1.39**	**1.57**	**1.56**	**1.42**	**1.43**	**1.3**
SA-2	Baseline Scenario Average (m^3/s)	1.147	1.089	1.04	1.221	1.972	1.972	1.658	1.442	1.394	1.463	1.376	1.199	1.414
	Affected Scenario Average (m^3/s)	1.16	1.103	1.054	1.235	1.983	1.983	1.67	1.455	1.407	1.476	1.389	1.213	1.427
	Percentage Change to Average Condition Flow (%)	**1.21**	**1.29**	**1.37**	**1.12**	**0.57**	**0.57**	**0.74**	**0.9**	**0.94**	**0.88**	**0.96**	**1.15**	**0.92**
	Baseline Scenario 5th Percentile (m^3/s)	0.712	0.66	0.613	0.81	1.278	1.008	0.852	0.734	0.663	0.663	0.716	0.71	0.785
	Affected Scenario 5th Percentile (m^3/s)	0.727	0.675	0.628	0.824	1.292	1.022	0.867	0.749	0.679	0.678	0.732	0.725	0.8
	Percentage Change to 5th Percentile Condition Flow (%)	**2.14**	**2.34**	**2.54**	**1.85**	**1.06**	**1.42**	**1.74**	**2.07**	**2.32**	**2.33**	**2.13**	**2.15**	**1.92**
SA-6/ LA-6	Baseline Scenario Average (m^3/s)	1.129	1.075	1.029	1.199	1.9	1.9	1.607	1.405	1.36	1.425	1.343	1.178	1.379
	Affected Scenario Average (m^3/s)	1.128	1.074	1.028	1.197	1.898	1.898	1.605	1.403	1.359	1.424	1.342	1.177	1.378
	Percentage Change to Average Condition Flow (%)	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**
	Baseline Scenario 5th Percentile (m^3/s)	0.724	0.675	0.631	0.814	1.252	0.999	0.854	0.744	0.678	0.677	0.728	0.722	0.791
	Affected Scenario 5th Percentile (m^3/s)	0.723	0.674	0.63	0.814	1.251	0.998	0.853	0.743	0.677	0.677	0.727	0.721	0.791
	Percentage Change to 5th Percentile Condition Flow (%)	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**	**-0.11**
LA-1	Baseline Scenario Average (m^3/s)	1.572	1.502	1.458	1.674	2.372	2.356	2.078	1.868	1.8	1.863	1.803	1.641	1.832

Station	Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Monthly Average
	Affected Scenario Average (m^3/s)	1.586	1.516	1.472	1.687	2.383	2.368	2.09	1.881	1.813	1.876	1.817	1.655	1.845
	Percentage Change to Average Condition Flow (%)	**0.88**	**0.94**	**0.98**	**0.82**	**0.48**	**0.48**	**0.59**	**0.7**	**0.73**	**0.69**	**0.73**	**0.84**	**0.71**
	Baseline Scenario 5th Percentile (m^3/s)	1.055	0.971	0.89	1.198	1.767	1.453	1.26	1.082	0.974	0.975	1.063	1.053	1.145
	Affected Scenario 5th Percentile (m^3/s)	1.07	0.987	0.906	1.213	1.781	1.467	1.274	1.097	0.989	0.991	1.078	1.069	1.16
	Percentage Change to 5th Percentile Condition Flow (%)	**1.45**	**1.59**	**1.75**	**1.25**	**0.76**	**0.99**	**1.18**	**1.4**	**1.58**	**1.58**	**1.43**	**1.45**	**1.31**
LA-5	Baseline Scenario Average (m^3/s)	1.456	1.391	1.351	1.551	2.198	2.184	1.925	1.731	1.668	1.727	1.671	1.521	1.698
	Affected Scenario Average (m^3/s)	1.47	1.406	1.365	1.565	2.209	2.195	1.938	1.744	1.681	1.74	1.684	1.535	1.711
	Percentage Change to Average Condition Flow (%)	**0.95**	**1.01**	**1.05**	**0.88**	**0.52**	**0.52**	**0.64**	**0.75**	**0.79**	**0.75**	**0.79**	**0.9**	**0.77**
	Baseline Scenario 5th Percentile (m^3/s)	0.978	0.9	0.825	1.11	1.638	1.347	1.167	1.002	0.902	0.904	0.985	0.976	1.061
	Affected Scenario 5th Percentile (m^3/s)	0.993	0.916	0.84	1.125	1.651	1.361	1.182	1.018	0.918	0.919	1	0.991	1.076
	Percentage Change to 5th Percentile Condition Flow (%)	**1.56**	**1.71**	**1.89**	**1.35**	**0.82**	**1.06**	**1.27**	**1.52**	**1.71**	**1.71**	**1.55**	**1.56**	**1.42**
SB-3	Baseline Scenario Average (m^3/s)	0.141	0.135	0.131	0.15	0.213	0.211	0.186	0.167	0.161	0.167	0.162	0.147	0.164
	Affected Scenario Average (m^3/s)	0.14	0.133	0.13	0.149	0.211	0.209	0.185	0.166	0.16	0.166	0.16	0.146	0.163
	Percentage Change to Average Condition Flow (%)	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**
	Baseline Scenario 5th Percentile (m^3/s)	0.095	0.087	0.08	0.107	0.158	0.13	0.113	0.097	0.087	0.087	0.095	0.094	0.103
	Affected Scenario 5th Percentile (m^3/s)	0.094	0.086	0.079	0.106	0.157	0.129	0.112	0.096	0.087	0.087	0.094	0.094	0.102
	Percentage Change to 5th Percentile Condition Flow (%)	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**	**-0.86**

8.1.4.2.4 Future Centuries

During the future centuries phase, remediation works will be completed and the site naturalized, thereby restoring drainage patterns to report to surface waterbodies. Water taking or discharge will have ceased for several hundred years. Groundwater contributions to baseflow in local waterbodies, including Whitefish Lake, are expected to have rebounded to pre-development levels; therefore, effects on future centuries with respect to Surface Water Quantity are expected to be undetectable. After remediation has been completed, thawing of the freeze wall will occur. This will allow the eventual re-establishment of the pre-operational groundwater flow regime in the former mining area. The groundwater levels and discharge volumes to Whitefish Lake will return to baseline condition nine years into Post-Decommissioning and is projected to stabilize moving forward (Figure 7.4-2 in Section 7).

8.1.5 Mitigation Measures

The mitigation measures presented in the following bullets are proposed to avoid or reduce Project-related effects on Surface Water Quantity.

- Limit and stage the construction footprint (i.e., Project Area).
- Maintain existing drainage patterns with the use of culverts, where applicable.
- Maintain access roads by periodically regrading and ditching to improve water flow, reduce erosion, and manage vegetation growth.
- Inspect culverts periodically. Remove accumulated material and debris upstream and downstream of the culverts to prevent erosion, flooding, habitat damage, property damage, and mobilization of sediment.
- Attenuate peak discharges and augment baseflows to the environment using Project water storage features (i.e., runoff, process water, contact water, monitoring/effluent ponds).
- Recycle contact water for use as process water.
- Recycle process water for re-use.

8.1.6 Residual Effects Evaluation

8.1.6.1 Residual Effects Characterization

General definitions of the residual effect characteristics are provided in Section 5.8. A residual effect on Surface Water Quantity is defined as a measurable change in the flow or water levels relative to baseline. Residual effect characteristics specific to Surface Water Quality are defined in Table 8.1-14.

Table 8.1-14: Surface Water Quantity – Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Effect moves measurable parameters (flow or water level) in a direction detrimental to water quantity relative to baseline conditions. A Project-caused increase in surface water levels and flows during flooding, or a decrease in surface water flow below environmental flow requirements. **Positive** – Effect moves measurable parameters (flow or water level) in a direction beneficial to water quantity relative to baseline conditions. A Project-caused reduction in flooding events and related peak-flows/surface water levels resulting from flooding events.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Low** – A Project-related change in hydrology (flows or levels) compared to baseline conditions, but where the change is <5% from baseline conditions. **Moderate** – A Project-related change in hydrology (flows or levels) compared to baseline conditions, but where the change is >5% from baseline conditions. **High** – A Project-related change in hydrology (flows or levels) that results in surface water levels and flows above existing flood maximums or a change in the surface water quantity within a watercourse that is less than the environmental flow threshold, which may affect aquatic ecosystems.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the Surface Water Quantity LSA. **Regional** – Effect extends beyond the Surface Water Quantity LSA into the Surface Water Quantity RSA. **Beyond Regional** – Effect extends beyond the Surface Water Quantity RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions. **Partially Reversible** – A residual effect that partially diminishes to baseline conditions. **Irreversible** – A residual effect that will not diminish to baseline conditions.
Context	The extent to which the VC or KI has been affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its ability to recover	**Low** – VC/KI has high resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or a lack of historic and ongoing anthropogenic or natural disturbance. **Moderate** – VC/KI has moderate resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or an intermediate level of historic or ongoing anthropogenic or natural disturbance with the capacity to assimilate more change. **High** – VC/KI has weak resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or

Residual Effect Characteristic	Definition	Rating
	from that effect (i.e., resilience).	ecosystem, and/or a high level of historic or ongoing anthropogenic or natural disturbance.
Likelihood	Likelihood that the residual effect will occur, including consideration of the likelihood that the mitigation will be successful.	**Likely** – There is a moderate to high probability that the residual effect will occur. **Unlikely** – There is a low probability that the residual effect will occur.

Flows and water levels in lakes and rivers within the LSA will realize some adverse change (reduction) as a result of overprinting drainage areas reporting specifically to Whitefish Lake and water taking from this same waterbody. However, under all scenarios, including under low flow (5th percentile), the reduction in flow is expected to be less than 3% and, therefore, below the criteria for magnitude of 5%. This would be considered a low impact to existing environmental flows. Furthermore, the maximum predicted reduction in lake water levels was 0.0032 m at LA-5. All anticipated water level effects on other lakes within the vicinity of the Project, including LA-6, are expected to have negligible effects, with magnitudes also in the sub-centimeter range. As natural fluctuations in lake water levels were approximately 0.4 m from 2011 to 2019, Project-related changes are not expected to be of a magnitude to compromise the Surface Water Quantity VC.

Effects on surface water flows and levels are predicted to be localized to the subwatersheds within proximity to the mine, specifically Whitefish Lake, yet they are expected to occur over the course of the Project. However, the effects are expected to be fully reversible following Decommissioning as natural drainage patterns will be restored. A summary of residual effect ratings is provided in Table 8.1-15.

Table 8.1-15: Surface Water Quantity – Summary of the Characteristics Ratings for Residual Effects

Residual Effect Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Water quantity (flow and level) will be reduced in Whitefish Lake (LA-5) as a result of the overprinting of its reporting drainage area by mine infrastructure and through site water balance. Water taking has an additional potential to reduce water levels in Whitefish Lake.
Magnitude	Low	Under all scenarios, the Project-related change in hydrology (flows or levels) compared to baseline conditions is predicted to be <5% of baseline conditions, and generally <3%.
Geographic Extent	Local	The effects are expected to be limited to the LSA, specifically the lakes within proximity to the Project site (i.e., LA-5, LA-6, and LA-1).
Duration	Medium-term	The effects are expected to last between 3 to 38 years (i.e., effects expected during Construction through to the end of Post-Decommissioning).

Residual Effect Characteristic	Rating	Summary Rationale for Rating
Frequency	Continuous	Although the mine is unlikely to require water taking on a continuous basis, this scenario was assessed as the bounding scenario and, as such, was considered to be a continuous effect.
Reversibility	Fully Reversible	Surface water hydrology is expected to return to pre-development levels following Post-Decommissioning.
Context	Moderate	Surface water flow regimes are variable and it is this variability that provides for morphological form to be maintained and for ecological reliance (i.e., riparian inundation, aquatic biota movement and migration, ecological life process success). Some change to environmental flows is tolerated by hydrological systems.
Likelihood	Unlikely	Due to the localized nature and low magnitude of the predicted effects on surface water hydrology, the likelihood of an effect is considered to be very low.

8.1.6.2 Confidence in Assessment

As Surface Water Quantity is considered an intermediate VC, the significance of any associated residual effects is assessed within the context as a pathway to effects on receptor VCs. These receptor VCs include Fish and Fish Habitat (Section 8.3) and Sediment Quality and Benthic Invertebrates (Section 8.4). Determinations of significance of residual effects are provided in these sections.

The confidence in the assessment of predicted effects on hydrology is quite high due to available hydrological data for the LSA. Uncertainty is minimal with the assumptions that water withdrawal and discharge scenarios presented herein represent the bounding case and hydrogeological modelling projections are not changed. The low potential water withdrawal and discharge magnitudes proposed by Denison for the Project are predicted to result in negligible effects on the receiving environment within the LSA. The RSA was not assessed due to the much larger drainage area at the outlet of Russell Lake and greater attenuation of the signal of expected effects. All projected influences on streamflow from the Project are within +/- 5% of baseline conditions on a monthly average basis, with the largest influence occurring during withdrawal at a magnitude of -3.1%. Lake levels are anticipated to have a similarly negligible effect, with expected changes to water levels in LA-1 and LA-5 being less than 0.01 m.

8.1.6.3 Summary of Project-related Residual Adverse Effects on Surface Water Quantity

Since Surface Water Quantity is an intermediate VC, the results of residual effect characterizations for Surface Water Quantity do not have significance determinations of their own. Determinations of significance of residual adverse effects related to Surface Water Quantity are provided in association with receptor VCs in Sections 8.3, 8.4, and 8.5 (Fish and Fish Habitat, Sediment Quality and Benthic Invertebrates and Fish Health, respectively).

8.1.7 Cumulative Effects

The spatial and temporal boundaries of the Project specific to the Surface Water Quantity VC are provided in Section 8.1.1.3. A description of the methods used in assessing cumulative effects is provided in Section 5.9.

Project-related interactions are predicted to be limited both spatially and temporally. Spatially, interactions between the Project and Surface Water Quantity are predicted to be highly localized to Whitefish Lake South (LA-5) with no further propagation downstream of this immediate area. This is due to the small footprint of the Project, the relatively small volume of water that may be taken from surface waters, and the limited interaction between groundwater and surface waterbodies (i.e., Whitefish Lake) during all Project phases.

Existing projects within the Wheeler River Watershed have been considered for potential to interact with the Surface Water Quantity VC for the Project. These include reasonably foreseeable projects that are described in Section 5.9.

Projects with the potential to interact with the Surface Water Quantity VC for the Project include three existing mines and mills (i.e., Cameco Cigar Lake Mine, Cameco Key Lake Operation, and Cameco McArthur River Operation).

The Project is situated approximately 35 km northeast of the Cameco Key Lake Operation and 35 km southwest of the Cameco McArthur River Operation. The Project is located approximately 85 km southwest of the Cameco Cigar Lake Mine. These projects do not overlap spatially with the LSA of the Project and are, therefore, not further considered in the cumulative effects assessment.

8.1.7.1 Additional Mitigation Measures

Additional mitigation measures were not warranted as no potential cumulative effects were identified for the Surface Water Quantity VC.

8.1.7.2 Cumulative Effects Characterization and Determination of Significance

A determination of significance was not warranted as no potential cumulative effects were identified for the Surface Water Quantity VC.

8.1.7.3 Cumulative Effects Assessment Summary

No cumulative effects were identified for the Surface Water Quantity VC as no project and/or activity that may be considered as reasonably foreseeable overlaps with the defined RSA.

8.1.7.4 Environmental Monitoring and Follow-Up

Additional monitoring and follow-up were not warranted as no potential cumulative effects were identified for the Surface Water Quantity VC.

8.1.7.5 Climate Change Considerations

As discussed in Section 8.1.3.3, climate change is projected to increase precipitation in the vicinity of the Project. Though this will result in an increase of runoff in the LSA, the potential implications to evaporative effects are unknown. Evaporation, being a function of air temperature, wind speed, relative humidity, and radiation, may have a small increase given that air temperature may increase by as much as 6.2% (Table 8.1-5), though wind speed may similarly decrease by 2.6% in the same RCP scenario. Relative humidity is a representation of the ratio of actual to saturated vapour pressure and both are a function of temperature as well as vapour phase water in the air. Without a complete projected dataset for all parameters, as well as an accepted model, it is difficult to estimate the response of evaporation to these climatic influences.

Augmenting the data in an existing dataset did not yield a consistent shift in evaporation, which indicates the relationship is dynamic (Appendix 10-B). Any noted change between the datasets resulted in a change in evaporation rates of less than 5%. As such, given the small influence of evaporation and the variable range of predicted changes in precipitation and snow depth, the effects of climate change on the water balance are discussed qualitatively based on the four scenarios described in Section 8.1.4.2. The four projections for climate change scenarios are:

1. mean precipitation static and increased evaporation – this projection would result in a marginal decrease in flow rates from the Project;
2. increased precipitation and evaporation – this projection would at least partially cancel out, with either increased or decreased flow rates from the Project;
3. mean precipitation static and decreased evaporation – this projection would result in increased flow rates from the Project; and
4. increased precipitation and decreased evaporation – this projection would also result in increased flow rates from the Project.

Of the four potential climate change scenarios, only projections 1 and 2 have the potential to result in a condition where flow rates decrease as a result of climate change. Any decrease in flow rates due to climate change would likely be marginal and not statistically detectable as a result of projections 1 and 2. This is typically due to the already highly variable climate in Saskatchewan. Appreciable changes to the timing and magnitude of snow depth have the potential to alter current flow rates but are still unlikely to have substantial influence from the Project.

Extreme events are expected to change due to climate change. Qualitatively, climate change is expected to increase the frequency and magnitude of such events. Though the potential maximum PMP is not expected to increase as it is limited by the persistent dew point, the magnitude of the 1:100 year, 24-hour storm is expected to increase from 77.9 to 88.6 mm (approximately 10%). This may require consideration for greater storage and conveyance capacity for Project water management infrastructure.

8.1.8 Monitoring and Follow-up

For the purposes of this EIS, monitoring and follow-up are defined as follows:

- monitoring programs are designed to meet regulatory requirements (e.g., permit or license conditions) and/or to demonstrate compliance with environmental commitments made in the EIS; and
- follow-up programs are those that are proposed to address any uncertainties identified during the EA process (e.g., to verify predictions made during the EA; determine the effectiveness of proposed and implemented mitigation measures) and to determine if and when to implement adaptive management measures.

As no significant residual effects were identified and uncertainty was low with respect to the assessment of Project effects on Surface Water Quantity, a follow-up program is not required. However, it is suggested that continued hydrologic monitoring is important to provide Project phase information to monitor predictions and support effluent discharge permitting and approvals (i.e., meet approvals for continued surface water quality levels).

The long-term hydrological monitoring study at the Project site has been in place since 2011. The program should remain consistent to allow for the continued establishment of long-term streamflow trends at the site through relationships to long-term operating hydrometric gauging stations in the same watershed.

Monitoring should continue to include the following:

- streamflow monitoring;
- lake level monitoring; and
- installation of stage dataloggers.

Monitoring stations should continue to survey at locations throughout key catchment areas. Hydrometric monitoring at streamflow stations should include measurement of stream discharge and water level survey and maintenance of in-stream dataloggers.

8.1.9 Surface Water Quantity Summary

Denison initiated hydrometric baseline monitoring in 2011, which has continued up to the present at various locations throughout the LSA. Streamflow records at existing stations provide an understanding of the range of flows during open water conditions, including snowmelt runoff, rainfall response to storm events, and late summer low flow periods. Winter data are not available at most stations due to a lack of winter field monitoring programs. Long-term flow records with winter discharge are available from a Water Survey of Canada hydrometric monitoring station located downstream of Russell Lake on the Wheeler River (station 06DA005). Flow records from station 06DA005 have been extended to the assessment nodes at the Project either through correlation or unit area runoff analysis.

Assessment node LA-5 (Whitefish Lake) is located immediately downstream of the outlet of the lake adjacent to the main Project facilities. The extended flow record estimated for this node indicates mean annual flows ranging from 0.867 to 2.990 m^3/s, with an average flow of 1.409 m^3/s. The projected withdrawal and discharge rates proposed for the Project are the largest influence on the hydrological effects of the Project; however, the largest predicted change in streamflow rate is -3.1% at the LA-5 and SA-2 nodes (immediately downstream of the Project) during Operation and Decommissioning, as projected against the 5th percentile low flow dataset in March. Lake levels are expected to deviate less than ±0.01 m due to all Project influences. All Project influences on the environment are expected to return to baseline conditions during Post-Decommissioning.

Following mitigation through design and water management, Project-related effects on Surface Water Quantity are predicted to be **not significant**. The low potential water withdrawal and discharge magnitudes proposed by Denison for the Project are expected to result in no significant residual effects on the receiving environment within the LSA.

Some influence as a result of climate change is expected; however, predicted scenarios do not indicate an exacerbation of potential effects on the Surface Water Quantity of LSA waterbodies as a result of the Project.

Critical locations for monitoring should include the following nodes to remain consistent with the current long-term dataset.

- SA-1 – Streamflow monitoring station on the stream colloquially known as the Icelander River, which is located downstream of LA-1 (McGowan Lake).
- SA-2 – Streamflow monitoring station situated downstream of the outflow from LA-5 (Whitefish Lake) and upstream of the inflow to LA-1 (McGowan Lake).
- SA-3 – Streamflow monitoring station situated upstream of the inflow to LA-1 (McGowan Lake).
- SA-4 – Streamflow monitoring station situated upstream of the inflow to LA-6 (Unnamed Lake).
- SA-5 – Streamflow monitoring station situated upstream of the inflow to LA-6 (Unnamed Lake).
- SA-6 – Stream flow monitoring station situated downstream of the outflow from LA-6 (Whitefish Lake North) and upstream of the inflow to LA-5 (Whitefish Lake South).
- LA-6 – Lake level monitoring station at LA-6 (Whitefish Lake North).
- SB-3 – South Project drainage basin flowing to Russell Lake.
- LA-1 – McGowan Lake.
- LA-5 – Whitefish Lake South.

No cumulative effects were identified for the Surface Water Quantity VC as there are no projects and/or activities that may be considered as reasonably foreseeable that overlap with the defined RSA for this VC.

Changes in precipitation volumes, periodicity, and extreme events are plausible based on predictive models; however, any decrease in flow rates due to climate change would likely be marginal and not statistically detectable.

8.1.10 References

19-EN-MN-SR3-1.2, Site Visit (2019-08-23), Available from: Engagement Database

19-EN-ML82-1.3, Site Visit (2019-08-23), Available from: Engagement Database

19-EN-MOE-1.4, Site Visit (2019-08-23), Available from: Engagement Database

18-EN-VILX-3.33, Workshop (2018-01-17), Available from: Engagement Database

18-EN-VILX-3.35, Workshop (2018-01-17), Available from: Engagement Database

18-EN-VILX-3.39, Workshop (2018-01-17), Available from: Engagement Database

18-EN-VILX-3.84, Workshop (2018-01-17), Available from: Engagement Database

21-EN-VPL-444.3, Virtual Meeting (2021-02-11), Available from: Engagement Database

21-EN-VPL-444.4, Virtual Meeting (2021-02-11) Available from: Engagement Database

21-EN-BNFN-479.6, Email (2021-05-10), Available from: Engagement Database

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Canadian Centre for Climate Services (CCCS). 2021. *Climate Data Viewer*. https://climate-viewer.canada.ca/climate-maps.html#/?t=annual&v=tmean&d=cmip5&r=rcp85&z=2&ts=3 (accessed February 2021).

English River First Nation (ERFN) and Shared Value Solutions (SVS). 2022. *Wheeler River Project – Summary of Traditional Knowledge Study Results – English River First Nation. Shared Value Solutions*. Prepared for English River First Nation. March 2022.

Environment and Climate Change Canada (ECCC). 2021. *Water Level and Flow Data*. https://wateroffice.ec.gc.ca/index_e.html (accessed February 2021).

Institute for Catastrophic Loss Reduction. 2021. *IDF_CC Tool 5.0*. FIDS – Facility for Intelligent Decision Support and Western University Canada. idf cc uwo.ca/home (accessed February 2021).

Denison Mines Wheeler River Project, Northern Saskatchewan. 680.0018.000.

8.2 Surface Water Quality

This subsection addresses the potential effects of the Project on the Surface Water Quality VC. The following are discussed herein as part of the EA:

- scope of the assessment;
- summary of existing conditions relevant to the Surface Water Quality VC;
- identification and description of potential interactions between the Project and the Surface Water Quality VC;
- identification and description of mitigation measures applicable to the Surface Water Quality VC to eliminate, reduce, or control the potential adverse Project-related effects;
- identification and characterization of predicted Project-related residual effects on the Surface Water Quality VC after mitigation;
- characterization of significance and assignment of the level of confidence in the predictions; and
- identification and characterization of potential cumulative effects.

Figure 8.2-1 is a graphic representation of the assessment process used in this EIS.

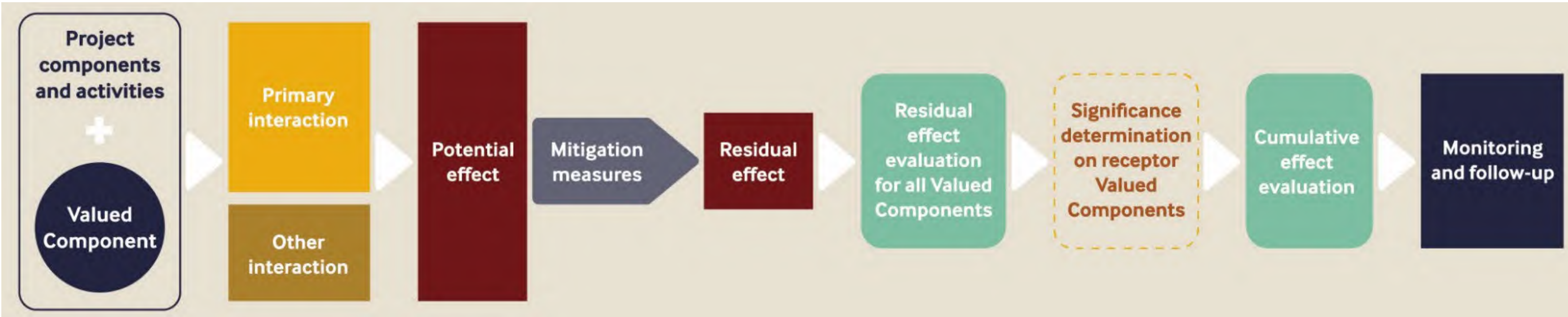

Figure 8.2-1: Environmental Assessment Process for the Wheeler River Project

8.2.1 Scope of the Assessment

The purpose of this assessment is to assess potential changes to Surface Water Quality in consideration of all Project phases at the Project, local, and regional study areas scales. Surface water quality pathways that are of interest are associated with site clearing and the potential for erosion-driven mobilization of suspended sediment, groundwater interactions with surface water features, and effluent discharge to the natural environment.

8.2.1.1 Valued Component Selection

The process and rationale for selection of VCs and establishment of KIs and associated MPs is described in Section 5. Section 5.8.1.1 defines intermediate VCs and receptor VCs. This section addresses the Surface Water Quality VC which is identified as an intermediate VC as it represents a physicochemical medium and pathway of influence to biological and ecological receptor VCs. The Surface Water Quality VC was selected for inclusion as Project activities have the potential to affect erosion-driven mobilization of suspended sediment, groundwater interactions with surface water features, and effluent discharge to the natural environment. Potential changes to water, from both a quantity and quality perspective, are key considerations within the EA process, as demonstrated by previous uranium mining development proposals in the Athabasca Basin, and draw a high level of concern from Interested Parties (see Section 8.2.2). Changes to Surface Water Quality have the potential to affect biodiversity and biological function through direct exposure and indirect food chain influences (i.e., aquatic sediments, fish and fish habitat, and benthic invertebrates), and the cultural values of Indigenous groups, the public, and other stakeholders. In this context, Surface Water Quality is interrelated or linked, to varying extents as an intermediate VC, to other intermediate and receptor VCs that are considered in this EIS, including:

Intermediate Valued Components

Surface Water Quantity: Surface water flow volumes and periodicity directly influence water quality in a waterbody. Natural and seasonal changes in precipitation, and therefore Surface Water Quantity, are directly related to Surface Water Quality. Project changes to surface drainage patterns, site water balance, and effluent discharge may influence Surface Water Quantity, which in turn may influence the assimilative capacity of receiving waters.

Groundwater Quality and Quantity: The quantity and quality of groundwater reporting to surface water through hydrologic connections can influence the water quality in surface waterbodies.

Receptor Valued Components

Terrestrial Environment: Surface water interacts with various VCs to shape ecosystem form, function, and biodiversity, including Vegetation and Ecosystems and Wetlands (i.e., riparian and wetland vegetation); Terrain, Soils, Organic Matter/Peat; Ungulates, Furbearers and Woodland

Caribou as well as Raptors, Migratory Breeding Birds, and Bird Species at Risk. Surface water quality is directly linked to terrestrial biota health through habitat and as a watering source.

Sediment Quality: Surface water and groundwater interface directly with the sediments of aquatic environments and the quality of this water directly influences the quality of the sediments. Aquatic sediments that fish, invertebrates, and microbes inhabit are the medium responsible for their ability to carry out some proportion of their life processes. An alteration to Surface Water and Groundwater Quality in the aquatic environment can affect Sediment Quality.

Fish and Fish Habitat, and Benthic Invertebrates: The water that fish and benthic invertebrates inhabit is the medium responsible for their ability to carry out their life processes. An alteration to Surface Water Quality in the aquatic environment can directly affect Fish and Fish Habitat, and Benthic Invertebrates.

Land and Resource Use: Indigenous Land and Resource Use and Other Land and Resource Use are influenced by Surface Water Quality as resource users use aquatic and terrestrial flora and fauna.

Human Health: Consideration is given to people drinking surface water as part of the Human Assessment.

Based on the above and the assessment approach described in Section 5, the Surface Water Quality VC is considered an intermediate VC. The assessment of the Surface Water Quality VC provides a full evaluation of residual effects with the determination of significance completed on receptor VCs such as Sediment Quality, Benthic Invertebrates, Fish and Fish Habitat, Fish Health, and Human Health.

Figure 8.2-2 is a graphic representation of the main linkages among the Surface Water Quality VC and other VCs, illustrating the flow of assessment information into and from the Surface Water Quality VC.

Figure 8.2-2: Integrated Assessment Approach - Key Connections between Surface Water Quality and Other Valued Components

8.2.1.2 Key Indicators and Measurable Parameters

The KI for this VC is any potential change in surface water quality from baseline conditions (e.g., a change in the concentration or level of a constituent in water that interacts with the Project). The rationale and MPs for the Surface Water Quality VC are provided in Table 8.2-1.

Table 8.2-1: Key Indicators and Measurable Parameters for Surface Water Quality

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Change in surface water quality from baseline concentrations	Introduction of constituents into receiving waterbodies as a result of the Project that are of a magnitude to negatively affect aquatic and non-aquatic biota associated with those waterbodies and/or water uses in the study area.	Change in the concentration of constituents that are directly related to Project activities as measured as a mass of a chemical per unit volume in water (e.g., mg/L).

8.2.1.3 Spatial and Temporal Boundaries

Generic considerations associated with the establishment of the spatial boundaries of the assessment are described in Section 5.3.3. As it pertains to the Surface Water Quality VC, the following is noted.

- The **Project Area** is the direct footprint of the Project. The Project Area represents the area within which Project activities and components may occur and, as such, represents the area within which direct physical disturbance may occur as a result of the Project, either temporary or permanent (i.e., the Project footprint; the area of maximum physical disturbance). This area is not VC-specific, but consistent throughout the EIS for all VCs.

- The **LSA** is the area that surrounds the Project Area where both direct and indirect effects resulting from Project activities can be reasonably measured. The LSA was established to assess the potential, largely direct effects of the Project and represents the extent to which there is a reasonable potential for the Project or Project-related activities to interact with and potentially adversely affect the VC. For the Surface Water Quality VC, the LSA was derived from watershed boundaries within proximity of the Project Area, including portions of watersheds that overlap the Project site, as well as areas directly downstream that may be influenced by the Project site or effluent discharge. The subwatersheds within the LSA are presented in Figure 8.1-3. This area was selected based on important waterbodies (notably Whitefish and McGowan lakes) downstream of the Project where effects may occur through all temporal phases. The LSA extends from those waterbodies down to their inflows to Russell Lake.
- The **RSA** is the area that surrounds and includes the LSA, and was established to assess the potential, largely indirect effects of the Project, as well as other activities, in a regional context. The RSA is large enough to capture the extent of potential effects (i.e., zone of influence) on a VC and defines the area within which cumulative effects may occur (i.e., cumulative effects assessment boundary). The RSA for the Surface Water Quality VC is bounded by the regional watershed area in which the Project Area is located. The RSA for this assessment is based on the whole watershed within which the Project is located and extends downstream to include Russell Lake (Figure 8.2-3).

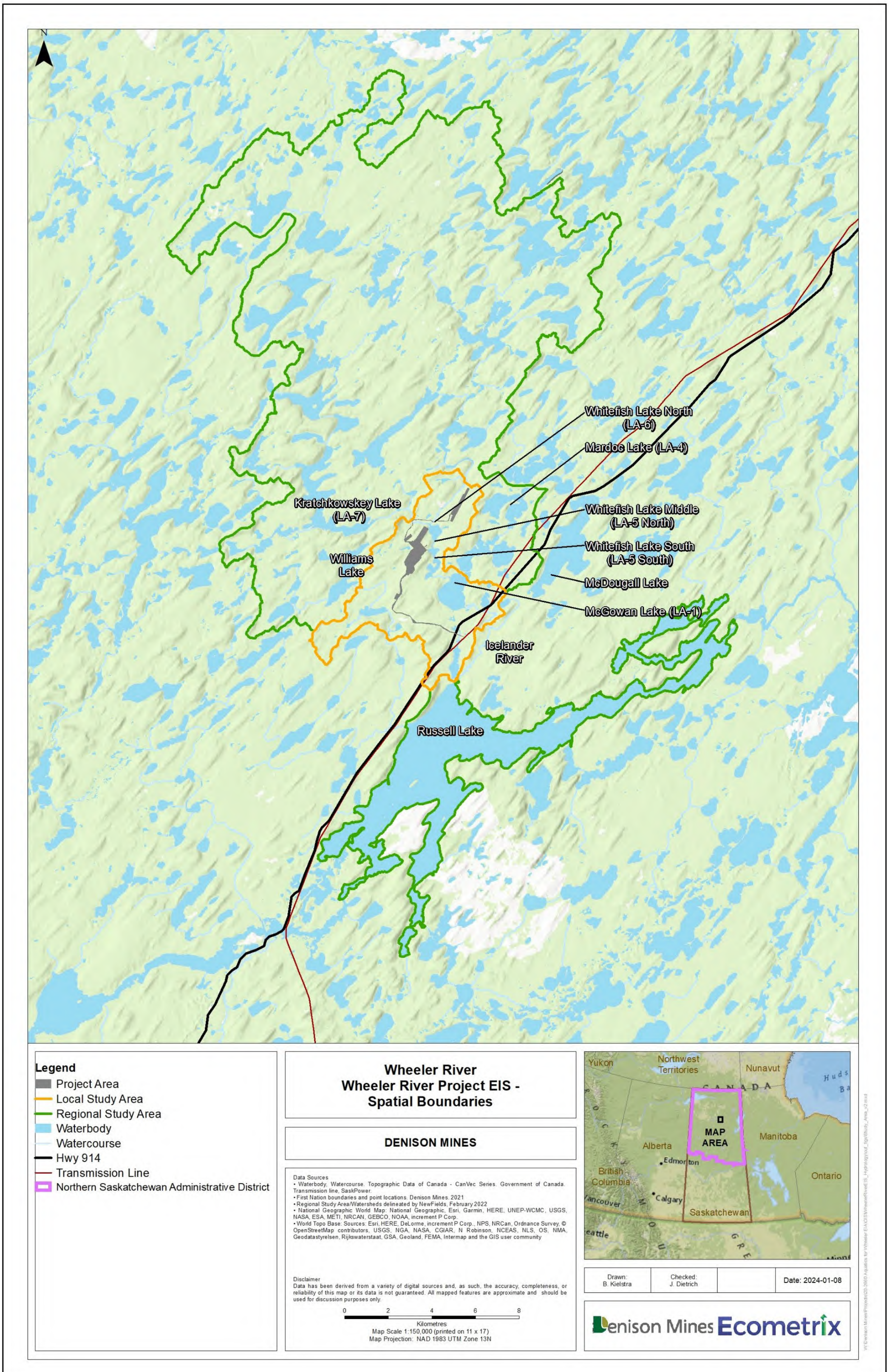

Figure 8.2-3: Spatial Boundaries for the Surface Water Quality Valued Component

Temporal boundaries for the EIS are defined in Table 5.3-3 in Section 5.3.4. The temporal boundaries applicable to and considered in the EIS include the following Project phases:

- Construction (Year 1 to 3);
- Operation (Year 3 to 18);
- Decommissioning (Year 18 to 23); and
- Post-Decommissioning (Year 23 to 38).

Additionally, a "future centuries" scenario is considered to assess the potential effects post-restoration (i.e., beyond the Project timeline of 0-38 years) and to reflect the time period over which the highest constituent concentrations in groundwater are predicted to migrate towards and interact with surface water.

This period represents the time where the highest constituent concentrations in groundwater are predicted to interact with surface water based on groundwater modeling. In this context, the future centuries scenario is considered with respect to the interaction of groundwater migration from the Project site and its potential influence on surface water in local water bodies. The future centuries projection encompasses the long-term period during which slow migration of groundwater from the Phoenix Ore Zone area to the surface water environment is anticipated and constitutes a bounding scenario of maximum concentrations of COPC.

8.2.2 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

At its broadest level, IK can be understood as the unique and collective knowledge of Indigenous peoples that may include, but is not limited to, the environmental, cultural, economic, political, and spiritual conditions of a community or region. In this section, IK and LK are viewed as complementary and influential alongside western science to produce a full understanding of the potential effects of the Project, whether measurable or perceived. Both forms of information have been given full and fair consideration.

Denison has recorded and stored information regarding IK, LK and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 18-EN-ERFN-5.68). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment. Appendix 8-A provides a summary of unique identification numbers referenced within Section 8.2.

Indigenous Knowledge and LK quotes and citations were included herein to provide readers with the information considered as the Project advanced throughout the EA process. Since 2016, Denison has been engaging with Interested Parties (i.e., local and Indigenous communities, residents, businesses, organizations, land users, and various regulatory authorities) to support the development of positive relationships and a mutual commitment to collaboration.

The history of resource sharing was described in sharing, such as:

> *"The biggest body of water to be impacted is Russell Lake – "Big Poor Fish Lake" in Dené. A lot of Scandinavians and Norwegians went up there in the 1930s and partnered with First Nations in that territory"* (18-EN-ERFN-5.68).

The influence of IK, LK, and engagement on the assessment of the Surface Water Quality VC has first and foremost shaped the shared value of water and its life-sustaining properties.

> *"The lands and waters, we are definitely connected as peoples of English River. If we don't have the lands, we are not connected. If we don't have the water... Water is life to us"* (ERFN and SVS 2022).

Comments associated with water management and discharge to the environment were significant in the engagement record[2], and these were considered within the context of community interest regarding surface waters remaining supportive of natural function for biota. To this end, Project-related water management and treatment are important to maintaining surface water quality within the LSA and RSA.

Indigenous peoples and LK holders were clear in their interest regarding current levels of constituents in the aquatic ecosystem and the potential for adverse changes resulting from the Project. For example:

> *"How many lakes have you tested? Is there mercury?"* (19-EN-ML21-62.34);
>
> *"Russell is one lake where I commercially fish. How will this effluent impact the water quality, fish health? Will I be able to sell fish from here? If there is going to water pollution, I just want to know"* (19-LK-ERFNTrap-134.255);
>
> *"How are you going to protect the water quality? We are concerned about mercury in fish, other animals, etc. Is there mercury or arsenic in the uranium solution?"* (21-EN-LLRIB-392.15); and
>
> *"What is the plan for storing and cleaning the water and where does it flow? What is the impact of ISR mining on water quality?"* (21-EN-VILX-443.25).

Indigenous Knowledge and LK clearly identify the importance of water quality to local community members, plants, wildlife, and fish. This affirms the necessity to include Surface Water Quality as a VC in the EA Based on engagement, it is understood that additional detail is expected with respect to the potential effects of the Project on Surface Water Quality, and this section of the EIS is responsive to that expectation.

[2] 19-EN-MN-SR3-1.2, 19-EN-ML82-1.3, 19-EN-MOE-1.4, 18-EN-VILX-3.33, 18-EN-VILX-3.35, 18-EN-VILX-3.39, and 18-EN-VILX-3.84.

8.2.3 Existing Environment

Sampling of the aquatic environment for water quality and biota was conducted from 2014 to 2019. Detailed accounts of the methods and results of these field surveys are provided in Ecometrix (2020) and further discussed from an ecological risk perspective in the *Environmental Risk Assessment for Wheeler River* (see Appendix 10-A in Section 10).

8.2.3.1 Methodology and Metrics

Surface water quality was sampled during 2016, 2018, and 2019 at lakes and watercourses within the LSA and RSA (Figure 8.2-4 and Appendix 8-D). Sampling at lakes and ponds included the measurement of both physical and chemical parameters obtained in situ during field surveys and by laboratory analysis. Field measurements at each station included:

- conductivity;
- pH;
- temperature;
- dissolved oxygen (DO); and
- water clarity.

A depth profile of these parameters was recorded in each lake at its deepest location, as identified during bathymetric investigations. Conductivity, pH, temperature, and DO were measured at 1 m intervals from the surface to the bottom of the water column. Water clarity at the lake profile location was assessed by measuring the secchi disk depth.

Laboratory analysis of samples collected during baseline collections included the following:

- pH and conductivity;
- total suspended solids (TSS) and total dissolved solids (TDS);
- alkalinity, acidity, and hardness;
- nutrients (total and dissolved phosphorus, ammonia, and total kjeldahl nitrogen);
- total metals; and
- radionuclides.

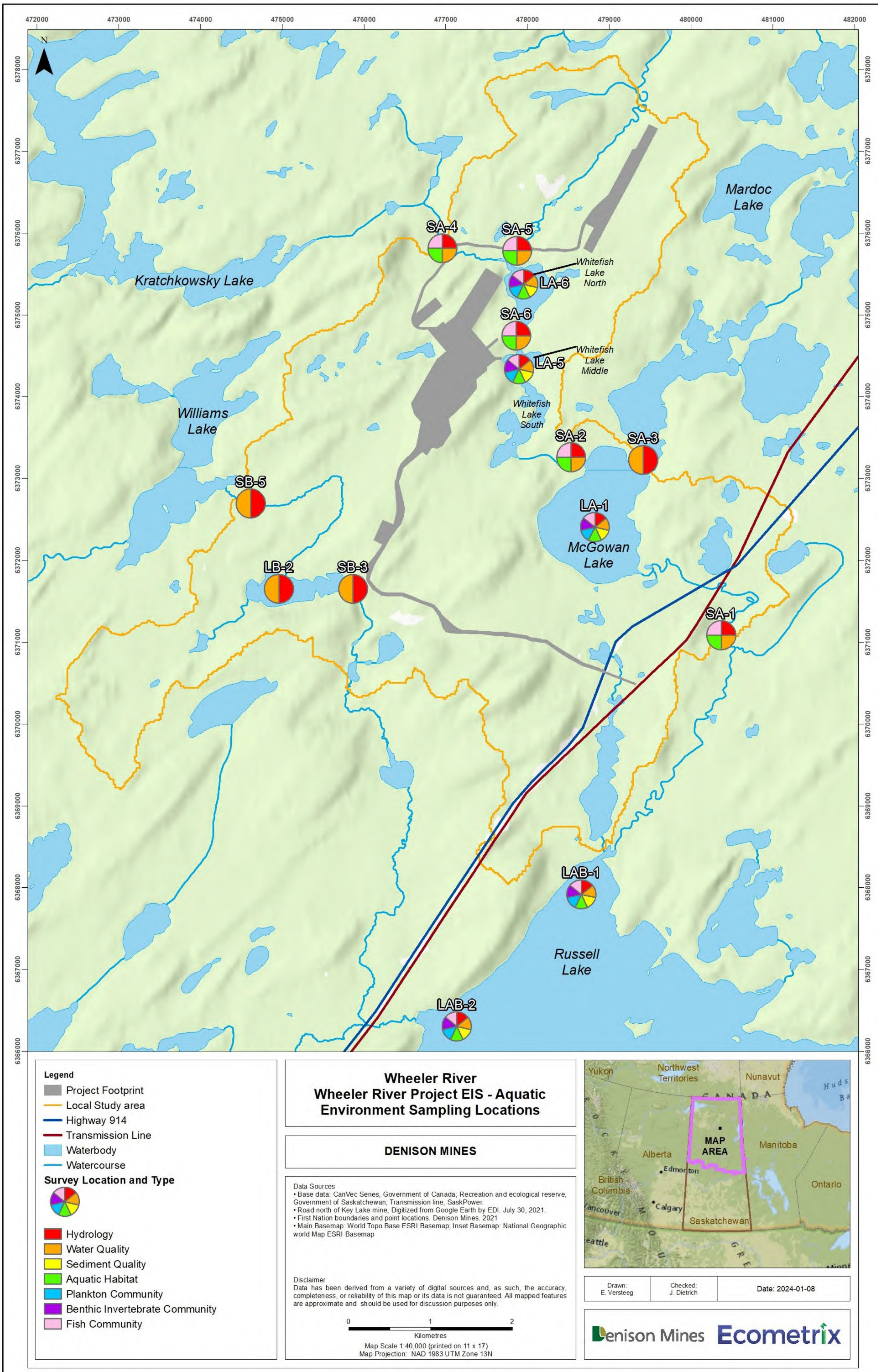

Figure 8.2-4: Water Quality, Biota, and Sediment Sampling Locations (2016 to 2018)

For each sampling location, a single surface water sample was collected for laboratory analysis from near the surface using a beta bottle. At stations where a distinct thermocline was observed at the time of the field sampling program (i.e., the water column was not well mixed), a second water sample was collected from below the thermocline using a beta bottle. Quality assurance samples (i.e., field blank, trip blank, and field duplicates) were collected as part of the sampling program. Sampling locations were georeferenced. Water samples were analyzed by Saskatchewan Research Council Environmental Analytical Laboratories (Saskatoon, Saskatchewan), a Canadian Association for Laboratory Accreditation Inc. certified laboratory, for the full series of constituents. Samples were analyzed with method detection limits at or below Saskatchewan Environmental Quality Guidelines (SEQG) Saskatchewan Surface Water Quality Objectives (SSWQO) and Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines (CWQG) for the Protection of Aquatic Life for each parameter. Surface water chemistry was also measured in situ at all stream stations and was consistent with those measured at lakes (Figure 8.2-4).

8.2.3.2 Sample Locations

Locations of interest for this assessment include the following nodes that are coincident with baseline monitoring stations and/or watersheds of interest to the assessment (Table 8.2-2; Figure 8.2-4). Surface water quality was sampled at these stations along with other study components, as listed below.

- SA-1 – Fish community and habitat survey location on the stream colloquially known as the Icelander River, which is located downstream of LA-1 (McGowan Lake).
- SA-2 – Fish community and habitat survey location situated downstream of the outflow from LA-5 (Whitefish Lake South) and upstream of the inflow to LA-1 (McGowan Lake).
- SA-3 – Hydrology and water quality survey location situated in a small channel upstream of LA-1 (McGowan Lake) and downstream of LA-2.
- SA-4 – Fish community and habitat survey location situated upstream of the inflow to LA-6 (Whitefish Lake North).
- SA-5 – Fish community and habitat survey location situated upstream of the inflow to LA-6 (Whitefish Lake North).
- SA-6 – Fish community and habitat survey location situated downstream of the outflow from LA-6 (Whitefish Lake North) and upstream of the inflow to LA-5 (Whitefish Lake South).
- SB-3 – Hydrology and water quality survey location situated upstream of LB-1, in the outlet of LB-2.
- SB-5 – Hydrology and water quality survey location situated upstream of LB-2, near the outlet of LB-3 (Williams Lake).
- LAB – Russell Lake.
- LB-2. – Unnamed Lake

- LA-1 – McGowan Lake.
- LA-5 – Whitefish Lake South.
- LA-6 – Whitefish Lake North.

8.2.3.3 Existing Surface Water Quality

Summary statistics of existing surface water quality for lakes and watercourses are provided in Table 8.2-2 and Table 8.2-3. Percent occurrence of water quality concentrations not meeting provincial or federal benchmarks during baseline are provided in Table 8.2-4. Additional detail is provided in Appendix 8-D.

For parameters where water quality guidelines were available, most were below their respective guidelines at all sampling locations. Cases where constituent concentrations exceeded guidelines are detailed in Table 8.2-2. Generally, at least one sample from each waterbody within the LSA contained aluminum concentrations that exceeded the SEQG. In some cases, such as waterbodies LB-2 and SB-3, all water samples exhibited aluminum concentrations higher than the SEQG. There were also several instances where water pH was below the lower threshold of the CCME CWQG for the Protection of Aquatic Life, such as samples from Whitefish Lake North, SA-1, SA-3, SA-5, SA-6, SB-3, and SB-5 (Table 8.2-4). Other metals that had higher concentrations than their guidelines included lead, iron, copper, and cadmium, though in these cases, the maximum concentration was only marginally above the guideline value and for copper the detection limit (0.0002 mg/L) is equal to the long-term guideline.

Table 8.2-2: Baseline Surface Water Quality in Local Study Area Lakes and Russell Lake

Parameter	Units	Short-term Benchmark			Long-term Benchmark			McGowan Lake (LA-1)			Whitefish Lake South (LA-5)			Whitefish Lake North (LA-6)		
		Value	Reference	Notes	Value	Reference	Notes	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Alkalinity	mg/L							2	10	6	3	13	7.7	3	38	15
Aluminum	mg/L				0.1	SEQG/CCME	(1)	0.001	0.0051	0.0034	0.0048	0.0078	0.0061	0.005	0.073	0.0201
Ammonia as N	mg/L				5.74	SEQG/CCME	(2)	<0.01	0.09	0.0266	<0.01	0.07	0.043	<0.01	0.05	0.026
Ammonia, unionized	mg/L				0.019	SEQG/CCME		1.84E-05	1.66E-04	4.89E-05	1.84E-05	1.29E-04	7.91E-05	1.84E-05	9.20E-05	4.78E-05
Antimony	mg/L							<0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.000233	<0.0002	<0.0002	<0.0002
Arsenic	mg/L				0.005	SEQG/CCME		<0.0001	<0.0001	<0.0001	0.0001	0.0001	<0.0001	0.0001	0.0001	<0.0001
Barium	mg/L							0.0023	0.0038	0.003	0.0021	0.0032	0.0027	0.0024	0.0051	0.00328
Beryllium	mg/L							<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Bicarbonate	mg/L							2	12	7.8	4	16	9.3	4	46	13.4
Boron	mg/L	29	CCME		1.5	SEQG/CCME		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/L	0.00011	SEQG/CCME	(3)	0.00004	SEQG/CCME		<0.00001	0.00003	0.000015	<0.00001	0.00002	0.000013	<0.00001	**0.00004**	0.000016
Calcium	mg/L							1.1	1.7	1.35	1.2	1.6	1.4	1.1	1.5	1.24
Carbonate	mg/L							<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloride	mg/L	640	SEQG/CCME	(4)	120	SEQG/CCME		0.4	0.5	0.43	0.3	0.4	0.33	0.3	0.4	0.32
Chromium	mg/L				0.001	SEQG/CCME	(5)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L				0.00078	FEQG	(14)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Copper	mg/L	0.0009	SEQG	(6)	0.0002	FEQG	(7)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	**0.0004**	**0.00024**
DOC	mg/L							2	2.6	2.23	2	2.5	2.2	2	2.5	2.22
Fluoride	mg/L							<0.01	0.08	0.03166	0.02	0.07	0.037	0.02	0.08	0.042
Hardness	mg/L							5	6	5.5	5	6	5.3	5	5	5
Hydroxide	mg/L							<1	<1	<1	<1	<1	<1	<1	<1	<1
Iron	mg/L				0.3	SEQG/CCME		0.037	0.27	0.12	0.04	0.19	0.11	0.031	0.21	0.1064
Lead	mg/L				0.001	SEQG/CCME		<0.0001	0.0004	0.00015	<0.0001	<0.0001	<0.0001	<0.0001	**0.0012**	0.00032
Lead-210	Bq/L				0.2	HC		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Magnesium	mg/L							0.3	0.5	0.42	0.4	0.4	0.4	0.2	0.4	0.36
Manganese	mg/L	0.501	CCME	(8)	0.21	SEQG/CCME	(9)	0.0039	0.029	0.016	0.0046	0.02	0.0142	0.0024	0.019	0.01232
Mercury	mg/L				0.000026	CCME		1.00E-07	1.00E-05	6.00E-06	1.00E-06	1.00E-05	7.00E-06	1.00E-07	1.00E-05	6.00E-06

Parameter	Units	Short-term Benchmark			Long-term Benchmark			McGowan Lake (LA-1)			Whitefish Lake South (LA-5)			Whitefish Lake North (LA-6)		
		Value	Reference	Notes	Value	Reference	Notes	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Molybdenum	mg/L				0.07	WHO		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel	mg/L				0.025	CCME		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0004	0.00016
Nitrate	mg/L	550	CCME		3.0	SEQG		<0.04	0.49	0.18	<0.04	0.26	0.15	<0.04	0.31	0.1725
pH	units				6.5-9.0	SEQG/CCME		6.52	6.94	6.77	6.60	7.00	6.80	**5.71**	6.79	6.50
Phosphorus	mg/L				0.004 - 0.01	CCME	(10)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Polonium-210	Bq/L				0.1	HC		<0.005	<0.005	<0.005	<0.005	0.008	0.006	<0.005	<0.005	<0.005
Potassium	mg/L							0.2	0.5	0.37	0.2	0.4	0.33	0.2	0.4	0.32
Radium-226	Bq/L				0.11	SEQG		<0.005	<0.005	<0.005	<0.005	0.01	0.0076667	<0.005	<0.005	<0.005
Selenium	mg/L				0.001	CCME		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Silver	mg/L				0.25	CCME		<0.00005	<0.00005	<0.00005	0.00005	0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Sodium	mg/L							1.4	1.8	1.5	1.4	1.7	1.5	1.4	1.8	1.52
Conductivity	µS/cm							9	24	16.8	16	22	19	9	21	15.2
Strontium	mg/L				2.5	FEQG		0.012	0.016	0.014	0.012	0.015	0.013	0.011	0.014	0.0126
Sulphate	mg/L				128	BC MOE		0.7	0.8	0.75	0.6	0.7	0.63	0.5	0.7	0.64
Sum of Ions								6	18	12.5	8	22	14	8	51	18
Temperature	°C	Narrative	CCME		Narrative	CCME		11.6	11.7	11.7	9.8	15.5	13.1	13.7	13.8	13.8
Thallium	mg/L				0.0008	SEQG/CCME		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Thorium-228	Bq/L							<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium-230	Bq/L				0.6	HC		<0.01	<0.01	<0.01	<0.01	0.02	0.0133	<0.01	<0.01	<0.01
Thorium-232	Bq/L							<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tin	mg/L							<0.0001	0.0013	0.0004	<0.0001	0.0008	0.00033	<0.0001	0.0011	0.0003
Titanium	mg/L							<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
TDS	mg/L				500	SEQG		18	26	22.167	22	29	24	14	29	22.2
TKN	mg/L							0.17	0.38	0.27333	0.14	0.34	0.22	0.24	0.43	0.306
TOC	mg/L							2.2	2.6	2.3667	1.9	4.3	2.8	2.2	2.9	2.36
TSS	mg/L				background + 5 mg/L	CCME		<1	4	2.5	<1	4	2.66	<1	4	2
Uranium	mg/L	0.033	CCME		0.015	SEQG/CCME		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Vanadium	mg/L				0.12	FEQG		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Parameter	Units	Short-term Benchmark			Long-term Benchmark			McGowan Lake (LA-1)			Whitefish Lake South (LA-5)			Whitefish Lake North (LA-6)		
		Value	Reference	Notes	Value	Reference	Notes	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Zinc	mg/L	0.008	CCME	(11)(12)	0.013	CCME	(13)	<0.0005	0.001	0.00058	<0.0005	<0.0005	<0.0005	<0.0005	**0.02**	0.00474

Table 8.2-2: Baseline Surface Water Quality in Local Study Area Lakes and Russell Lake (Continued)

Parameter	Units	Short-term Benchmark			Long-term Benchmark			Russell Lake (LAB-1)			Russell Lake (LAB-2)			LB-2		
		Value	Reference	Notes	Value	Reference	Notes	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Alkalinity	mg/L							2	14	7.7	8	8	8	7	12	9.5
Aluminum	mg/L				0.1	SEQG/CCME	(1)	0.0023	0.0025	0.0024	0.0029	0.0029	0.0029	0.0067	0.0096	0.0082
Ammonia as N	mg/L				5.74	SEQG/CCME	(2)	<0.01	0.05	0.0233	<0.01	<0.01	<0.01	<0.01	0.04	0.025
Ammonia, unionized	ug/L				0.019	SEQG/CCME		1.84E-05	9.20E-05	4.29E-05	1.84E-05	1.84E-05	1.84E-05	1.84E-05	7.36E-05	4.60E-05
Antimony	mg/L							<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Arsenic	mg/L				0.005	SEQG/CCME		0.0001	0.0001	<0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Barium	mg/L							0.0033	0.0039	0.0036	0.0034	0.0034	0.0034	0.0033	0.0046	0.004
Beryllium	mg/L							<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Bicarbonate	mg/L							2	17	9	10	10	10	8	15	12
Boron	mg/L	29	CCME		1.5	SEQG/CCME		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/L	0.00011	SEQG/CCME	(3)	0.00004	SEQG/CCME		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Calcium	mg/L							2.7	3.9	3.5	3.5	3.5	3.5	1.3	1.8	1.6
Carbonate	mg/L							<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloride	mg/L	640	SEQG/CCME	(4)	120	SEQG/CCME		<0.1	0.5	0.3333333	0.4	0.4	0.4	0.2	0.2	0.2
Chromium	mg/L				0.001	SEQG/CCME	(5)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L				0.00078	FEQG	(14)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Copper	mg/L	0.0009	SEQG	(6)	0.0002	FEQG	(7)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
DOC	mg/L							2.1	2.5	2.3	2.2	2.2	2.2	2.6	3.5	3.1
Fluoride	mg/L							0.02	0.07	0.04	0.03	0.03	0.03	<0.01	0.07	0.04
Hardness	mg/L							9	13	11	12	12	12	5	6	5.5
Hydroxide	mg/L							<1	<1	<1	<1	<1	<1	<1	<1	<1
Iron	mg/L				0.3	SEQG/CCME		0.056	0.08	0.070667	0.039	0.039	0.039	0.15	0.15	0.15

Parameter	Units	Short-term Benchmark			Long-term Benchmark			Russell Lake (LAB-1)			Russell Lake (LAB-2)			LB-2		
		Value	Reference	Notes	Value	Reference	Notes	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Lead	mg/L				0.001	SEQG/CCME		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Lead-210	Bq/L				0.2	HC		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Magnesium	mg/L							0.5	0.7	0.6	0.7	0.7	0.7	0.4	0.4	0.4
Manganese	mg/L	0.501	CCME	(8)	0.21	SEQG/CCME	(9)	0.029	0.064	0.045	0.019	0.019	0.019	0.0094	0.037	0.0232
Mercury	mg/L				0.000026	CCME		1.00E-06	1.00E-05	7.00E-06	1.00E-07	1.00E-07	1.00E-07	1.00E-06	1.00E-05	5.50E-06
Molybdenum	mg/L				0.07	WHO		0.0003	0.0013	0.00077	0.0011	0.0011	0.0011	<0.0001	<0.0001	<0.0001
Nickel	mg/L				0.025	CCME		0.0001	0.0001	<0.0001	0.0003	0.0003	0.0003	0.0001	0.0002	0.00015
Nitrate	mg/L	550	CCME		3.0	SEQG		0.05	0.44	0.25	0.05	0.05	0.05	<0.04	0.66	0.35
pH	units				6.5-9.0	SEQG/CCME		6.70	7.00	6.90	7.20	7.20	7.20	6.70	6.80	6.80
Phosphorus	mg/L				0.004 - 0.01	CCME	(10)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Polonium-210	Bq/L				0.1	HC		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Potassium	mg/L							0.3	0.6	0.5	0.8	0.8	0.8	0.2	0.4	0.3
Radium-226	Bq/L				0.11	SEQG		<0.005	0.006	0.0053333	0.007	0.007	0.007	<0.005	0.008	0.0065
Selenium	mg/L				0.001	CCME		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Silver	mg/L				0.25	CCME		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Sodium	mg/L							1.7	2	1.8	1.7	1.7	1.7	1.4	1.6	1.5
Conductivity	µS/cm							30	47	38	42	42	42	20	22	21
Strontium	mg/L				2.5	FEQG		0.017	0.018	0.017	0.016	0.016	0.016	0.013	0.016	0.0145
Sulphate	mg/L				128	BC MOE		3.7	8.1	6.5	8.3	8.3	8.3	0.5	0.8	0.65
Sum of Ions								18	28	23	25	25	25	12	21	16.5
Temperature	ºC	Narrative	CCME		Narrative	CCME		11.6	11.4	11.5	10.2	15.5	13.6	12.1	15.3	14.1
Thallium	mg/L				0.0008	SEQG/CCME		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Thorium-228	Bq/L							<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium-230	Bq/L				0.6	HC		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium-232	Bq/L							<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tin	mg/L							<0.0001	0.001	0.0004	<0.0001	<0.0001	<0.0001	<0.0001	0.0008	0.00045
Titanium	mg/L							<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
TDS	mg/L				500	SEQG		30	35	32	35	35	35	19	30	24.5
TKN	mg/L							0.14	0.22	0.17	0.29	0.29	0.29	0.13	0.35	0.24

Parameter	Units	Short-term Benchmark			Long-term Benchmark			Russell Lake (LAB-1)			Russell Lake (LAB-2)			LB-2		
		Value	Reference	Notes	Value	Reference	Notes	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
TOC	mg/L							2.2	2.6	2.4	2.2	2.2	2.2	2.7	3.6	3.2
TSS					background + 5 mg/L	CCME		1	1	<1	4	4	4	<1	<1	<1
Uranium	mg/L	0.033	CCME		0.015	SEQG/CCME		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Vanadium	mg/L				0.12	FEQG		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Zinc	mg/L	0.008	CCME	(11)(12)	0.013	CCME	(13)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0018	0.00115

Notes:

All parameters listed as total concentrations unless otherwise specified.

Saskatchewan Water Quality Objectives, SEQG on-line (https://envrbrportal.crmp.saskatchewan.ca/seqg-search/), SEQG for the protection of aquatic life were selected, based on total concentrations.

Bold numbers indicate exceedance of a long-term criterion.

Bold and italicized indicate exceedance of the short-term criterion and long-term criterion.

SEQG – Saskatchewan Environmental Quality Guidelines – Water Quality Guidelines for Freshwater Aquatic Life.

CWQG – Canadian Council of Ministers of the Environment – Canadian Water Quality Guidelines for the Protection of Aquatic Life.

SSWQO – Saskatchewan Surface Water Quality Objectives.

DOC – Dissolved organic carbon.

TDS – Total dissolved solids.

TKN – Total Kjeldahl Nitrogen.

TOC – Total organic carbon.

TSS – Total suspended solids.

Temperature - Maximum Weekly Average Temperature: Thermal additions to receiving waters should be such that the maximum weekly average temperature is not exceeded. Short-term Exposure to Extreme Temperature: Thermal additions to receiving waters should be such that the short-term exposures to maximum temperatures are not exceeded. Exposures should not be so lengthy or frequent as to adversely affect the important species.

pH of 7 and a temperature of 15°C were assumed to convert total ammonia to un-ionized ammonia in accordance with CCME (2002).

(1) Long-term criterion for aluminum based on CCME/SEQG of 0.1 mg/L for dissolved aluminum when pH is greater than 6.5.
(2) Total ammonia-N calculated from the total ammonia guideline for an average annual temperature of 15°C and a pH of 7.0, Un-ionized Ammonia from Table 1 of temperature and pH, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Ammonia (https://ccme.ca/en/res/ammonia-en-canadian-water-quality-guidelines-for-the-protection-of-aquatic-life.pdf).
(3) Based on water hardness of >0 to <5.3 mg/L (Site-specific background hardness is 5.26 mg/L (95th percentile of LA-5 and LA-6).
(4) Based on water hardness >0 to <17 mg/L.
(5) Guideline specific to Chromium VI for conservative comparison to baseline water quality.

(6) Based on hardness of 5.26 mg/L (Short-term equation is ($e^{\{0.979123[\ln(hardness)]-8.64497\}}$)*1000 (SEGQ via AEP 1996b).
(7) Federal Water Quality Guideline for Copper Biotic Ligand Model (BLM) Tool and User Manual, (Site-specific background hardness is 5.26 mg/L, DOC is 2.24 mg/L, pH is 6.61 (95th percentile of LA-5 and LA-6).
(8) Short Term Guideline is based on dissolved manganese. Benchmark = exp(0.878[ln(hardness)] + 4.76) where the benchmark is expressed in dissolved manganese concentration (µg/L), and hardness is measured as CaCO3 equivalents in mg/L. (Site-specific hardness is 5.26 mg/L (95th percentile of LA-5 and LA-6).
(9) Long-term guideline for manganese based on Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life - Manganese, Appendix B - Canadian Water Quality Guidelines Calculator (pH = 6.61, hardness = 5.26 mg/L.
(10) Framework provides Trigger Ranges for Total Phosphorus (µg/L) - guideline for oligotrophic waterbody 4 - 10 µg/L.
(11) Guideline is based on dissolved zinc.
(12) Short term guideline is based on Benchmark = exp(0.833[ln(hardness mg·L-1)] + 0.240[ln(DOC mg·L-1)] + 0.526). (Site-specific background hardness is 5.26 mg/L, DOC is 2.24 mg/L, pH is 6.61 (95th percentile of LA-5 and LA-6). Note – extrapolated for value outside the hardness range.
(13) Long term guideline is based on CWQG = exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625). (Site-specific background hardness is 5.26 mg/L, DOC is 2.24 mg/L, pH is 6.61 (95th percentile of LA-5 and LA-6). Note – extrapolated for value outside the hardness range.
(14) Environment Canada 2017. Federal Environmental Quality Guidelines, Cobalt, May. Based on equation and lowest hardness for equation of 52 mg/L.

Table 8.2-3: Baseline Surface Water Quality in Local Study Area Watercourses

Parameter	Units	Short-term Benchmark			Long-term Benchmark			Icelander River (SA-1)			SA-2			SA-3	
		Value	Reference	Notes	Value	Reference	Notes	Min	Max	Mean	Min	Max	Mean	Min	Max
Alkalinity	mg/L							2	13	5.5	2	11	6.75	1	23
Aluminum	mg/L				0.1	SEQG/CCME	(1)	0.0022	0.0056	0.0037	0.0039	0.081	0.015	0.0013	0.006
Ammonia as N	mg/L				5.74	SEQG/CCME	(2)	<0.01	0.04	0.014	<0.01	0.04	0.01375	<0.01	0.04
Ammonia, unionized	mg/L				0.019	SEQG/CCME		1.84E-05	7.36E-05	2.576E-05	1.84E-05	7.36E-05	2.53E-05	1.84E-05	7.36E-05
Antimony	mg/L							<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Arsenic	mg/L				0.005	SEQG/CCME		<0.0001	<0.0001	<0.0001	0.0001	0.0001	<0.0001	0.0001	0.0001
Barium	mg/L							0.0022	0.0035	0.00267	0.0019	0.0041	0.0026625	0.0025	0.004
Beryllium	mg/L							<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Bicarbonate	mg/L							2	16	6.7	2	13	8.125	1	28
Boron	mg/L	29	CCME		1.5	SEQG/CCME		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/L	0.00011	SEQG/CCME	(3)	0.00004	SEQG/CCME		<1.0E-05	0.00002	0.000012	<1.0E-05	0.00002	0.0000125	1.00E-05	0.00002
Calcium	mg/L							1.3	1.7	1.4	1.2	1.7	1.3375	1.5	1.9
Carbonate	mg/L							<1	<1	<1	<1	<1	<1	<1	<1
Chloride	mg/L	640	SEQG/CCME	(4)	120	SEQG/CCME		0.4	0.6	0.45	0.2	0.4	0.3125	0.5	0.7
Chromium	mg/L				0.001	SEQG/CCME	(5)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L				0.00078	FEQG	(14)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Copper	mg/L	0.0009	SEQG	(6)	0.0002	FEQG	(7)	<0.0002	<0.0002	<0.0002	<0.0002	**0.0008**	**0.000275**	<0.0002	<0.0002
DOC	mg/L							1.7	2.4	2.13	1.9	2.5	2.225	1.7	2.6
Fluoride	mg/L							0.01	0.07	0.026	0.01	0.03	0.01625	<0.01	0.07
Hardness	mg/L							5	6	5.3	4	6	4.75	5	7
Hydroxide	mg/L							<1	<1	<1	<1	<1	<1	<1	<1
Iron	mg/L				0.3	SEQG/CCME		0.031	0.31	0.1215	0.041	0.11	0.073875	0.036	0.13
Lead	mg/L				0.001	SEQG/CCME		<0.0001	<0.0001	<0.0001	<0.0001	0.0003	0.000125	<0.0001	<0.0001
Lead-210	Bq/L				0.2	HC		<0.02	<0.02	<0.02	<0.02	0.05	0.02375	<0.02	0.03
Magnesium	mg/L							0.3	0.7	0.43	0.3	0.6	0.375	0.4	0.5
Manganese	mg/L	0.501	CCME	(8)	0.21	SEQG/CCME	(9)	0.0041	0.025	0.01467	0.0044	0.017	0.010325	0.0066	0.023
Mercury	mg/L				0.000026	CCME		<1.0E-05	<1.0E-05	<1.0E-05	<1.0E-05	<1.0E-05	<1.0E-05	<1.0E-05	<1.0E-05

Parameter	Units	Short-term Benchmark			Long-term Benchmark			Icelander River (SA-1)			SA-2			SA-3	
		Value	Reference	Notes	Value	Reference	Notes	Min	Max	Mean	Min	Max	Mean	Min	Max
Molybdenum	mg/L				0.07	CCME		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel	mg/L				0.025	CCME		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nitrate	mg/L	550	CCME		3.0	SEQG		<0.04	0.26	0.0714286	<0.04	0.31	0.094	<0.04	0.26
pH	units				6.5-9.0	SEQG/CCME		**6.34**	6.99	6.75	6.58	7.01	6.78	**6.42**	7.02
Phosphorus	mg/L				0.004 - 0.01	CCME	(10)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Polonium-210	Bq/L				0.1	HC		<0.005	0.01	0.0054999	<0.005	<0.005	<0.005	<0.005	0.01
Potassium	mg/L							0.2	0.5	0.36	0.1	0.4	0.3375	0.3	0.5
Radium-226	Bq/L				0.11	SEQG		<0.005	0.009	0.0061	<0.005	0.01	0.006125	<0.005	0.01
Selenium	mg/L				0.001	CCME		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Silver	mg/L				0.25	CCME		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Sodium	mg/L							1.4	1.7	1.53	1.2	1.8	1.45	1.4	1.8
Conductivity	µS/cm							16	22	18.2	14	22	17	18	24
Strontium	mg/L				2.5	FEQG		0.011	0.015	0.0127	0.011	0.015	0.012125	0.013	0.018
Sulphate	mg/L				128	BC MOE		0.4	0.9	0.71	<0.2	0.7	0.5875	0.4	0.8
Sum of Ions								6	22	11.5	6	19	12.5	6	33
Temperature		Narrative	CCME		Narrative	CCME		10.8	12.5	14.0	9.8	13.1	15.5	11.6	17.7
Thallium	mg/L				0.0008	SEQG/CCME		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Thorium-228	Bq/L							<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium-230	Bq/L				0.6	HC		<0.01	<0.01	<0.01	<0.01	0.02	0.01125	<0.01	<0.01
Thorium-232	Bq/L							<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tin	mg/L							<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Titanium	mg/L							<0.0002	<0.0002	<0.0002	<0.0002	0.0015	0.000375	<0.0002	<0.0002
TDS	mg/L				500	SEQG		18	25	21.7	13	30	21.25	17	26
TKN	mg/L							0.11	0.3	0.241	<0.05	0.31	<0.195	0.13	0.3
TOC	mg/L							1.8	2.6	2.25	2.1	2.4	2.2875	1.8	2.6
TSS	mg/L				background + 5 mg/L	CCME		<1	3	2.2	1	3	1.5	<1	2
Uranium	mg/L	0.033	CCME		0.015	SEQG/CCME		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Vanadium	mg/L				0.12	FEQG		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Parameter	Units	Short-term Benchmark			Long-term Benchmark			Icelander River (SA-1)			SA-2			SA-3	
		Value	Reference	Notes	Value	Reference	Notes	Min	Max	Mean	Min	Max	Mean	Min	Max
Zinc	mg/L	0.008	CCME	(11)(12)	0.013	CCME	(13)	<0.0005	0.0028	0.00074	<0.0005	0.0096	0.001675	<0.0005	0.0011

Table 8.2-3: Baseline Surface Water Quality in Local Study Area Watercourses (Continued)

Parameter	Units	Short-term Benchmark			Long-term Benchmark			SA-4			SA-5			SA-6	
		Value	Reference	Notes	Value	Reference	Notes	Min	Max	Mean	Min	Max	Mean	Min	Max
Alkalinity	mg/L							2	15	7.5	2	8	5.2	3	13
Aluminum	mg/L				0.1	SEQG/CCME	(1)	0.0025	0.0099	0.0053	0.004	0.014	0.0065	0.0032	0.02
Ammonia as N	mg/L				5.74	SEQG/CCME	(2)	<0.01	0.05	0.015	<0.01	0.05	0.01444	<0.01	0.04
Ammonia, unionized	ug/L				0.019	SEQG/CCME		1.84E-05	9.2E-05	2.76E-05	1.84E-05	9.2E-05	2.657E-05	1.84E-05	7.36E-05
Antimony	mg/L							<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Arsenic	mg/L				0.005	SEQG/CCME		0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001
Barium	mg/L							0.0021	0.0032	0.0025625	0.0021	0.0031	0.0025556	0.0023	0.0032
Beryllium	mg/L							<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Bicarbonate	mg/L							2	18	9.125	2	10	6.2222	4	16
Boron	mg/L	29	CCME		1.5	SEQG/CCME		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/L	0.00011	SEQG/CCME	(3)	0.00004	SEQG/CCME		1.00E-05	0.00007	0.0000175	1.00E-05	**0.00004**	1.44E-05	1.00E-05	0.00005
Calcium	mg/L							1.3	2	1.5625	1.2	1.4	1.2444	1.2	1.8
Carbonate	mg/L							<1	<1	<1	<1	<1	<1	<1	<1
Chloride	mg/L	640	SEQG/CCME	(4)	120	SEQG/CCME		0.4	0.6	0.45	0.2	0.3	0.23333	0.3	0.5
Chromium	mg/L				0.001	SEQG/CCME	(5)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L				0.00078	FEQG	(14)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Copper	mg/L	0.0009	SEQG	(6)	0.0002	FEQG	(7)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
DOC	mg/L							2	2.4	2.275	1.8	2.5	2.2667	1.9	2.5
Fluoride	mg/L							0.01	0.07	0.02625	0.01	0.08	0.0233	<0.01	0.07
Hardness	mg/L							5	7	5.625	4	5	4.56	4	6
Hydroxide	mg/L							<1	<1	<1	<1	<1	<1	<1	<1
Iron	mg/L				0.3	SEQG/CCME		0.034	0.13	0.077375	0.03	0.11	0.071222	0.036	0.16

Parameter	Units	Short-term Benchmark			Long-term Benchmark			SA-4			SA-5			SA-6	
		Value	Reference	Notes	Value	Reference	Notes	Min	Max	Mean	Min	Max	Mean	Min	Max
Lead	mg/L				0.001	SEQG/CCME		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Lead-210	Bq/L				0.2	HC		<0.02	0.03	0.02125	<0.02	<0.02	<0.02	<0.02	<0.02
Magnesium	mg/L							0.4	0.6	0.4375	0.2	0.4	0.33333	0.3	0.5
Manganese	mg/L	0.501	CCME	(8)	0.21	SEQG/CCME	(9)	0.0029	0.019	0.010625	0.0025	0.018	0.0083333	0.0037	0.029
Mercury	mg/L				0.000026	CCME		<1.0E-05	<1.0E-05	<1.0E-05	<1.0E-05	<1.0E-05	<1.0E-05	<1.0E-05	<1.0E-05
Molybdenum	mg/L				0.07	WHO		<0.0001	0.0002	0.00011	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel	mg/L				0.025	CCME		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nitrate	mg/L	550	CCME		3.0	SEQG		<0.04	0.35	0.112	<0.04	0.31	0.093	<0.04	0.35
pH	units				6.5-9.0	SEQG/CCME		6.58	7.16	6.85	**6.17**	6.97	6.72	**6.48**	7.07
Phosphorus	mg/L				0.004 - 0.01	CCME	(10)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Polonium-210	Bq/L				0.1	HC		<0.005	0.007	0.0052	<0.005	<0.005	<0.005	<0.005	0.006
Potassium	mg/L							0.2	0.6	0.375	0.2	0.4	0.32222	0.2	0.4
Radium-226	Bq/L				0.11	SEQG		<0.005	0.009	0.00625	<0.005	0.007	0.00544	<0.005	<0.005
Selenium	mg/L				0.001	CCME		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Silver	mg/L				0.25	CCME		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Sodium	mg/L							1.4	2.1	1.63	1.3	1.6	1.41	1.3	1.9
Conductivity	µS/cm							17	25	19.375	14	20	16.111	14	23
Strontium	mg/L				2.5	FEQG		0.012	0.018	0.0141	0.011	0.013	0.0113	0.011	0.016
Sulphate	mg/L				128	BC MOE		0.4	0.7	0.525	0.4	0.8	0.63333	0.3	0.8
Sum of Ions								7	25	14.125	6	14	10.667	8	22
Temperature		Narrative	CCME		Narrative	CCME		10.8	12.5	14	9.8	13.1	15.5	11.6	17.7
Thallium	mg/L				0.0008	SEQG/CCME		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Thorium-228	Bq/L							<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium-230	Bq/L				0.6	HC		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium-232	Bq/L							<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tin	mg/L							<0.0001	0.0002	0.0001125	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Titanium	mg/L							<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0003
TDS	mg/L				500	SEQG		21	32	25	13	28	20	15	28
TKN	mg/L							0.13	0.3	0.215	0.11	0.29	0.213	0.15	0.41

Parameter	Units	Short-term Benchmark			Long-term Benchmark			SA-4			SA-5			SA-6	
		Value	Reference	Notes	Value	Reference	Notes	Min	Max	Mean	Min	Max	Mean	Min	Max
TOC	mg/L							2	2.6	2.325	1.9	2.7	2.3111	1.9	2.6
TSS	mg/L				background + 5 mg/L	CCME		1	3	2	<1	3	1.89	1	6
Uranium	mg/L	0.033	CCME		0.015	SEQG/CCME		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Vanadium	mg/L				0.12	FEQG		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Zinc	mg/L	0.008	CCME	(11)(12)	0.013	CCME	(13)	<0.0005	0.0012	0.0006	<0.0005	0.0017	0.0007445	<0.0005	0.0006

Table 8.2-3: Baseline Surface Water Quality in Local Study Area Watercourses (Continued)

Parameter	Units	Short-term Benchmark			Long-term Benchmark			SB-3			SB-5		
		Value	Reference	Notes	Value	Reference	Notes	Min	Max	Mean	Min	Max	Mean
Alkalinity	mg/L							<1	24	<6.7778	3	13	7.375
Aluminum	mg/L				0.1	SEQG/CCME	(1)	0.0052	0.012	0.0089	0.0016	0.0086	0.0054
Ammonia as N	mg/L				5.74	SEQG/CCME	(2)	<0.01	0.04	0.01333	<0.01	0.04	0.0138
Ammonia, unionized	ug/L				0.019	SEQG/CCME	(2)	1.84E-05	7.36E-05	2.453E-05	1.84E-05	7.36E-05	2.539E-05
Antimony	mg/L							<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Arsenic	mg/L				0.005	SEQG/CCME		<0.0001	<0.0001	<0.0001	0.0001	0.0001	<0.0001
Barium	mg/L							0.0025	0.0041	0.0031111	0.0026	0.004	0.0030625
Beryllium	mg/L							<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Bicarbonate	mg/L							<1	29	<8.3333	4	16	9
Boron	mg/L	29	CCME		1.5	SEQG/CCME		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/L	0.00011	SEQG/CCME	(3)	0.00004	SEQG/CCME		<1.0E-05	0.00002	1.11E-05	<1.0E-05	**0.00004**	0.000016
Calcium	mg/L							1.1	1.7	1.3778	1.2	1.7	1.3625
Carbonate	mg/L							<1	<1	<1	<1	<1	<1
Chloride	mg/L	640	SEQG/CCME	(4)	120	SEQG/CCME		0.1	0.2	0.17778	<0.1	0.2	<0.175
Chromium	mg/L				0.001	SEQG/CCME	(5)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L				0.00078	FEQG	(14)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Copper	mg/L	0.0009	SEQG	(6)	0.0002	FEQG	(7)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
DOC	mg/L							2.2	3.4	3.0222	2.6	3.2	2.975

Parameter	Units	Short-term Benchmark			Long-term Benchmark			SB-3			SB-5		
		Value	Reference	Notes	Value	Reference	Notes	Min	Max	Mean	Min	Max	Mean
Fluoride	mg/L							0.01	0.07	0.023333	0.01	0.07	0.02375
Hardness	mg/L							4	6	5.11	4	6	4.88
Hydroxide	mg/L							<1	<1	<1	<1	<1	<1
Iron	mg/L				0.3	SEQG/CCME		0.042	0.22	0.095111	0.036	0.16	0.098375
Lead	mg/L				0.001	SEQG/CCME		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Lead-210	Bq/L				0.2	HC		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Magnesium	mg/L							0.3	0.5	0.38889	0.2	0.5	0.375
Manganese	mg/L	0.501	CCME	(8)	0.21	SEQG/CCME	(9)	0.0053	0.02	0.010633	0.0071	0.016	0.010325
Mercury	mg/L				0.000026	CCME		<1.0E-05	<1.0E-05	<1.0E-05	<1.0E-05	<1.0E-05	<1.0E-05
Molybdenum	mg/L				0.07	WHO		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel	mg/L				0.025	CCME		0.0001	0.0002	0.00011	<0.0001	<0.0001	<0.0001
Nitrate	mg/L	550	CCME		3.0	SEQG		<0.04	0.4	0.115	<0.04	0.4	0.13
pH	units				6.5-9.0	SEQG/CCME		**6.18**	6.99	6.70	**6.47**	6.99	6.73
Phosphorus	mg/L				0.004 - 0.01	CCME	(10)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Polonium-210	Bq/L				0.1	HC		<0.005	0.008	0.0058	<0.005	<0.005	<0.005
Potassium	mg/L							0.2	0.5	0.33333	0.2	0.5	0.3625
Radium-226	Bq/L				0.11	SEQG		<0.005	0.01	0.0059	<0.005	0.006	0.0051
Selenium	mg/L				0.001	CCME		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Silver	mg/L				0.25	CCME		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Sodium	mg/L							1.2	1.7	1.4	1.3	1.7	1.44
Conductivity	µS/cm							15	22	16.778	15	23	17.25
Strontium	mg/L				2.5	FEQG		0.011	0.015	0.0124	0.011	0.015	0.0119
Sulphate	mg/L				128	BC MOE		0.3	0.9	0.68889	0.5	1	0.725
Sum of Ions								4	34	12.667	8	22	13.375
Temperature		Narrative	CCME		Narrative	CCME		10.6	14	12.8	9.9	16.2	14.4
Thallium	mg/L				0.0008	SEQG/CCME		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Thorium-228	Bq/L							<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium-230	Bq/L				0.6	HC		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium-232	Bq/L							<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Parameter	Units	Short-term Benchmark			Long-term Benchmark			SB-3			SB-5		
		Value	Reference	Notes	Value	Reference	Notes	Min	Max	Mean	Min	Max	Mean
Tin	mg/L							<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Titanium	mg/L							<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
TDS	mg/L				500	SEQG		14	26	20.556	16	26	20.125
TKN	mg/L							0.16	0.34	0.256	0.18	0.33	0.27
TOC	mg/L							2.4	3.6	3.1111	2.7	3.2	3
TSS					background + 5 mg/L	CCME		<1	4	2.56	<1	3	1.875
Uranium	mg/L	0.033	CCME		0.015	SEQG/CCME		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Vanadium	mg/L				0.12	FEQG		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Zinc	mg/L	0.008	CCME	(11)(12)	0.013	CCME	(13)	<0.0005	0.0012	0.00059	<0.0005	0.0016	0.00065

Notes

All parameters listed as total concentrations unless otherwise specified.

Saskatchewan Water Quality Objectives, SEQG on-line (https://envrbrportal.crmp.saskatchewan.ca/seqg-search/), SEQG for the protection of aquatic life were selected, based on total concentrations.

Bold numbers indicate exceedance of a long-term criterion.

Bold and italicized indicate exceedance of the short-term criterion and long-term criterion.

SEQG – Saskatchewan Environmental Quality Guidelines – Water Quality Guidelines for Freshwater Aquatic Life.

CWQG – Canadian Council of Ministers of the Environment – Canadian Water Quality Guidelines for the Protection of Aquatic Life.

SSWQO – Saskatchewan Surface Water Quality Objectives.

DOC – Dissolved organic carbon.

TDS – Total dissolved solids.

TKN – Total Kjeldahl Nitrogen.

TOC – Total organic carbon.

TSS – Total suspended solids.

Temperature - Maximum Weekly Average Temperature: Thermal additions to receiving waters should be such that the maximum weekly average temperature is not exceeded. Short-term Exposure to Extreme Temperature: Thermal additions to receiving waters should be such that the short-term exposures to maximum temperatures are not exceeded. Exposures should not be so lengthy or frequent as to adversely affect the important species.

A pH of 7 and a temperature of 15°C were assumed to convert total ammonia to un-ionized ammonia in accordance with CCME (2002).

(1) Long-term criterion for aluminum based on CCME/SEQG of 0.1 mg/L for dissolved aluminum when pH is greater than 6.5.

(2) Total ammonia-N calculated from the total ammonia guideline for an average annual temperature of 15°C and a pH of 7.0, Un-ionized Ammonia from Table 1 of temperature and pH, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Ammonia (https://ccme.ca/en/res/ammonia-en-canadian-water-quality-guidelines-for-the-protection-of-aquatic-life.pdf).
(3) Based on water hardness of >0 to <5.3 mg/L (Site-specific background hardness is 5.26 mg/L (95th percentile of LA-5 and LA-6).
(4) Based on water hardness >0 to <17 mg/L.
(5) Guideline specific to Chromium VI for conservative comparison to baseline water quality.
(6) Based on hardness of 5.26 mg/L (Short-term equation is ($e^{\{0.979123[\ln(hardness)]-8.64497\}}$)*1000 (SEGQ via AEP 1996b).
(7) Federal Water Quality Guideline for Copper Biotic Ligand Model (BLM) Tool and User Manual, (Site-specific background hardness is 5.26 mg/L, DOC is 2.24 mg/L, pH is 6.61 [95th percentile of LA-5 and LA-6]).
(8) Short Term Guideline is based on dissolved manganese. Benchmark = exp(0.878[ln(hardness)] + 4.76) where the benchmark is expressed in dissolved manganese concentration (µg/L), and hardness is measured as CaCO3 equivalents in mg/L. (Site-specific hardness is 5.26 mg/L (95th percentile of LA-5 and LA-6).
(9) Long-term guideline for manganese based on Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life - Manganese, Appendix B - Canadian Water Quality Guidelines Calculator (pH = 6.61, hardness = 5.26 mg/L.
(10) Framework provides Trigger Ranges for Total Phosphorus (µg/L) - guideline for oligotrophic waterbody 4 - 10 µg/L.
(11) Guideline is based on dissolved zinc.
(12) Short term guideline is based on Benchmark = exp(0.833[ln(hardness mg·L-1)] + 0.240[ln(DOC mg·L-1)] + 0.526). (Site-specific background hardness is 5.26 mg/L, DOC is 2.24 mg/L, pH is 6.61 (95th percentile of LA-5 and LA-6). Note – extrapolated for value outside the hardness range.
(13) Long term guideline is based on CWQG = exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625). (Site-specific background hardness is 5.26 mg/L, DOC is 2.24 mg/L, pH is 6.61 (95th percentile of LA-5 and LA-6). Note – extrapolated for value outside the hardness range.
(14) Environment Canada 2017. Federal Environmental Quality Guidelines, Cobalt, May. Based on equation and lowest hardness for equation of 52 mg/L.

Table 8.2-4: Summary of Constituents from Baseline Surface Water Quality Sampling of Waterbodies within the Local Study Area that Exceed Guideline Values

Location	Parameter	Percent of Samples Not Meeting Guideline	Max Value (mg/L)	Guideline Reference	Guideline Value
McGowan Lake (LA-1)	Aluminum	13%	0.0051	SEQG	0.005 mg/L
Whitefish Lake South (LA-5)	Aluminum	50%	0.0078	SEQG	0.005 mg/L
Whitefish Lake North (LA-6)	Aluminum	80%	0.073	SEQG	0.005 mg/L
	Copper	11%	0.0004	FEQG	0.0002 mg/L
	Lead	33%	0.0012	CWQG	0.001 mg/L
	pH	33%	5.71	CWQG	6.5–9
Russell Lake Inlet (LAB-1)	N/A	N/A	N/A	N/A	N/A
LB-2	Aluminum	100%	0.0098	SEQG	0.005 mg/L
Icelander River (SA-1)	Aluminum	10%	0.0056	SEQG	0.005 mg/L
	Iron	10%	0.31	SEQG	0.3 mg/L
	pH	10%	6.34	CWQG	6.5–9
SA-2	Aluminum	40%	0.081	SEQG	0.005 mg/L
	Copper	6%	0.0008	FEQG	0.0002 mg/L
SA-3	Aluminum	13%	0.006	SEQG	0.005 mg/L
	pH	13%	6.42	CWQG	6.5–9
SA-4	Aluminum	40%	0.0099	SEQG	0.005 mg/L
	Cadmium	20%	0.00007	CWQG	0.00004 mg/L
SA-5	Aluminum	67%	0.014	SEQG	0.005 mg/L
	Cadmium	22%	0.0004	CWQG	0.00004 mg/L
	pH	11%	6.17	CWQG	6.5–9
SA-6	Aluminum	71%	0.02	SEQG	0.005 mg/L
	Cadmium	43%	0.00005	CWQG	0.00004 mg/L
	pH	14%	6.48	CWQG	6.5–9
SB-3	Aluminum	100%	0.012	SEQG	0.005 mg/L
	pH	11%	6.18	CWQG	6.5–9
SB-5	Aluminum	50%	0.0086	SEQG	0.005 mg/L
	Cadmium	38%	0.0004	CWQG	0.00004 mg/L
	pH	13%	6.47	CWQG	6.5–9

Notes:

The maximum value excludes pH, where the minimum or maximum value is used due to guidelines including a minimum range.

SEQG – Saskatchewan Environmental Quality Guidelines – Water Quality Guidelines for Freshwater Aquatic Life.

CWQG – Canadian Council of Ministers of the Environment – Canadian Water Quality Guidelines for the Protection of Aquatic Life.

8.2.4 Assessment of Project-related Effects

8.2.4.1 Potential Interactions Between the Project and Valued Component / Key Indicators

The Project will require the construction, operation, and decommissioning of several components (as described in Section 2). Potential interactions between Project activities and Surface Water Quality are summarized by Project phase in Table 8.2-5 and are ranked as:

- Primary Interaction (✓): Project activity is expected to interact with the VC/KI, which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- Other interaction (✓): Project activity is expected to interact with the VC/KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- No Interaction: Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

Based on professional judgment and understanding of the nature of Project activities and their sequencing, the Project activity list was reviewed and the type of interactions determined. Potential Project-related effects are then discussed in Section 8.2.4.2. Primary Project activities with the potential for adverse effects on Surface Water Quality (i.e., flagged as 'Primary Interactions') are expected to involve surface land clearing, major earthworks, surface/grading preparations, changes to land cover, water management feature construction and function, and water taking and effluent discharge. Other Project activities (i.e., flagged as 'Other Interactions') refer to those activities that may be associated with hydrogeological influences on local waterbodies and are expected to be secondary contributors to potential adverse effects. The remaining activities (e.g., power generation and supply) were deemed to have no interaction and were not carried forward in the assessment as they are not expected to result in detectable changes in the MPs associated with Surface Water Quality. Activities during Post-Decommissioning (e.g., site inspections; monitoring and on-site engagement with Interested Parties) were deemed to have no interaction because they do not involve any land clearing, surface preparations, or major earthworks.

Table 8.2-5: Potential Project Interactions for Surface Water Quality

Project Phase/Activity	Surface Water Quality
Construction Activities	
Development of access roads and air strip	✓
Site preparation and earthworks; clearing, levelling, and grading of the Project Area	✓
Power generation – generators	
Installation of main substation and distribution of power around site	
Wellfield and freeze hole drilling; ground freezing	✓

Project Phase/Activity	Surface Water Quality
Batch plant operation (concrete); crusher at borrow area	
Development of surface infrastructure (camp, operations centre, plants, ponds, pads, and support facilities)	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	✓
Water management (including treatment and site runoff)	✓
Groundwater supply	✓
Surface water withdrawal	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	
On-site and off-site operation of vehicles and transport of materials	✓
Air transportation for workers	
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Operation Activities	
Operation of the ISR wellfield	✓
Wellfield and freeze wall drilling	✓
Operation and expansion of freeze wall	✓
Batch plant operation (grout and cement); crusher in borrow area	
Expansion of pond and pads	✓
Operation of the processing plant and production of uranium concentrate	✓
Water withdrawal from groundwater or surface waterbody	✓
Management of surface water (including seepage and site runoff)	✓
Water treatment, both domestic and industrial	✓
Water release to surface waterbody	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	✓
Hazardous waste management (temporary storage, handling, and off-site transportation)	
Storage and disposal of drill waste rock, process precipitates, and industrial wastewater treatment plant precipitates	✓
On-site and off-site operation of vehicles and transport of materials	✓
Power supply – primarily power from the grid, also generators and back-up generators	
Package and transport of nuclear substances	
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	
Air transportation for workers	
Progressive decommissioning and reclamation	✓
Regulatory site inspections	
Engagement – site visit from Interested Parties	

Project Phase/Activity	Surface Water Quality
Decommissioning Activities	
Site water management, treatment, and release	✓
Mining horizon remediation and thawing of freeze wall	✓
Process water treatment and release	✓
Closure of ISR and freeze wells and related infrastructure	✓
Decontamination of surface facilities and injection, recovery, and monitoring wells	✓
Asset removal (including site power transmission lines and electrical infrastructure)	
Demolition and disposal of non-salvageable surface infrastructure and materials	✓
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	✓
Generators	
Waste management (composting and landfill operation)	✓
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)	✓
On-site and off-site operation of vehicles and transport of materials	
Reclamation of disturbed areas	✓
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Post-Decommissioning Activities	
Environmental monitoring	
Regulatory site inspections	
Engagement – site visit from Interested Parties	

Interactions between the Project and Surface Water Quality during the future centuries phase were considered indirect (secondary) interactions associated with changes in groundwater migration from the restored area source to the surface water environment. Such interactions and their potential for residual effects are discussed in Section 8.2.4.2.5.

8.2.4.1.1 Site Water Management

Site water management is described in Section 2, with water block flow diagrams for each phase of the Project provided in Figure 2.2-14, Figure 2.2-15, and Figure 2.2-16. It is important to note that Denison plans to recycle process water to the greatest extent possible, thereby reducing the demand for freshwater supply and reducing the need for discharge to the receiving water environment.

Construction

Groundwater or surface water taking will be used to support the concrete batch plant, wash station, drilling activities, and the potable water plant (Figure 2.2-14 in Section 2). Domestic wastewater will be disposed of via vacuum truck at a licenced disposal location until the Industrial Wastewater Treatment Plant (IWWTP) is commissioned. Site contact water will be directed to the Clean Waste Rock Pond, which will be built to hold this water through Construction without the need for discharge to the natural environment.

Operation

During Operation (Figure 2.2-15 in Section 2), site contact water will be collected at the following locations:

- Domestic Wastewater Pond;
- IWWTP Precipitate Pond;
- Clean Waste Rock Pond;
- Process Precipitate Pond;
- Process Water Pond;
- Industrial Landfill Leachate Collection Pond; and
- Wellfield Runoff Pond.

Most of the collected contact water will be directed to the Process Water Pond and the Wellfield Runoff Pond, which will store water for use during ISR drilling (i.e., recycled). Other site runoff collection needs will be examined and identified as part of detailed design and permitting. Any excess water not required during the ISR process will be directed to the IWWTP.

The IWWTP will be designed to treat contaminated water removed during the ISR process (e.g., backwash of sand filters, bleed solution), runoff collected from the waste pad, and other contact water, such as water from the wash bay and process sumps. The IWWTP will be located inside of the processing plant.

Treated water from the IWWTP will be pumped to the three Effluent Monitoring and Release Ponds (each 3,300 m^3). These ponds will be designed to hold effluent for 72 hours for testing before discharge to the environment.

Treated water in the Effluent Monitoring and Release Ponds will be monitored prior to release Whitefish Lake. The treated effluent discharge line will be heated and have secondary containment in place.

The conceptual design for the diffuser used in the assessment of potential effects consisted of a diffuser line with three evenly spaced nozzles, with each nozzle approximately 0.07 m in diameter. The diffuser line is located approximately 115 m offshore from the north shoreline and 440 m from the west shoreline, in approximately 3 m of water. The diffuser extends from a single pipe, which reaches a ‘T’ that extends parallel to the north shoreline (Figure 8.2-5 and Appendix 8-E). The exact design configuration will be optimized as required during the engineering design and permitting phase to facilitate optimal performance of the diffuser specific to site conditions.

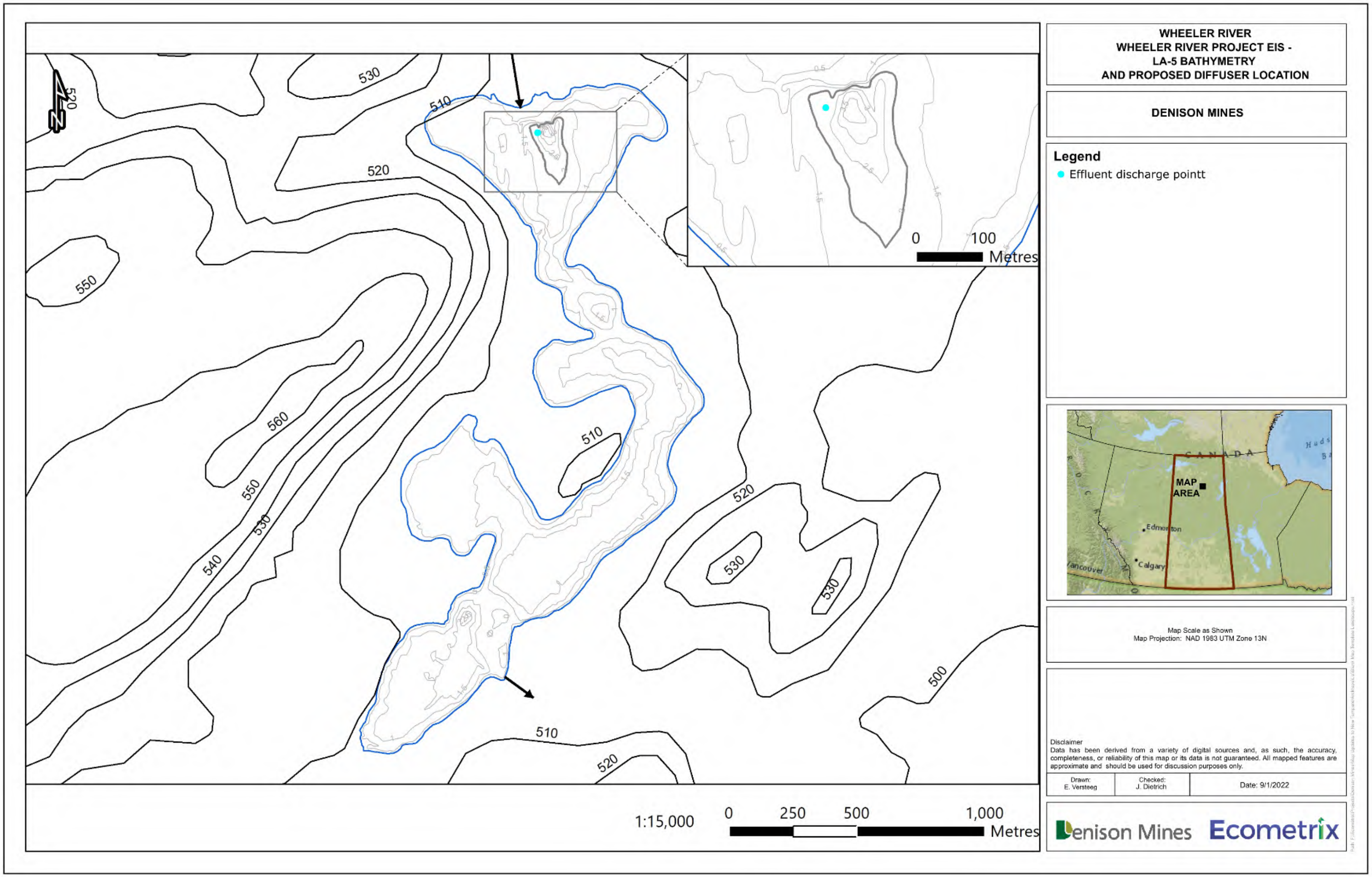

Figure 8.2-5: LA-5 Bathymetry and Proposed Diffuser Location

Decommissioning and Post-Decommissioning

The water balance during this phase will be consistent with the cessation of drilling and ore extraction followed by mining area remediation, and finally the gradual thawing of the freeze wall (Figure 2.2-16 in Section 2). Recycling of water through the ore zone from the IWWTP will continue to make sure contact and wellfield water meet water quality objectives prior to discharge to the environment through the Effluent and Monitoring Release Ponds. It is expected that discharge will cease at the end of physical decommissioning, which includes mining are remediation, decontamination, asset removal, and demolition and disposal.

8.2.4.2 Potential Project-related Effects

Project activities may interact with Surface Water Quality during all Project phases. In general, the interactions can be characterized as being primarily associated with controlled, routine discharges from the Project site. During Construction, the primary effect pathway relates to the mobilization of suspended material into natural surface water features as a result of land disturbance and clearing. During Operation and Decommissioning, excess water from the effluent monitoring ponds will be released to the environment. Routine discharge of this sort will be directed to Whitefish Lake only. Direct discharge of treated effluent to the natural environment has the potential to change surface water constituent concentrations and temperature. Decommissioning will involve the restoration of natural site drainage to the Whitefish Lake receiver and, similar to Construction, has the potential to increase the mobilization of suspended solids into natural surface waters. The following sections discuss each predicted residual effect.

8.2.4.2.1 Mobilization of Suspended Materials

Construction

The primary effect pathway during Construction relates to the mobilization of suspended material into natural surface water features as a result of land disturbance and clearing. According to the site water balance (Figure 2.2-14 in Section 2), there is no planned discharge to Whitefish Lake during Construction. The mobilization of suspended material into natural surface water features is readily mitigatable by virtue of the mine development plan and through the implementation of standard water management and sediment control practices. Water management infrastructure (e.g., collection ditches, ponds, pumping, stations), as well as various aspects of the water management and sediment control management systems, will be put into place coincident with the initiation of construction activities. Waters (e.g., runoff) associated with areas under development will be collected and stored within management infrastructure (e.g., Clean Waste Rock Pond; Figure 2.2-14 in Section 2). In the event that releases into the natural environment are necessary, they would only occur once it is safe to do so (i.e., suspended solid levels in the water would be at acceptable levels). No downstream effects on local surface waters are expected.

Operation

During Operation, mobilization of suspended materials will be managed through the development of water management infrastructure and the Surface Water Management Program. Releases to the natural environment of contact water will be directed through the applicable collection ponds, IWWTP, and Effluent Monitoring and Release Ponds. Discharge will only occur once it is safe to do so (i.e., suspended solid levels in the water would be at acceptable levels). Management of TSS levels in the final discharge will be implemented to make sure discharge quality can be maintained consistently. As necessary, Denison may employ active means (e.g., filtering), if required, to achieve low TSS levels in discharge, in addition to passive means such as settling and clarification in the IWWTP to manage TSS in the effluent stream to low levels. No downstream effects on local surface waters are expected.

Decommissioning

During Decommissioning, the site wide management system will continue to operate such that Denison will maintain control of the site aspect affected water through the IWWTP. Surface drainage during decommissioning activities will continue to be directed to the collection ponds, IWWTP, and Effluent Monitoring and Release Ponds to facilitate the control of suspended solids and achieve low TSS levels in the discharge.

8.2.4.2.2 Controlled Discharge

Construction

Discharge to the environment is not expected during Construction. Site contact water will be collected and held in the Clean Waste Rock Pond (Figure 2.2-14 in Section 2). Therefore, potential effects of discharge on the Surface Water Quality VC are not expected.

Operation

Denison does not intend to include constant freshwater withdrawal or effluent discharge throughout Operation; however, for the purpose of assessing the scenario of greatest potential effects, the Project was assessed as having a continuous freshwater withdrawal rate of 40.5 m^3/hr and a continuous effluent discharge rate of 36.5 m^3/hr. The withdrawal and discharge rates were assessed independently, despite withdrawal from and discharge to being associated with the same waterbody, to exaggerate the predicted effects. In addition, they were assessed cumulatively with the Project site and estimated changes to groundwater contributions through different temporal phases of the Project.

The approach to assessing Project-related effects on the Surface Water Quality VC was conservative for the following reasons:

- The assessment was based on a continuous (year-round) discharge rate at an expected average effluent discharge of 0.0101 m^3/s (or 36.5 m^3/hr) throughout Construction, Operation, and

Decommissioning despite the likelihood that effluent discharge is not expected to be continuous and is anticipated to only discharge when the site water balance requires such, based on water storage capabilities. Water storage capability of the Effluent Monitoring and Release Ponds has been designed to enable contingency in water storage (i.e., three ponds of 3,300 m^3 capacity each).

- Ninety-fifth percentile (95%) concentrations of constituents at baseline condition were used in modelling potential effects.
- The water quality analysis was conducted for each of the low flow scenarios (i.e., 7Q10 low flow, monthly low flow, and monthly average flow) for the receiving water environment.

Flows and water levels under pre-development conditions were used as the baseline against which Project-related changes during Construction, Operation, Decommissioning and Post-Decommissioning were assessed. The assessment of Surface Water Quantity supporting the Surface Water Quality VC is provided in Section 8.2.4.2. Groundwater is received in LA-5 (Whitefish Lake South) under natural conditions and estimates of the changes to this contribution are evaluated for Operation and Decommissioning. An analysis of the potential effects on the Surface Water Quality VC during Operation is provided in Sections 8.2.4.2.3 and 8.2.4.2.4.

Decommissioning and Post-Decommissioning

Discharge to the aquatic environment of Whitefish Lake during some portion of Decommissioning is expected. Effluent rates during this phase are expected to be less than during Operation. Effluent water quality is also expected to have lower levels of COPC compared to Operation. Therefore, the analysis of potential effects on the Surface Water Quality VC during Operation provided in Sections 8.2.4.2.3 and 8.2.4.2.4 is considered the bounding scenario for Decommissioning as well.

8.2.4.2.3 Near-Field Water Quality Model

A near-field water quality model was used to predict the potential change in constituent concentrations and the near-field mixing zone as a result of effluent discharge to the LA-5 portion of Whitefish Lake (Figure 8.2-5) (Appendix 8-E). The analysis is detailed further in Appendix 10-A and Appendix A of Appendix 10-A). To assess constituent concentrations within LA-5, information about local inflow rates, site discharge rates, background receiver water quality, and predicted effluent discharge water quality was required.

A hydrological assessment of the LSA was conducted by NewFields Canada (Appendix 8-C) and a water quality assessment, including identifying applicable screening concentrations, was conducted by Ecometrix (Appendix 8-E).

The effluent from the Project site is predicted to discharge to Whitefish Lake North (LA-5) through an engineered, offshore, submerged, multiport diffuser, designed to maximize the mixing potential and reduce the spatial extent of the mixing zone (as described above) (Appendix 8-E). Upon discharge, the effluent flows within the lake current, both downstream and offshore, are expected to gradually mix across the lake until fully mixed. Key definitions of terms related to this section are provided below.

- **Mixing zone**: An area of water contiguous to a point source or definable non-point source where water quality does not comply with one or more of the water quality guideline concentrations.
- **Edge of the mixing zone**: The point within the constituent plume at which water quality objectives are met.
- **Well mixed**: The point in which the water column is completely mixed (i.e., no vertical or horizontal concentration gradients exist) and no further dilution occurs.

For the purpose of calculating water quality predictions within LA-5, an expected average effluent discharge rate of 0.0101 m^3/s (or 36.5 m^3/hr) was considered. Furthermore, it was assumed that discharge from the Project site remains constant throughout the year; however, this is unlikely and therefore provides a conservative approach.

To assess the variability in inflow rates to LA-5, three flow scenarios were considered to determine effects on LA-5 water quality. These flow scenarios are summarized below with monthly average flow rates summarized in Table 8.2-6 and model input flow rates summarized in Table 8.2-7.

- **7Q10 low flow**: The 7Q10 low flow scenario was defined as "the lowest flow averaged over a period of seven consecutive days that can be statistically expected to occur once every 10 climatic years". This flow condition was used to assess concentrations under an extreme low flow event.
- **Monthly low flow**: The monthly low flow scenario was calculated from historical flow monitoring data collected via the Water Survey of Canada on the Wheeler River (Station 06DA005, 57°28'40"N, 104°59'50"W). A drainage area of 3,030 km^2 was used to estimate average monthly flows in the north basin of LA-5. The monthly low flow into LA-5 occurred in March and was calculated as 1.04 m^3/s.
- **Monthly average flow**: The monthly average flow scenario was calculated from historical flow monitoring data collected via the Water Survey of Canada on the Wheeler River (Station 06DA005, 57°28'40"N, 104°59'50"W). A drainage area of 3,030 km^2 was used to estimate annual average flows in the north basin of LA-5. The monthly average flow into LA-5 was calculated as 1.40 m^3/s.

Table 8.2-6: Monthly Average Baseline Flow Rates to LA-5

Month	Baseline Flow Rate (m^3/s)
January	1.14
February	1.08
March	1.04
April	1.21

Month	Baseline Flow Rate (m^3/s)
May	1.94
June	1.94
July	1.63
August	1.43
September	1.38
October	1.45
November	1.36
December	1.19
Annual	**1.40**

Table 8.2-7: Estimated Flow Rates to LA-5

Flow Parameter	Estimated Flow Rate (m^3/s)
Discharge Rate	0.0101
7Q10 Low Flow	0.616
Monthly Low Flow	1.04
Monthly Average Flow	1.40

Surface water quality criteria for the receiving environment were obtained from existing federal and Saskatchewan provincial guidelines. The most restrictive of either the Saskatchewan provincial (SEQG) or federal (CCME and/or FEQG) guidelines for the protection of aquatic life were used for the screening criteria. Where there was no screening criterion provided by the province of Saskatchewan or federal government, an appropriate and available criteria from another jurisdiction was used as an alternative. In some instances, screening concentrations for select parameters were adjusted for hardness, dissolved organic carbon, and pH. For a complete description on screening values, see Appendix A of Appendix 10-A in Section 10 Human Health. The following is noted for reference.

For molybdenum, the Saskatchewan Water Security Agency published an updated water quality objective for the protection of aquatic life based on current understanding of aquatic toxicity of molybdenum to freshwater aquatic organisms (WSA 2017). This water quality objective of 31 mg/L was adopted for the Project for the protection of aquatic life in preference over the CCME water quality objective of 0.073 mg/L. For the protection of human health through the drinking water pathway, a value of 0.07 mg/L was used from the World Heath Organization (WHO 2017).

Background water quality was defined by 95th percentile concentrations for constituents in LA-5, as taken from the baseline data collected. The 95th percentile generates a conservative baseline for water quality assessment.

A summary of background water quality and screening level criteria are provided in Table 8.2-8. Screening level values represent the most restrictive criteria for the protection of aquatic life.

Table 8.2-8: Summary of Background Water Quality Screening Criteria

Parameter	Units	Short-term Screening Criteria (background hardness)	Short-term Screening Criteria (Hardness induced [>250 mg/L])	Source	Note	Long-term Screening Criteria (background hardness)	Long-term Screening Criteria with Toxicity Modifier Applied (induced hardness)	Source	Note
General Chemistry, Nutrients and Anions									
Alkalinity	mg/L	--	--	--	--	--	--	--	
Ammonia (as N)	mg/L	--	--	--	--	5.74	5.74	SEQG/CCME	(2)
Un-Ionized Ammonia	mg/L	--	--	--	--	0.019	0.019	SEQG/CCME	
Hardness	mg/L	--	--	--	--	--	--	--	--
Conductivity	µS/cm	--	--	--	--	--	--	--	--
Nitrate	mg/L	550	550	CCME		3	3	SEQG	--
pH	pH units	--	--	--	--	6.5-9.0	6.5-9.0	SEQG/CCME	--
Phosphorus	mg/L	--	--	--	--	0.004-0.01	0.004-0.01	CCME	(9)
Sulphate	mg/L	--	--	--	--	128	429	BC MOE	
TDS	mg/L	--	--	--	--	500	500	SEQG	--
Temperature	°C	--	--	--	--	narrative	narrative	--	--
TSS	mg/L	--	--	--	--	background + 5 mg/L	background + 5 mg/L	CCME	--
Chloride	mg/L	640	640	SEQG/CCME		120	120	SEQG/CCME	
Metals									
Aluminum	mg/L	--	--	--	--	0.1	0.1	SEQG/CCME	(1)
Arsenic	mg/L	--	--	--	--	0.005	0.005	SEQG/CCME	--
Cadmium	mg/L	0.00011	0.0053	SEQG/CCME	(3)	0.00004	0.00034	SEQG/CCME	--
Chromium	mg/L	--	--	--	--	0.001	0.001	SEQG/CCME	(4)
Cobalt	mg/L	--	--	--	--	0.00078	0.00149	FEQG	(13)(14)
Copper	mg/L	0.0009	0.00004	SEQG	(5)	0.0002	0.0005	FEQG	(6)
Cyanide	mg/L	--	--	--	--	--	--	--	--
Iron	mg/L	--	--	--	--	0.3	0.3	SEQG/CCME	--

Parameter	Units	Short-term Screening Criteria (background hardness)	Short-term Screening Criteria (Hardness induced [>250 mg/L])	Source	Note	Long-term Screening Criteria (background hardness)	Long-term Screening Criteria with Toxicity Modifier Applied (induced hardness)	Source	Note
Lead	mg/L	--	--	--	--	0.001	0.007	SEQG/CCME	
Manganese	mg/L	0.501	15	CCME	(7)	0.21	0.64	SEQG/CCME	(8)
Mercury	mg/L	--	--	--	--	0.000026	0.000026	CCME	--
Molybdenum	mg/L	--	--	--	--	0.073	0.073	CCME	
Nickel	mg/L	--	--	--	--	0.025	0.025	CCME	
Selenium	mg/L	--	--	--	--	0.001	0.001	CCME	--
Strontium	mg/L	--	--	--	--	2.5	2.5	FEQG	
Thallium	mg/L	--	--	--	--	0.0008	0.0008	SEQG/CCME	--
Uranium	mg/L	0.033	0.033	CCME		0.015	0.015	SEQG/CCME	--
Vanadium	mg/L	--	--	--	--	0.12	0.12	FEQG	
Zinc	mg/L	0.008	0.204	CCME	(10)(11)	0.013	0.058	CCME	(12)
Radiological									
Lead-210	Bq/L	--	--	--	--	0.2	0.2	HC	--
Polonium-210	Bq/L	--	--	--	--	0.1	0.1	HC	--
Radium-226	Bq/L	--	--	--	--	0.11	0.11	SEQG	--
Thorium-230	Bq/L	--	--	--	--	0.6	0.6	HC	--
Uranium-238	Bq/L	--	--	--	--	3	3	HC	--
Uranium-234	Bq/L	--	--	--	--	3	3	HC	--

Notes:

Induced hardness was considered to be >250 mg/L unless otherwise specified.

All parameters listed as total concentrations unless otherwise specified.

Saskatchewan Water Quality Objectives, SEQG on-line (https://envrbrportal.crmp.saskatchewan.ca/seqg-search/), SEQG for the protection of aquatic life were selected, based on total concentrations.

Bold numbers indicate exceedance of long-term criteria.

Bold and italicized indicate exceedance of short-term criteria and long-term criteria.

SEQG – Saskatchewan Environmental Quality Guidelines – Water Quality Guidelines for Freshwater Aquatic Life; CCME – Canadian Council of Ministers of the Environment; HC – Health Canada; BC MOE – British Columbia Ministry of the Environment; FEQG – Federal Environmental Quality Guidelines; MDMER – Metal and Diamond Mining Effluent Regulations; DOC – Dissolved organic carbon; TDS – Total dissolved solids; TSS – Total suspended solids.

Narrative – Temperature - Maximum Weekly Average Temperature: Thermal additions to receiving waters should be such that the maximum weekly average temperature is not exceeded. Short-term Exposure to Extreme Temperature: Thermal additions to receiving waters should be such that the short-term exposures to maximum temperatures are not exceeded. Exposures should not be so lengthy or frequent as to adversely affect the important species.

(1) Long-term criterion for aluminum based on CCME/SEQG of 0.1 mg/L for dissolved aluminum when pH is greater than 6.5.
(2) Total ammonia-N calculated from the total ammonia guideline for an average annual temperature of 15°C and a pH of 7.0, Un-ionized Ammonia from Table 1 of temperature and pH, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Ammonia (https://ccme.ca/en/res/ammonia-en-canadian-water-quality-guidelines-for-the-protection-of-aquatic-life.pdf).
(3) Cadmium criteria based on water hardness of >0 to <5.3 mg/L (Site-specific background hardness is 5.26 mg/L (95th percentile of LA-5 and LA-6).
(4) Guideline specific to Chromium VI for conservative comparison to baseline water quality.
(5) Based on hardness of 5.26 mg/L (Short-term equation is (e{0.979123[ln(hardness)]-8.64497})*1000 (SEGQ via AEP 1996b).
(6) Federal Water Quality Guideline for Copper using the Biotic Ligand Model (BLM) Tool and User Manual is 0.0002 mg/L using site-specific background hardness of 5.26 mg/L, DOC of 2.24 mg/L, and pH of 6.61 (95th percentile of LA-5 and LA-6) and 0.0005 mg/L using conditions expected during operations including hardness of 9 mg/L, DOC of 2.24, and pH of 7.
(7) Short term guideline is based on dissolved manganese. Benchmark = exp(0.878[ln(hardness)] + 4.76) where the benchmark is expressed in dissolved manganese concentration (µg/L), and hardness is measured as CaCO3 equivalents in mg/L. (Site-specific hardness is 5.26 mg/L (95th percentile of LA-5 and LA-6).
(8) Long-term guideline for manganese based on Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life - Manganese, Appendix B - Canadian Water Quality Guidelines Calculator (pH = 6.61, hardness = 5.26 mg/L.
(9) Framework provides Trigger Ranges for Total Phosphorus (µg/L) - guideline for oligotrophic waterbody 4 - 10 µg/L.
(10) Guideline is based on dissolved zinc.
(11) Short term guideline is based on Benchmark = exp(0.833[ln(hardness mg·L-1)] + 0.240[ln(DOC mg·L-1)] + 0.526). (Site-specific background hardness is 5.26 mg/L, DOC is 2.24 mg/L, pH is 6.61 (95th percentile of LA-5 and LA-6). Note – extrapolated for value outside the hardness range.
(12) Long term guideline is based on CWQG = exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625). (Site-specific background hardness is 5.26 mg/L, DOC is 2.24 mg/L, pH is 6.61 (95th percentile of LA-5 and LA-6). Note – extrapolated for value outside the hardness range.
(13) Environment Canada 2017. Federal Environmental Quality Guidelines, Cobalt, May. Based on equation and lowest hardness for equation of 52 mg/L.
(14) Environment Canada 2017. Federal Environmental Quality Guidelines, Cobalt. Based on equation and hardness of 250 mg/L for equation of FWQG = exp{(0.414[ln(hardness)] – 1.887}.

Predicted maximum effluent concentrations during Operations of constituents of interest are provided in Table 8.2-9.

Table 8.2-9: Predicted Effluent Water Quality

Constituent	Unit	Predicted Discharge Concentrations (Max Expected)
General Chemistry, Nutrients and Anions		
Alkalinity	mg/L	12.4
Ammonia (as N)	mg/L	3.9
Un-Ionized Ammonia	mg/L	0.0129
Hardness	mg/L (as CaCO3)	250 [1]
Conductivity	µS/cm	21.7
Nitrate	mg/L	0.249
pH	pH Unit	7
Phosphorus	mg/L	0.01
Sulphate	mg/L	2600
TDS	mg/L	6420
Temperature	deg C	16.5
TSS	mg/L	6
Chloride	mg/L	600
Metals		
Aluminum	mg/L	0.051
Arsenic	mg/L	0.006
Cadmium	mg/L	0.0018
Chromium	mg/L	0.025
Cobalt	mg/L	0.0027
Copper	mg/L	0.02
Cyanide	mg/L	NA
Iron	mg/L	0.0039
Lead	mg/L	0.0003
Manganese	mg/L	0.03
Mercury	mg/L	0.00001
Molybdenum	mg/L	2.5
Nickel	mg/L	0.0138
Selenium	mg/L	0.042
Strontium	mg/L	1.68
Thallium	mg/L	0.0006
Uranium	mg/L	0.057

Constituent	Unit	Predicted Discharge Concentrations (Max Expected)
Vanadium	mg/L	0.059
Zinc	mg/L	0.042
Radiological		
Lead-210	Bq/L	0.42
Polonium-210	Bq/L	0.15
Radium-226	Bq/L	0.15
Thorium-230	Bq/L	0.9
Uranium-238	Bq/L	0.7
Uranium-234	Bq/L	0.7

(1) Hardness value provided here is not the expected hardness in effluent, but was selected as a concentration at which to evaluate a high hardness condition at the edge of the mixing zone for interpretation of modelled results against water quality guidelines.

Using these inputs, water quality was estimated for the near-field mixing zone under the three flow scenarios (i.e., 7Q10 low flow, monthly low flow, and monthly average flow). The results of this analysis are provided in Table 8.2-10.

Parameters where the available assimilative capacity is less than the max predicted discharge concentration when screening criteria subject to background water quality include sulphate, copper, chromium, molybdenum, and selenium. For chromium and selenium, the assessment was influenced by datapoints with values below the detection limit.

For the screening criteria subject to induced (by effluent) water quality these parameters include chromium, copper, molybdenum, and selenium. For chromium and selenium, the assessment was influenced by datapoints with values below the detection limit.

Parameters whose available assimilative capacity exceed short term criteria listed in Table 8.2-10 for both sets of screening criteria include chloride, cadmium, copper, manganese, uranium, and zinc.

Note that although cyanide is a parameter identified in Schedule 4 of the MDMER, it was not considered in the above assessment due to the lack of background cyanide concentration in the receiver. Furthermore, cyanide will not be present in the effluent as it is not part of the mining process.

Table 8.2-10: Near-field Receiving Water Quality Results

Parameter	Units	Short-term Screening Criteria (background hardness)	Short-term Screening Criteria (Hardness induced [>250 mg/L])	Source	Note	Long-term Screening Criteria (background hardness)	Long-term Screening Criteria with Toxicity Modifier Applied (induced hardness)	Source	Note	Discharge Concentration (max predicted)	LA-5 Well Mixed (7Q10)	LA-5 Well Mixed (Monthly Low)	LA-5 Well Mixed (Average)
General Chemistry, Nutrients and Anions													
Alkalinity	mg/L	--	--	--	--	--	--	--	--	12.4	12.4	12.4	12.4
Ammonia (as N)	mg/L	--	--	--	--	5.74	5.74	SEQG/CCME	(2)	3.9	0.13	0.11	0.1
Un-Ionized Ammonia	mg/L	--	--	--	--	0.019	0.019	SEQG/CCME	--	0.0129	0.0004	0.0003	0.0003
Hardness	mg/L	--	--	--	--	--	--	--	(15)	250	9	8	7
Conductivity	µS/cm	--	--	--	--	--	--	--	--	21.7	21.7	21.7	21.7
Nitrate	mg/L	550	550	CCME		3	3	SEQG	--	0.249	0.249	0.249	0.249
pH	pH units	--	--	--	--	6.5-9.0	6.5-9.0	SEQG/CCME	--	7	7	7	7
Phosphorus	mg/L	--	--	--	--	0.004-0.01	0.004-0.01	CCME	(9)	**<u>0.01</u>**	0.005	0.005	0.005
Sulphate	mg/L	--	--	--	--	128	429	BC MOE	--	**<u>2600</u>**	43	26	19
TDS	mg/L	--	--	--	--	500	500	SEQG	--	**<u>6420</u>**	131	90	74
Temperature	°C	--	--	--	--	narrative	narrative	--	--	16.5	15	15	15
TSS	mg/L	--	--	--	--	background + 5 mg/L	background + 5 mg/L	CCME	--	6	4	4	4
Chloride	mg/L	640	640	SEQG/CCME		120	120	SEQG/CCME	--	**<u>600</u>**	10	6	5
Metals													
Aluminum	mg/L	--	--	--	--	0.1	0.1	SEQG/CCME	(1)	0.051	0.01	0.01	0.01
Arsenic	mg/L	--	--	--	--	0.005	0.005	SEQG/CCME	--	**<u>0.006</u>**	0.0002	0.0002	0.0001
Cadmium	mg/L	0.00011	0.0053	SEQG/CCME	(3)	0.00004	0.00034	SEQG/CCME	--	***<u>0.0018</u>***	**0.00005**	0.00004	0.00003
Chromium	mg/L	--	--	--	--	0.001	0.001	SEQG/CCME	(4)	**<u>0.025</u>**	0.001	0.001	0.001
Cobalt	mg/L	--	--	--	--	0.00078	0.00149	FEQG	(13) (14)	**<u>0.0027</u>**	0.000142	0.000125	0.000119
Copper	mg/L	0.0009	0.004	SEQG	(5)	0.0002	0.0005	FEQG	(6)	***<u>0.02</u>***	**0.00046**	**0.00031**	**0.00026**

Parameter	Units	Short-term Screening Criteria (background hardness)	Short-term Screening Criteria (Hardness induced [>250 mg/L])	Source	Note	Long-term Screening Criteria (background hardness)	Long-term Screening Criteria with Toxicity Modifier Applied (induced hardness)	Source	Note	Discharge Concentration (max predicted)	LA-5 Well Mixed (7Q10)	LA-5 Well Mixed (Monthly Low)	LA-5 Well Mixed (Average)
Cyanide	mg/L	--	--	--	--	--	--	--	--	N/A	--	--	--
Iron	mg/L	--	--	--	--	0.3	0.3	SEQG/CCME	--	0.0039	0.178	0.179	0.180
Lead	mg/L	--	--	--	--	0.001	0.007	SEQG/CCME		0.0003	0.00005	0.00005	0.00005
Manganese	mg/L	0.501	15	CCME	(7)	0.21	0.64	SEQG/CCME	(8)	0.03	0.020	0.020	0.020
Mercury	mg/L	--	--	--	--	0.000026	0.000026	CCME	--	0.00001	0.000010	0.000010	0.000010
Molybdenum	mg/L	--	--	--	--	0.073	0.073	CCME		**2.5**	0.04	0.02	0.02
Nickel	mg/L	--	--	--	--	0.025	0.025	CCME		0.0138	0.0003	0.0002	0.0002
Selenium	mg/L	--	--	--	--	0.001	0.001	CCME	--	**0.042**	0.001	0.001	0.000
Strontium	mg/L	--	--	--	--	2.5	2.5	FEQG		1.68	0.04	0.03	0.03
Thallium	mg/L	--	--	--	--	0.0008	0.0008	SEQG/CCME	--	0.0006	0.0002	0.0002	0.0002
Uranium	mg/L	0.033	0.033	CCME		0.015	0.015	SEQG/CCME	--	***0.057***	0.001	0.001	0.001
Vanadium	mg/L	--	--	--	--	0.12	0.12	FEQG		0.059	0.0011	0.0007	0.00
Zinc	mg/L	0.008	0.204	CCME	(10) (11)	0.013	0.058	CCME	(12)	***0.042***	0.002	0.001	0.001
Radiological													
Lead-210	Bq/L	--	--	--	--	0.2	0.2	HC	--	**0.42**	0.026	0.024	0.023
Polonium-210	Bq/L	--	--	--	--	0.1	0.1	HC	--	**0.15**	0.007	0.006	0.006
Radium-226	Bq/L	--	--	--	--	0.11	0.11	SEQG	--	**0.15**	0.008	0.007	0.007
Thorium-230	Bq/L	--	--	--	--	0.6	0.6	HC	--	**0.9**	0.024	0.019	0.016
Uranium-238	Bq/L	--	--	--	--	3	3	HC	--	0.7	0.013	0.008	0.006
Uranium-234	Bq/L	--	--	--	--	3	3	HC	--	0.7	0.013	0.008	0.006

Notes:

Induced hardness was considered to be >250 mg/L unless otherwise specified.

All parameters listed as total concentrations unless otherwise specified.

Saskatchewan Water Quality Objectives, SEQG on-line (https://envrbrportal.crmp.saskatchewan.ca/seqg-search/), SEQG for the protection of aquatic life were selected, based on total concentrations.

Bold numbers indicate exceedance of long-term criteria based on background hardness.

Underlined numbers indicate exceedance of long-term criteria based on induced hardness.

Italicized numbers indicate exceedance of short-term criteria

SEQG – Saskatchewan Environmental Quality Guidelines – Water Quality Guidelines for Freshwater Aquatic Life.

CCME – Canadian Council of Ministers of the Environment.

HC – Health Canada.

BC MOE – British Columbia Ministry of the Environment.

FEQG – Federal Environmental Quality Guidelines.

MDMER – Metal and Diamond Mining Effluent Regulations

DOC – Dissolved organic carbon.

TDS – Total dissolved solids.

TSS – Total suspended solids.

Narrative – Temperature - Maximum Weekly Average Temperature: Thermal additions to receiving waters should be such that the maximum weekly average temperature is not exceeded. Short-term Exposure to Extreme Temperature: Thermal additions to receiving waters should be such that the short-term exposures to maximum temperatures are not exceeded. Exposures should not be so lengthy or frequent as to adversely affect the important species.

A pH of 7 and a temperature of 15°C were assumed to convert total ammonia to un-ionized ammonia in accordance with CCME (2002).

(1) Long-term criterion for aluminum based on CCME/SEQG of 0.1 mg/L for dissolved aluminum when pH is greater than 6.5.
(2) Total ammonia-N calculated from the total ammonia guideline for an average annual temperature of 15°C and a pH of 7.0, Un-ionized Ammonia from Table 1 of temperature and pH, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Ammonia (https://ccme.ca/en/res/ammonia-en-canadian-water-quality-guidelines-for-the-protection-of-aquatic-life.pdf).
(3) Cadmium criteria based on water hardness of >0 to <5.3 mg/L (Site-specific background hardness is 5.26 mg/L (95th percentile of LA-5 and LA-6).
(4) Guideline specific to Chromium VI for conservative comparison to baseline water quality.
(5) Based on hardness of 5.26 mg/L (Short-term equation is ($e^{\{0.979123[\ln(hardness)]-8.64497\}}$)*1000 (SEGQ via AEP 1996b).
(6) Federal Water Quality Guideline for Copper using the Biotic Ligand Model (BLM) Tool and User Manual is 0.0002 mg/L using site-specific background hardness of 5.26 mg/L, DOC of 2.24 mg/L, and pH of 6.61 (95^{th} percentile of LA-5 and LA-6) and 0.0005 mg/L using conditions expected during operations including hardness of 9 mg/L, DOC of 2.24, and pH of 7.
(7) Short Term Guideline is based on dissolved manganese. Benchmark = exp(0.878[ln(hardness)] + 4.76) where the benchmark is expressed in dissolved manganese concentration (µg/L), and hardness is measured as CaCO3 equivalents in mg/L. (Site-specific hardness is 5.26 mg/L (95th percentile of LA-5 and LA-6).
(8) Long-term guideline for manganese based on Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life - Manganese, Appendix B - Canadian Water Quality Guidelines Calculator (pH = 6.61, hardness = 5.26 mg/L.

(9) Framework provides Trigger Ranges for Total Phosphorus (µg/L) - guideline for oligotrophic waterbody 4 - 10 µg/L.

(10) Guideline is based on dissolved zinc.

(11) Short term guideline is based on Benchmark = exp(0.833[ln(hardness mg·L-1)] + 0.240[ln(DOC mg·L-1)] + 0.526). (Site-specific background hardness is 5.26 mg/L, DOC is 2.24 mg/L, pH is 6.61 (95th percentile of LA-5 and LA-6). Note – extrapolated for value outside the hardness range.

(12) Long term guideline is based on CWQG = exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625). (Site-specific background hardness is 5.26 mg/L, DOC is 2.24 mg/L, pH is 6.61 (95th percentile of LA-5 and LA-6). Note – extrapolated for value outside the hardness range.

(13) Environment Canada 2017. Federal Environmental Quality Guidelines, Cobalt, May. Based on equation and lowest hardness for equation of 52 mg/L.

(14) Environment Canada 2017. Federal Environmental Quality Guidelines, Cobalt. Based on equation and hardness of 250 mg/L for equation of FWQG = exp{(0.414[ln(hardness)] – 1.887}.

(15) Hardness value provided here is not the expected hardness in effluent, but was selected as a concentration at which to evaluate a high hardness condition at the edge of the mixing zone for interpretation of modelled results against water quality guidelines.

In addition to concentration predictions, a preliminary mixing zone assessment was conducted for the discharge of effluent to LA-5. This preliminary mixing zone assessment predicts the extent/size of the area for which constituent water quality guidelines may be exceeded relative to the screening level criteria within LA-5 (Table 8.2-10). Simulations were carried out to assess the size of the mixing zone under different flow scenarios. To assess the size of a mixing zone within a lake, Cornell Mixing Zone Expert System (CORMIX) was used. CORMIX (Jirka and Akar, 1991) is a US EPA-supported mixing zone model and decision support system for environmental impact assessment of regulatory mixing zones resulting from continuous point source discharges. The model uses local current velocities around the diffuser rather than volumetric flow rates. For this investigation, current velocities near the diffuser were estimated by converting Icelander River (from LA-6 to LA-5) volumetric flow rates to current speeds using the cross-sectional area of the river. This characterization of current speed near the diffuser is appropriate since the current diffuser design is placed near the mouth of the river. To assess variability in river flow rates, current velocity estimates were made by considering the minimum, average, and maximum flow rates through the mouth of the river. Current velocities used in the mixing zone assessment are summarized in Table 8.2-11.

Table 8.2-11: Estimated Current Velocities Near the Diffuser

Flow Condition	Current Velocity (m/s)
Minimum	0.1
Average	0.23
Maximum	0.297

The extent of the mixing zone for concentrations predicted for the minimum, average, and maximum current velocities are provided in Table 8.2-12. Under all flow scenarios, the size of the mixing zone for all constituents remains less than 5 m^3.

Table 8.2-12: Size of the Mixing Zone Under Various Flow Conditions

Current Velocity (m/s)	Mixing Zone Distance (m)		
	7Q10 Low Flow	Monthly Low Flow	Monthly Average Flow
0.1	4.2	0.7	0.5
0.23	0.8	0.1	0.05

[3] We note that in response to the EIS review process and specifically comment Round 4 IR-114, the hardness induced guideline for Cu (hardness 9 mg/L, pH 7, DOC 2.24, temperature 13C) was include in Table 8.2-10, and this hardness was in relation to interpreting the well mixed results, which are downstream of the mixing zone. Using the expected parameters at the edge of the mixing zone (hardness 250 mg/L, pH 7, DOC 2.24, temperature 13C), the size of the mixing zone for copper remains less than 5 m.

0.297	0.5	0.1	0.05

Notes:
Under all flow conditions, all constituents meet screening concentrations within the mixing zone.

Under a conservative assessment, effluent discharge from the monitoring/effluent ponds is expected to occur year-round. Since effluent is stored in on-site ponds, it is anticipated that during the summer months, effluent temperatures and lake temperatures will be subject to the same ambient conditions. Furthermore, the receiving waterbody has a maximum depth of 4 m and therefore, is not expected to be stratified throughout the year with respect to temperature. As a result, the receiving environment is expected to have a similar water temperature to that of the discharged effluent. However, during winter, the ponds may be maintained at a slightly increased water temperature (compared to lake temperature) to prevent freezing.

It was assumed that the effluent temperature during winter would be approximately 5°C, while the ice-covered lake would have a temperature of 3 to 4°C. This results in a temperature differential of 1 to 2°C at end of pipe, leading to a slight temperature increase of the well-mixed (beyond the extend of the mixing zone) portion of LA-5 by approximately 0.2°C. Qualitatively, this suggests that there is a low thermal affect on the well-mixed portion of LA-5, a low thermal affect within the small mixing zone, and a low temporal occurrence (the largest temperature difference occurring under ice).

8.2.4.2.4 Regional Surface Water Quality Model

A regional surface water quality model was used to predict the effects on Surface Water Quality within Whitefish Lake. The model also served to support the human health and ecological risk assessments for the Project. Full details of the methodology in model inputs, model assumptions, and screening of COPC for surface water are provided in Appendix A of Appendix 10-A in Section 10.

The screening involved a conservative process of comparing the reasonable upper bound treated effluent quality against the selected water quality guidelines protective of human and ecological health Appendix A of Appendix 10-A. The reasonable upper bound treated effluent was derived using information available from pilot tests conducted by Denison, as well as derived effluent quality based on not exceeding water and sediment quality guidelines in the middle part of Whitefish Lake.

Surface water quality modeling was completed using IMPACT version 5.6.0. IMPACT is consistent with the COPC transport equations outlined in CSA N288.1-20 (CSA Group 2020). The modeling is discussed in detail in the *IMPACT Model Report for the Wheeler River Project* (Appendix A of Appendix 10-A). Waterbodies from Whitefish Lake to the Russell Lake inlet were modelled in IMPACT to assess the effects of the Project on the downstream environment. This included the following distinct water polygons: Whitefish Lake Middle, Whitefish Lake South, McGowan Lake, and Russell Lake. Kratchkowsky Lake and Whitefish Lake North were modelled as reference locations.

Model inputs, including hydrology, background water quality, effluent quality and discharge volume, and the screening level criteria, were consistent with those presented in Table 8.2-8 and Table 8.2-9**.**

Surface water quality modelling included predicting water and sediment concentrations in Whitefish Lake, the lake to which treated effluent will be released, as well as locations farther downstream. The geometric mean of measured water concentrations from baseline studies performed between 2011 and 2019 (Ecometrix 2020) was selected as the water baseline concentration for constituents that had measured data over the detection limit. Sediment baseline concentrations were predicted from surface water concentrations using the partitioning coefficients (Kd), which consist of regional published values that have been calibrated on similar sites in northern Saskatchewan and have been checked against measured data for the Wheeler River. In the case of constituents for which most or all measured concentrations in water were under the detection limit, but sediment concentration measurements were over the detection limit, the baseline water concentration was calculated from the geometric mean of the sediment measurements using the Kds (Section 3.3.2 in Appendix A of Appendix 10-A in Section 10).

When the treated effluent is released to Whitefish Lake South (LA-5), surface water concentrations were predicted using IMPACT according to the equations outlined in the IMPACT model (Section 2.2.2 in Appendix A of Appendix 10-A). The predicted maximum concentrations of COPC in water are shown in Table 8.2-13. With the exception of copper where baseline concentrations exceed the FEQG (due to the copper analytical detection limit being equal to the FEQG) and the guideline does not consider conditions expected during operations, there are no predicted exceedances of water quality guidelines for any of the COPC during Construction, Operation, or Decommissioning.

Table 8.2-13: Maximum Concentration of Surface Water Constituents of Potential Concern in Surface Water

Constituent	Unit	Kratchkowsky Lake (LA-7)	Whitefish Lake North (LA-6)	Whitefish Lake Middle (LA-5 North)	Whitefish Lake South (LA-5 South)	McGowan Lake (LA-1)	Icelander River	Russell Lake Inlet	Short-term Benchmark			Long-term Benchmark		
									Value	Reference	Notes	Value	Reference	Notes
Alkalinity	mg/L	NE	NE	12.4	12.4	NE	NE	NE						
Aluminum	mg/L	0.01766	0.01616	0.01835	0.02226	0.01500	0.01499	0.01614				0.1	SEQG/ CCME	(1)
Ammonia (as N)	mg/L	0.01463	0.01463	0.05232	0.05215	0.03978	0.0395	0.03368				5.74	SEQG /CCME	(2)
Un-ionized Ammonia	mg/L	0.0000086	0.0000086	0.0000309	0.0000308	0.0000235	0.0000233	0.0000199				0.019	SEQG/ CCME	
Arsenic	mg/L	0.00012	0.00011	0.00015	0.00015	0.00013	0.00013	0.00012				0.005	SEQG/ CCME	
Cadmium	mg/L	0.000024	0.000023	0.00004	0.000039	0.000033	0.000033	0.00003	0.00011	CCME	(3)	0.00004	SEQG/ CCME	
Chloride	mg/L	0.32	0.32	6.14	6.11	4.2	4.16	3.26	640	SEQG/ CCME		120	SEQG/ CCME	
Chromium	mg/L	0.00053	0.0005	0.0007	0.0007	0.0007	0.0007	0.0006				0.001	SEQG/ CCME	(4)
Cobalt	mg/L	0.000101	0.000101	0.000129	0.000128	0.000119	0.000119	0.000114				0.00078	FEQG	(13) (14)
Copper	mg/L	**0.00062**	**0.00062**	**0.00082**	**0.00082**	**0.00075**	**0.00075**	**0.00072**	0.0009	SEQG	(5)	0.0002	FEQG	(6)
Iron	mg/L	0.0467	0.0424	0.0470	0.0567	0.0400	0.0400	0.0425				0.3	SEQG/ CCME	
Lead	mg/L	0.000124	0.000114	0.000118	0.00013	0.000114	0.000114	0.000116				0.001	SEQG/ CCME	
Lead-210	Bq/L	0.0062	0.0057	0.0084	0.0083	0.0067	0.0067	0.0064				0.2	HC	
Manganese	mg/L	0.001674	0.001524	0.001722	0.001867	0.001593	0.001590	0.001593	0.501	CCME	(7)	0.21	SEQG/ CCME	(8)
Mercury	mg/L	0.0000053	0.0000053	0.0000053	0.0000053	0.0000053	0.0000053	0.0000053				0.000026	CCME	
Molybdenum	mg/L	0.0001	0.0001	0.0243	0.024	0.0158	0.0156	0.0118				0.073	CCME	
Nickel	mg/L	0.00039	0.00038	0.00051	0.0005	0.00046	0.00046	0.00044				0.025	CCME	
Nitrate	mg/L	NE	NE	0.249	0.249	NE	NE	NE	550	CCME		3	SEQG	
Phosphorus	mg/L	<0.01	<0.01	0.01	0.01	0.01	<0.01	<0.01				0.004 - 0.01	CCME	(9)
Polonium-210	Bq/L	0.0063	0.0058	0.0067	0.0072	0.0062	0.0062	0.0062				0.1	HC	

Constituent	Unit	Kratchkowsky Lake (LA-7)	Whitefish Lake North (LA-6)	Whitefish Lake Middle (LA-5 North)	Whitefish Lake South (LA-5 South)	McGowan Lake (LA-1)	Icelander River	Russell Lake Inlet	Short-term Benchmark			Long-term Benchmark		
									Value	Reference	Notes	Value	Reference	Notes
Radium-226	Bq/L	0.0057	0.0056	0.0069	0.0067	0.0063	0.0063	0.0061				0.11	SEQG	
Selenium	mg/L	0.000034	0.00003	0.00043	0.00041	0.00026	0.00026	0.0002				0.001	CCME	
Sulphate	mg/L	0.69	0.69	38.66	38.49	26.03	25.75	19.88				128	BC MOE	
Thallium	mg/L	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001				0.0008	SEQG/ CCME	
Thorium-230	Bq/L	0.01014	0.01012	0.01868	0.01854	0.01569	0.01563	0.0143				0.6	HC	
TSS	mg/L	1.60	1.60	1.65	1.65	1.63	1.63	1.63				backgrou nd +5 mg/L	CCME	
Uranium	mg/L	0.00003	0.00003	0.00057	0.00055	0.00034	0.00033	0.00025	0.033	CCME		0.015	SEQG/ CCME	
Uranium-234	Bq/L	0.000385	0.000377	0.00705	0.00672	0.00415	4.11E-03	3.09E-03				3	HC	
Uranium-238	Bq/L	0.000385	0.000377	0.00705	0.00672	0.00415	4.11E-03	3.09E-03				3	HC	
Vanadium	mg/L	0.00017	0.00015	0.00067	0.00056	0.00033	0.00033	0.00027				0.12	FEQG	
Zinc	mg/L	0.0007	0.00069	0.00106	0.00103	0.0009	0.0009	0.00084	0.008	CCME	(10) (11)	0.013	CCME	(12)

Notes:

All parameters listed as total concentrations unless otherwise specified

Saskatchewan Water Quality Objectives, SEQG on-line (https://envrbrportal.crmp.saskatchewan.ca/seqg-search/), SEQG for the protection of aquatic life were selected, based on total concentrations

Bold numbers indicate exceedance of long-term criteria

Bold and italicized indicate exceedance of short-term criteria and long-term criteria.

SEQG – Saskatchewan Environmental Quality Guidelines – Water Quality Guidelines for Freshwater Aquatic Life.

CCME – Canadian Council of Ministers of the Environment.

HC – Health Canada.

BC MOE – British Columbia Ministry of the Environment.

FEQG – Federal Environmental Quality Guidelines.

MDMER – Metal and Diamond Mining Effluent Regulations

DOC – Dissolved organic carbon.

TSS – Total suspended solids.

A pH of 7 and a temperature of 15°C were assumed to convert total ammonia to un-ionized ammonia in accordance with CCME (2002).

(1) Long-term criterion for aluminum based on CCME/SEQG of 0.1 mg/L for dissolved aluminum when pH is greater than 6.5.

(2) Total ammonia-N calculated from the total ammonia guideline for an average annual temperature of 15°C and a pH of 7.0, Un-ionized Ammonia from Table 1 of temperature and pH, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Ammonia (https://ccme.ca/en/res/ammonia-en-canadian-water-quality-guidelines-for-the-protection-of-aquatic-life.pdf).

(3) Cadmium criteria based on water hardness of >0 to <5.3 mg/L (Site-specific background hardness is 5.26 mg/L [95th percentile of LA-5 and LA-6]).

(4) Guideline specific to Chromium VI for conservative comparison to baseline water quality.

(5) Based on hardness of 5.26 mg/L (Short-term equation is (e{0.979123[ln(hardness)]-8.64497})*1000 (SEGQ via AEP 1996b).

(6) Federal Water Quality Guideline for Copper using the Biotic Ligand Model (BLM) Tool and User Manual is 0.0002 mg/L using site-specific background hardness of 5.26 mg/L, DOC of 2.24 mg/L, and pH of 6.61 (95^{th} percentile of LA-5 and LA-6).

(7) Short Term Guideline is based on dissolved manganese. Benchmark = exp(0.878[ln(hardness)] + 4.76) where the benchmark is expressed in dissolved manganese concentration (µg/L), and hardness is measured as CaCO3 equivalents in mg/L. (Site-specific hardness is 5.26 mg/L (95th percentile of LA-5 and LA-6).

(8) Long-term guideline for manganese based on Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life - Manganese, Appendix B - Canadian Water Quality Guidelines Calculator (pH = 6.61, hardness = 5.26 mg/L.

(9) Framework provides Trigger Ranges for Total Phosphorus (µg/L) - guideline for oligotrophic waterbody 4 - 10 µg/L.

(10) Guideline is based on dissolved zinc.

(11) Short term guideline is based on Benchmark = exp(0.833[ln(hardness mg·L-1)] + 0.240[ln(DOC mg·L-1)] + 0.526). (Site-specific background hardness is 5.26 mg/L, DOC is 2.24 mg/L, pH is 6.61 (95th percentile of LA-5 and LA-6). Note – extrapolated for value outside the hardness range.

(12) Long term guideline is based on CWQG = exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625). (Site-specific background hardness is 5.26 mg/L, DOC is 2.24 mg/L, pH is 6.61 (95th percentile of LA-5 and LA-6). Note – extrapolated for value outside the hardness range.

(13) Environment Canada 2017. Federal Environmental Quality Guidelines, Cobalt, May. Based on equation and lowest hardness for equation of 52 mg/L.

(14) Environment Canada 2017. Federal Environmental Quality Guidelines, Cobalt. Based on equation and hardness of 250 mg/L for equation of FWQG = exp{(0.414[ln(hardness)] – 1.887}.

8.2.4.2.5 Long-Term Transport of Groundwater Solutes to Whitefish Lake in Future Centuries

During the 'future centuries' phase as described in Section 8.2.1.3, remediation works will be completed, and the site naturalized, thereby restoring drainage patterns to report to surface waterbodies. As indicated in Section 7 of the EIS, groundwater plumes may develop from residual mass remaining post mining based on bench-scale lab tests of core flushing, and numerical modelling of reactive fate and transport.

Groundwater flow and reactive transport of dissolved constituents were modelled using three-dimensional modelling whereby the reactions were computed using PHREEQC and the transport was computed using FEFLOW (Ecometrix 2022). Groundwater flow observed, and simulated in the calibrated groundwater model, travels eastward from the mining zone within the Lower Sandstone Aquifer before moving upward through the Desilicified Zone in the Athabasca Sandstone and overlying overburden deposits toward Whitefish Lake. Modelled transport of dissolved constituents along the groundwater flow path allowed for interactions of the dissolved constituents with the geologic media through which they are flowing. Due to the relatively low groundwater velocities between the mining zone and Whitefish Lake and chemical reactions along the groundwater flow pathway, the "Future Centuries" scenario spans 100s to 1000s of years.

The results of the numerical modelling, as provided in Section 7 and Appendix 10-A in Section 10, support the conclusion that with the implementation of appropriate mitigation during the decommissioning and restoration phase of the Project, the residual effects of the Project on the intermediate Groundwater VC will not result in an adverse effect to surface water. Dissolved constituent concentrations emanating over hundreds to thousands of years in the future from the deep Ore Zone to Whitefish Lake remain below fresh water environmental quality criteria in Whitefish Lake.

For the COPC identified in the effluent, the predicted mass flux from groundwater into Whitefish Lake starting 200 years after the Project phases during the future centuries was added into the IMPACT model to predict the surface water concentrations over time at the exposed locations (see Table 8.2-14). As shown in the Environmental Risk Assessment (ERA; Appendix 10-A in Section 10), predicted surface water concentrations at all locations are expected to be below water guidelines for the protection of aquatic life, except for copper where baseline concentrations exceed the FEQG (due to the copper analytical detection limit being equal to the FEQG) and an incremental increase in concentration is predicted such that the predicted copper concentration (0.0006 mg/L) would be greater than the FEQG of 0.0002 mg/L under baseline conditions, indicating a slight increased level of risk to the most sensitive aquatic biota.

Table 8.2-14: Maximum Concentration of Surface Water Constituents of Potential Concern in Surface Water During Future Centuries

Constituent	Unit	Kratchkowsky Lake (LA-7)	Whitefish Lake North (LA-6)	Whitefish Lake Middle (LA-5 North)	Whitefish Lake South (LA-5 South)	McGowan Lake (LA-1)	Icelander River	Russell Lake Inlet	Long-term Screening Concentration	Source of Screening Concentration	Notes
Alkalinity	mg/L	NC	NC	8.1	8.1	NC	NC	NC	NC	NC	(10)
Aluminum	mg/L	0.01358	0.01358	0.01388	0.01373	0.0136	0.0136	0.01359	0.1	SEQG/CCME	(1)
Ammonia (as N)	mg/L	0.01463	0.01463	0.01463	0.01463	0.01463	0.01463	0.01463	5.74	SEQG/CCME	(2)
Un-ionized Ammonia	mg/L	0.000035	0.000035	0.000035	0.000035	0.000035	0.000035	0.000035	0.019	SEQG/CCME	
Arsenic	mg/L	0.000103	0.000103	0.000107	0.000107	0.000105	0.000105	0.000104	0.005	SEQG/CCME	
Cadmium	mg/L	0.0000232	0.0000232	0.0000233	0.0000233	0.0000233	0.0000233	0.0000232	0.00004	SEQG/CCME	
Chloride	mg/L	0.32	0.32	0.41	0.41	0.39	0.39	0.38	120	SEQG/CCME	
Chromium	mg/L	0.00052	0.00052	0.00053	0.00053	0.00052	0.00052	0.00052	0.001	SEQG/CCME	(3)
Cobalt	mg/L	0.0001	0.0001	0.00011	0.00011	0.00011	0.0001	0.0001	0.00078	FEQG	(8) (9)
Copper	mg/L	**0.00062**	**0.00062**	**0.00063**	**0.00063**	**0.00062**	**0.00062**	**0.00062**	0.0002	FEQG	(4)
Iron	mg/L	0.12126	0.12126	0.12756	0.12672	0.12408	0.12405	0.12308	0.3	SEQG/CCME	
Lead	mg/L	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.001	SEQG/CCME	
Lead-210	Bq/L	0.00527	0.00527	0.00605	0.00592	0.00557	0.00556	0.00545	0.2	HC	
Manganese	mg/L	0.01206	0.01206	0.01419	0.01413	0.01355	0.01353	0.01317	0.21	SEQG/CCME	(5)
Mercury	mg/L	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.000026	CCME	
Molybdenum	mg/L	0.00011	0.00011	0.00012	0.00012	0.00011	0.00011	0.00011	0.073	CCME	
Nickel	mg/L	0.00038	0.00038	0.00041	0.00041	0.0004	0.0004	0.00039	0.025	CCME	
Nitrate	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	(10)
Phosphorus	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.004 - 0.01	CCME	(6)
Polonium-210	Bq/L	0.00536	0.00536	0.00615	0.00602	0.00566	0.00564	0.00553	0.1	HC	
Radium-226	Bq/L	0.00557	0.00557	0.00639	0.00637	0.00615	0.00614	0.006	0.11	SEQG	
Selenium	mg/L	0.00003	0.00003	0.00004	0.00004	0.00004	0.00004	0.00004	0.001	CCME	
Sulphate	mg/L	0.69	0.69	0.72	0.72	0.71	0.71	0.71	128	BC MOE	
Thallium	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0008	SEQG/CCME	
Thorium-230	Bq/L	0.0101	0.0101	0.01036	0.01036	0.0103	0.0103	0.01025	0.6	HC	

Constituent	Unit	Kratchkowsky Lake (LA-7)	Whitefish Lake North (LA-6)	Whitefish Lake Middle (LA-5 North)	Whitefish Lake South (LA-5 South)	McGowan Lake (LA-1)	Icelander River	Russell Lake Inlet	Long-term Screening Concentration	Source of Screening Concentration	Notes
TSS	mg/L	3.0	2.0	2.6	2.6	2.5	2.2	4.0	background +5 mg/L	CCME	
Uranium	mg/L	0.00003	0.00003	0.00004	0.00004	0.00003	0.00003	0.00003	0.015	SEQG/CCME	
Uranium-234	Bq/L	0.0004	0.0004	0.0005	0.0005	0.0004	0.0004	0.0004	3	HC	
Uranium-238	Bq/L	0.0004	0.0004	0.0005	0.0005	0.0004	0.0004	0.0004	3	HC	
Vanadium	mg/L	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.12	FEQG	
Zinc	mg/L	0.00068	0.00068	0.00074	0.00074	0.00072	0.00072	0.00071	0.013	CCME	(7)

Notes:

All parameters listed as total concentrations unless otherwise specified

Saskatchewan Water Quality Objectives, SEQG on-line (https://envrbrportal.crmp.saskatchewan.ca/seqg-search/), SEQG for the protection of aquatic life were selected, based on total concentrations

Bold numbers indicate exceedance of long-term criteria

SEQG – Saskatchewan Environmental Quality Guidelines – Water Quality Guidelines for Freshwater Aquatic Life.

CCME – Canadian Council of Ministers of the Environment.

HC – Health Canada.

BC MOE – British Columbia Ministry of the Environment.

FEQG – Federal Environmental Quality Guidelines.

MDMER – Metal and Diamond Mining Effluent Regulations.

DOC – Dissolved organic carbon.

TSS – Total suspended solids.

A pH of 7 and a temperature of 15°C were assumed to convert total ammonia to un-ionized ammonia in accordance with CCME (2002).

(1) Long-term criterion for aluminum based on CCME/SEQG of 0.1 mg/L for dissolved aluminum when pH is greater than 6.5.
(2) Total ammonia-N calculated from the total ammonia guideline for an average annual temperature of 15°C and a pH of 7.0, Un-ionized Ammonia from Table 1 of temperature and pH, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Ammonia (https://ccme.ca/en/res/ammonia-en-canadian-water-quality-guidelines-for-the-protection-of-aquatic-life.pdf).
(3) Guideline specific to Chromium VI for conservative comparison to baseline water quality.

(4) Federal Water Quality Guideline for Copper Biotic Ligand Model (BLM) Tool and User Manual (Site-specific background hardness is 5.26 mg/L, DOC is 2.24 mg/L, pH is 6.61 [95th percentile of LA-5 and LA-6]).

(5) Long-term guideline for manganese based on Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life - Manganese, Appendix B - Canadian Water Quality Guidelines Calculator (pH = 6.61, hardness = 5.26 mg/L.

(6) Framework provides Trigger Ranges for Total Phosphorus (µg/L) - guideline for oligotrophic waterbody 4 - 10 µg/L.

(7) Long term guideline is based on CWQG = exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625). (Site-specific background hardness is 5.26 mg/L, DOC is 2.24 mg/L, pH is 6.61 (95th percentile of LA-5 and LA-6). Note – extrapolated for value outside the hardness range.

(8) Environment Canada 2017. Federal Environmental Quality Guidelines, Cobalt, May. Based on equation and lowest hardness for equation of 52 mg/L.

(9) Environment Canada 2017. Federal Environmental Quality Guidelines, Cobalt. Based on equation and hardness of 250 mg/L for equation of FWQG = exp{(0.414[ln(hardness)] – 1.887}.

(10) "NC" means not calculated/estimated in the IMPACT model during future centuries. Nitrate is not a COPC associated with ISR mining for the Project and was not included in the groundwater source term to Whitefish Lake developed through geochemical reactive transport modelling (Section 7, Appendix 7-C). Nitrate concentrations are low in the groundwater environment and in metallurgical testing informing the groundwater reactive transport model (Section 7, Appendix 7-C). As such, nitrate concentrations are expected to remain at baseline conditions in surface water bodies in the future centuries. Alkalinity was included in the geochemical reactive transport model but not in the IMPACT modelling. As such, the maximum alkalinity concentration (mg/L as $CaCO_3$) during future centuries was calculated outside of IMPACT using the same equations/approach presented in Section 10 (Appendix A of Appendix 10-A) and the mass flux of alkalinity from the geochemical reactive transport model (Reported as "C" in Table 4-4 of Appendix 7-C). The maximum concentration calculated (8.1 mg/L) is within the range or alkalinity values measured in the south part of Whitefish Lake (3-13 mg/L; Table 8.2-2) and represents an increase of approximately 5.2% over the mean baseline value of 7.7 mg/L in the south part of Whitefish Lake (Table 8.2-2). Alkalinity values in the other lakes were not calculated because they are expected to remain at baseline levels during future centuries.

8.2.5 Mitigation Measures

To mitigate adverse effects on Surface Water Quality, Denison will implement the following mitigation measures.

- Develop and implement a Surface Water Management Program that provides an integrated framework to manage water quality, including provision for water management practices for each of the primary site aspects, as well as areas of the Project site where contact water is expected.
- Maximize the recycle and reuse of process water to reduce freshwater intake and release to Whitefish Lake.
- Design the discharge diffuser/outfall to provide effective mixing and dilution and discharge flows that do not detrimentally affect sediments.
- Develop site-specific effluent treatment to treat COPC to appropriate release limits in accordance with provincial standards and licence/permit conditions.
- Discharge effluent under a scenario that will meet provincial and federal discharge criteria as identified through permitting. Scenarios may include:
  - discharging at a fixed rate while maintaining an appropriate minimum dilution ratio (i.e., discharge when able to meet the required dilution ratio and cease discharge during periods when unable to meet the necessary dilution ratio);
  - discharging under a variable waste load allocation (i.e., discharge an appropriate effluent volume based on flow in the receiver to maintain minimum dilution ratio); and
  - managing discharge via a hybrid of these (i.e., discharge effluent at a fixed rate to maintain the required dilution ratio, but the fixed rate can be varied on a seasonal basis based on flow).
- Collect and monitor contact water to determine whether treatment is required prior to release to the environment to inform optimal levels of treatment.
- Maintain the water management system in place during decommissioning until such time that water quality is suitable to release to the environment.
- Monitor and manage effluent, including contingency for effluent treatment as may be required, so that water discharge objectives are achieved as defined by applicable provincial and federal regulatory instruments.
- Design and implement an Environmental Code of Practice that defines action levels and appropriate steps to be taken to mitigate elevated concentrations of chemical and radiological constituents in treated effluent discharge to acceptable levels.

- Implement Project-specific monitoring programs (e.g., effluent monitoring plan, environmental monitoring plan) that include monitoring treated effluent, surface water and sediment quality, and applying adaptive management, if necessary.
- Work with the associated communities to develop and implement the Project-specific monitoring programs and a framework to share the results for the purpose of assessing the performance of the water management system.
- Develop and implement a decommissioning and reclamation plan to decommission and transfer the site to the province under the Institutional Control Program.

8.2.6 Residual Effects Evaluation

8.2.6.1 Residual Effects Characterization

This section describes the likely residual effects of the Project on the VC of Surface Water Quality and its associated KI. Residual effects are effects that remain after the implementation of mitigation measures and management strategies and are the expected consequences of the Project. The approach to assessing residual Project effects on the Surface Water Quality VC follows the methodology outlined in Section 5.8 in Section 5. For each VC and associated KI, each residual effect is characterized in the context of the Project activities that will occur within each Project phase. A residual effect on Surface Water Quality is defined as a measurable change in the concentration of a water quality parameter (or parameters) that exceeds relevant water quality assessment benchmarks that represent concentrations that are protective of aquatic biota and water uses in watercourse and waterbodies that receive mine-affected drainage. Residual effect characteristics specific to Surface Water Quality are defined in Table 8.2-15 and summarized in Table 8.2-16. A reminder that Surface Water Quality is an intermediate VC and as such, the rating of residual effects as being not significant or significant is completed for the receptor VCs and KIs.

Construction

The primary potential water quality change associated with Construction is the mobilization of suspended material into natural surface water features as a result of land clearing activities and road crossing construction. According to the site water balance (Figure 2.2-14 in Section 2), there is no planned discharge to Whitefish Lake during Construction. However, the potential influence of such discharge, if it were to occur, would be bounded by the analysis of water quality in Whitefish Lake during Operation.

Mobilization of suspended solids into natural surface water features is readily mitigatable by virtue of the mine development plan and through the implementation of standard water management and sediment control practices. Water management infrastructure (e.g., collection pads, ponds, pumping stations), as well as various aspects of the water management and sediment control management systems, will be put into place coincident with the initiation of construction activities. Runoff associated with areas under development will be collected and either stored within management infrastructure (e.g., water management ponds) or potentially released into natural surface water features once it is safe to do so (i.e., suspended solid levels in the water would be at acceptable levels). No downstream effects on local surface waters are expected.

Operation

During Operation, the primary potential water quality effect from the Project is the discharge of excess water from the site water management system to Whitefish Lake (LA-5). Discharge to Whitefish Lake South has the potential to change the concentrations of water quality constituents from background.

For planning purposes, a continuous (year-round) discharge at an expected average effluent discharge rate of 0.0101 m^3/s (or 36.5 m^3/hr) was used during Operation, despite the likelihood that effluent discharge will not be continuous, and Denison will only discharge when the site water balance requires (based on water storage capabilities). The water storage capability of the Effluent Monitoring and Release Ponds has been designed to enable contingency in water storage (i.e., three ponds of 3,300 m^3 capacity).

No other routine mine-related discharges to other receiving environments are proposed during Operation. Water management infrastructure will collect and divert all site aspect influenced water (often referred to as contact water), as well as water associated with the ISR process, through the IWWTP. Any excess water not required during the ISR process will be directed to the WTP. Treated water from the WTP will be pumped to the Effluent Monitoring and Release Ponds.

Treated water in the Effluent Monitoring Ponds will be monitored prior to release to Whitefish Lake. The treated effluent discharge line will be heated and have secondary containment in place.

Based on pilot tests completed for the IWWTP to date, sulphate, chromium, molybdenum, TSS, and selenium have been identified as having potential management needs. However, for each of these parameters, the estimated discharge concentrations provided herein are conservative in nature with a contingency factor of 1 to 3 times incorporated for conservancy. Additionally, the effluent discharge concentrations for these parameters do not consider any further physical or chemical mechanisms that may occur in the effluent/monitoring ponds prior to discharge to the environment. As such, concentrations of these parameters have the potential to be lower than presented. Despite further reduction in constituent effluent concentrations, the near-field and regional surface water quality models predict concentrations of these parameters in the receiving environment below criteria for the protection of aquatic biota and human health within a short distance of the diffuser. One exception is copper where incremental increase in concentration is predicted such that the predicted copper concentration (~0.0007 to 0.0008 mg/L) would be greater than the FEQG of 0.0002 mg/L under baseline conditions, indicating a slight increased level of risk to the most sensitive aquatic biota.

Local Indigenous communities have expressed direct concern with respect to mercury. Mercury has not been identified as a COPC for the Project as it is currently not present in the receiving environment (i.e., background condition) at detectable concentrations and will not be produced as part of the mine process, and, therefore, not discharged to the aquatic environment. However, it is understood that potential nutrient enrichment-related effects are possible and can be linked to increases in mercury in the environment.

As described above, the site-wide water management strategy involves care and control of all site aspect influenced water and no discharge is proposed beyond that to Whitefish Lake. In practice, it may be necessary at times to manage runoff from disturbed areas that are either outside the water management system or are yet to be integrated into the water management system. In these cases, the areas would be isolated and specific water and sediment control management practices would be implemented to make sure that any water released to natural surface water drainages would be suitable for release and that water quality in these natural surface water drainages would be protected.

Decommissioning/Post-Decommissioning

Following the cessation of mining operations, discharge to Whitefish Lake will cease. Water quality in Whitefish Lake is expected to return to background, pre-mining conditions at that time.

The site-wide water management system will continue to operate such that Denison will remain in control of site aspect affected water via the IWWTP. At that time, water (runoff) from the ISR wellfield, and contact water from the developed portion of the Project site (e.g., contaminated runoff pond, landfill pond, process water pond), will continue to be collected and diverted to the IWWTP. From the IWWTP, the water will be directed back to the ISR wellfield to be pumped as clean water to ground or pumped to the Effluent Monitoring and Release Ponds for monitoring prior to discharge to LA-5. Following Decommissioning, piping infrastructure will be removed and discharge to surface water will cease.

Table 8.2-15: Surface Water Quality – Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Effect moves measurable parameters in a direction detrimental to surface water quality. An increase in constituent concentrations in comparison to baseline conditions and trends. **Positive** – Effect moves measurable parameters in a direction beneficial to surface water quality. An improvement in water quality in comparison to baseline conditions and trends.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Low** – A measurable change that is not within the variability of baseline conditions but below relevant water quality objectives and criteria. **Moderate** – A measurable change that is not within the variability of baseline conditions and not within applicable guidelines, legislated

Residual Effect Characteristic	Definition	Rating
		requirements, and/or federal and provincial management objectives; therefore, it could have an adverse effect on water uses in the LSA. **High** – A measurable change that is not within the variability of baseline conditions and not within applicable guidelines, legislated requirements, and/or federal and provincial management objectives; therefore, it is likely to have an adverse effect on water uses in the LSA, with the effect extending beyond the LSA.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the Surface Water Quality LSA. **Regional** – Effect extends beyond the Surface Water Quality LSA into the Surface water Quality RSA. **Beyond Regional** – Effect extends beyond the Surface Water Quality RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions. **Partially Reversible** – A residual effect that partially diminishes to baseline conditions. **Irreversible** – A residual effect that will not diminish to baseline conditions.
Context	The extent to which the VC or KI has been affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its ability to recover from that effect (i.e., resilience).	**Low** – VC/KI has high resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or a lack of historic and ongoing anthropogenic or natural disturbance. **Moderate** – VC/KI has moderate resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or an intermediate level of historic or ongoing anthropogenic or natural disturbance with the capacity to assimilate more change. **High** – VC/KI has weak resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or a high level of historic or ongoing anthropogenic or natural disturbance.
Likelihood	Likelihood that the residual effect will occur, including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability that the residual effect will occur. **Unlikely** – A low probability that the residual effect will occur.

Table 8.2-16: Surface Water Quality – Summary of the Characteristics Ratings for Residual Effects

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project, and specifically the discharge of effluent to the natural environment, will cause a change in the concentration of constituents, measured as a mass of a chemical per unit volume in water (e.g., mg/L). Surface water quality in the local receiving environment will be adversely affected by effluent discharge to the environment.
Magnitude	Moderate	The magnitude of the residual effects associated with the Project is predicted to be low overall as the vast majority of constituents that may be introduced as part of Project activities are expected to remain below criteria for the protection of aquatic life and human health. However, with the exceedance of the Cu FEQG and in response to Round 4 IR-114, the overall rating was conservatively changed to moderate, even though the copper values in the EIS have been overpredicted in the models for a number of reasons including the fact that the baseline water quality analytical detection limit for copper was equal to the Cu FEQG.
Geographic Extent	Local	The geographic extent of the residual effects is predicted to be local as effects are expected to be confined to the immediate waterbody adjacent to the Project (i.e., Whitefish Lake) and the estimated mixing zone is less than 5 m, implementing an effluent discharge configuration that promotes mixing.
Duration	Long-term	Effects are expected to last between 3 to 38 years (i.e., effects expected during Construction through to the end of Post-Decommissioning).
Frequency	Continuous	For the purposes of this EIS in identifying the conservative scenario, effluent discharge has been considered as continuous during Operation and Decommissioning.
Reversibility	Fully Reversible	Surface water quality is expected to return to pre-development levels following Post-Decommissioning as Project-related sources will cease to operate.
Context	Low	The Surface Water Quality VC is resilient in the context of this assessment as COPC meet protective criteria at the extreme low water scenario. Therefore, under applicable mitigative measures and average flow conditions, the contextual resilience of the aquatic system to respond to change is considered to be great.
Likelihood	Likely	There is a high probability that a change in water quality from background condition will occur.

8.2.6.2 Confidence of Assessment

As Surface Water Quality is considered an intermediate VC, the significance of any associated residual effects is assessed within the context as a pathway to effects on receptor VCs. These receptor VCs include Fish and Fish Habitat (Section 8.3), and Sediment Quality and Benthic Invertebrates (Section 8.4) and Fish Health (Section 8.5). Determinations of significance of residual adverse effects are provided in these sections which include surface water quality as a KI of potential residual effects.

The prediction confidence with respect to Surface Water Quality is high as the mobilization of sediment can be readily mitigated, making the effects prediction relative to this effect pathway easily understood.

Potential effects on Surface Water Quality as a result of Project discharges to local receiving environments were assessed by way of numerical modeling. These predictions are generally considered conservative in nature because the assumptions on which they are based are conservative. For example:

- The assessment is based on a continuous (year-round) discharge at an expected average effluent discharge rate of 0.0101 m^3/s (or 36.5 m^3/hr) throughout Construction, Operation, and Decommissioning, despite the likelihood that effluent discharge will not be continuous and Denison will only discharge when the site water balance requires, based on water storage capabilities.
- Constituents in effluent discharge have been estimated conservatively. Presented discharge concentrations provided herein include contingency factors of 1 to 3 times incorporated to facilitate conservancy.
- Baseline water quality is defined by the 95th percentile concentrations of individual constituents. Such an assumption is conservative as it constrains the assimilative capacity associated with the receiving environment. By definition, the assimilative capacity of a receiving environment is equal to the incremental difference between the existing baseline condition and the assessment benchmark (i.e., water quality criterion) on which the evaluation is based. Use of the 95th percentile concentration, rather than a measure of central tendency (i.e., 50th percentile, geomean), means that the incremental change in a given constituent concentration can be assimilated by the receiving environment, whereby use of the receiving environment is projected to be relatively small in magnitude.
- Water quality predictions did not consider physical or chemical processes that may attenuate concentrations in the receiving environment. An example of such a process would be partitioning of constituents from the water column to Whitefish Lake sediments. No attempt has been made to adjust water quality predictions to account for this portioning, despite using this relationship to consider the potential effects of discharge on Sediment Quality.

Due to the conservative nature of the assumptions on which the numerical assumptions are based, a high degree of confidence can be assumed.

8.2.6.3 Summary of Project-related Residual Adverse Effects on Surface Water Quality

Since Surface Water Quality is an intermediate VC, the results of residual effect characterizations for Surface Water Quality do not have significance determinations of their own. Determinations of significance of residual adverse effects related to Surface Water Quality are provided in association with receptor VCs in Sections 8.3, 8.4, and 8.5 (Fish and Fish Habitat, Sediment Quality and Benthic Invertebrates, and Fish Health, respectively).

8.2.7 Cumulative Effects

Existing projects within the Wheeler River Watershed have been considered for potential to interact with the Surface Water Quality VC for the Project. These include reasonably foreseeable projects that are described in Section 5.9.

The Cameco Key Lake Operation has the potential to interact with the Surface Water Quality VC for the Project (Figure 5.9.1). The site has been in operation since 1983. In 2018, sustained low uranium prices resulted in a decision to curtail production for the foreseeable future and place the operation into safe care and maintenance. On February 9, 2022, Cameco announced plans for the operation's gradual return to production. Cameco's Key Lake Operation will overlap spatially and temporally with the Project.

The Project is situated approximately 35 km northeast of the Key Lake Operation and both are located in watersheds that ultimately report to Russell Lake. Releases to the aquatic environment from the Key Lake Operation are received by the David Creek, McDonald Creek, and Outlet Creek drainages. These three drainages join the Wheeler River, which then flows to Russell Lake (Cameco 2020). Therefore a potential spatial overlap was identified for the Project and the Key Lake Operation and further assessed or cumulative effects.

The assessment of cumulative effects on the Surface Water Quality VC considered releases from the Project and the Key Lake Operation during all phases of the Project. The key Project component contributing to potential cumulative effects is the discharge of treated effluent to the aquatic environment during Operation and Decommissioning which may interact with Cameco's current releases to water including treated water released to David Creek drainage, treated groundwater and diverted surface water to the McDonald Creek drainage (Cameco 2020).

Temporal overlap of the Key Lake Operation and the Project will also occur during 'future centuries' as described as 'post-decommissioning phase' in the Key Lake Extension Project EIS (Cameco 2020). There is potential for increased contaminant transport via groundwater to surface water during the long-term, post-decommissioning phase (i.e., 10,000 years after operations cease and the site has been reclaimed) for the Key Lake Operation. The long-term storage of tailings at a higher elevation has the potential to influence contaminants in the groundwater and incrementally add to the effect on surface water quality in the Outlet Creek Drainage.

Operation and Decommissioning

The assessment of cumulative effects on the aquatic environment considered releases from the Key Lake Operation and proposed Project during all phases of the Project. The primary Key Lake Operation component contributing to potential cumulative effects is the placement of tailings to a higher elevation in the Deilmann Tailings Management Facility (DTMF). The increased loadings from the DTMF are anticipated to result in an incremental (i.e., existing conditions plus the Project) increase of concentrations of COPCs in the aquatic environment (Cameco 2013). The spatial extent of any significant adverse effects on the aquatic environment from the Key Lake Operation were anticipated to be localized and not to extend to the Wheeler River and Russell Lake during any phase of the Project (Cameco 2013). The 2010 Status of the Environment report for the Key Lake Operation identified that no adverse effects to individual fish or fish populations are present in the Wheeler River (EcoMetrix 2010 as cited in Cameco 2020).

Potential Project residual effects on surface water quality relate to changes (increases) in constituent concentrations that are related to the controlled discharge of Project site waters into local receiving environments (Whitefish Lake). Such changes are predicted to be negligible to low in magnitude and limited to the LSA. For example, during Construction, no discharge from the Project site is planned. During Operation, treated effluent will be discharged to Whitefish Lake. The Whitefish Lake discharge will be the only routine discharge location during Operation. Water quality in Whitefish Lake and, by extension, downstream of Whitefish Lake will meet appropriate benchmarks for the protection of aquatic life in consideration of a small mixing zone in the lake. Following Decommissioning and the restoration of drainage patterns that are similar to pre-mining conditions, water quality is expected to meet appropriate benchmarks for the protection of aquatic life in Whitefish Lake and downstream. This includes Russell Lake of which the Icelander River system is associated.

In consideration of the above discussion, effects on the aquatic environment due to changes in surface water quality from the Key Lake Operation are not anticipated to spatially overlap with those from the Project and therefore a cumulative effect is not expected.

Future Centuries

The 2013 Key Lake ERA indicated that during the 10,000-year post-decommissioning period, predicted exposure levels may affect lower trophic level aquatic biota on a population or community level within some isolated lakes in the SSA, but adverse effects on the ecology of the Outlet Creek drainage, and therefore further downstream were not expected during the post-decommissioning phase (Cameco 2013). The results of the 2020 ERA for the Key Lake Operation were consistent with the findings from the 2013 ERA in that there were limited significant risks posed to aquatic receptors situated in the area surrounding the Operation, but not to areas farther downstream. The 2020 ERA concluded that environmental health in the vicinity of the Key Lake Operation will remain protected (Cameco 2020).

The results of the numerical modelling for the Project, as provided in Section 7 and Appendix 10-A in Section 10, support the conclusion that with the implementation of appropriate mitigation during the decommissioning and mining area remediation phase of the Project, the residual effects of the Project on the intermediate Groundwater VC will not result in an adverse effect to surface water. Dissolved constituent concentrations emanating over hundreds to thousands of years in the future ("Future Centuries") from the mining area to Whitefish Lake will be localized to that waterbody and remain below fresh water environmental quality criteria. As such, impacts to downstream portions of the drainage including Russell Lake are not expected.

In consideration of the above discussion, effects on the aquatic environment due to changes in surface water quality from the Key Lake Operation are not anticipated to spatially overlap with those from the Project and therefore a cumulative effect is not expected.

8.2.7.1 Additional Mitigation Measures

Additional mitigation measures not warranted as no potential cumulative effects were identified for this VC.

8.2.7.2 Cumulative Effects Characterization and Determination of Significance

A determination of significance is not warranted as no potential cumulative effects were identified for this VC.

8.2.7.3 Cumulative Effects Assessment Summary

Surface water impacts on the aquatic environment from the Key Lake Operation are expected to remain localized and not extend to the Wheeler River system or Russell Lake. Likewise, impacts on surface water quality from the Project are expected to remain localized (Whitefish Lake) and not extend to Russell Lake. Effects on the aquatic environment due to changes in surface water quality associated with the Key Lake Operation are not anticipated to spatially overlap with those from the Project during operation/decommissioning or during “future centuries” and therefore a cumulative effect is not expected.

8.2.7.4 Climate Change Considerations

As discussed in Section 8.1.7.5**,** the frequency and magnitude of extreme precipitation events has the potential to change water levels and flows in the RSA. Changes to the periodicity and frequency of flood and drought conditions has the potential to vary the interaction of the watersheds with their floodplains and subsequently the nutrient and mineral inputs and concentrations. Changes in water quality during storms, snowmelt, and periods of elevated air temperature or drought can cause conditions that exceed thresholds of ecosystem tolerance thereby leading to changes in water-quality. Surface water quantity changes are likely first to occur during episodes of climate-induced stress, and in ecosystems where the factors controlling water quality are sensitive to climate variability. Climate changes over the life of the project (i.e., 35 to 40 years) will be monitored by default as part of environmental monitoring programs and the influence of such on Surface Water Quality, Sediment Quality and Fish Health will require adaptive management to mitigate any potential effects of the mine that may be exacerbated by climate related changes in the aquatic environment.

8.2.8 Monitoring and Follow-up

For the purposes of this EIS, monitoring and follow-up are defined as follows:

- monitoring programs are designed to meet regulatory requirements (e.g., permit or license conditions) and/or to demonstrate compliance with environmental commitments made in the EIS; and
- follow-up programs are those that are proposed to address any uncertainties identified during the EA process (e.g., to verify predictions made during the EA; determine the effectiveness of proposed and implemented mitigation measures) and to determine if and when to implement adaptive management measures.

Monitoring and follow-up are proposed for the Surface Water Quality VC to verify the accuracy of the predicted effects and the effectiveness of the proposed mitigation measures. The surface water quality monitoring program should be considered in conjunction with the surface water quantity (hydrology) monitoring program.

The surface water quality monitoring and follow-up program will have the following objectives:

- collecting and recording surface water quality to confirm that source and receiving water quality predictions are consistent with those presented in the EIS; and
- monitoring to confirm the effluent and receiving water quality meet applicable regulation criteria.

The monitoring and follow-up program will include measurement of water quality parameters to meet regulatory criteria (i.e., provincial discharge permits, Metal and Diamond Mining Effluent Regulations [MDMER; Government of Canada 2022] and CSA N288.4-19 (CSA Group 2019). At a minimum, this will include collection of non-radiological parameters (e.g., metals, nutrients, hardness, temperature, pH, TDS, TSS, and sulphate) and radiological parameters.

Monitoring will occur within the collection ponds, specifically the Effluent Monitoring and Release Ponds and the receiving water (Whitefish Lake). Water quality monitoring in the natural environment will occur at the point of discharge (near-field) at LA-5 (Whitefish Lake South), at an upstream reference location (Whitefish Lake North [LA-6]) and at downstream locations (far-field locations). The far-field monitoring locations will be located in Whitefish Lake South (LA-5) prior to its discharge to McGowan Lake (LA-1).

Constituent concentrations will be compared to the values used in the EIS and to applicable regulatory criteria or objectives.

Specific monitoring and follow-up plans for the Surface Water Quality VC will be prepared to refine and finalize the approach and specific metrics following consultation with Indigenous groups, other stakeholders, and relevant federal and provincial agencies with interest in the development and implementation of this VC-specific program.

8.2.9 Surface Water Quality Summary

The Project Area is in primarily undisturbed area of the boreal forest and the existing water quality in the LSA lakes and rivers is indicative of a low level of disturbance. In general water quality parameters were below criteria for the protection of aquatic life, yet several constituents had concentrations higher than guidelines including aluminum, lead, iron, copper, and cadmium. Though in these cases, the maximum concentration was only marginally above the guideline value. The waters within the local and regional study areas sustains aquatic life and supports resource users and Indigenous peoples. Changes to surface water quality have the potential to influence biodiversity and biological function through direct exposure and indirect food chain influence (i.e., aquatic sediments, fish and fish habitat, and benthic invertebrates) and cultural values of Indigenous groups, the public and other stakeholders.

Project activities may interact with surface water quality in all Project phases. In general, the interactions can be characterized as being primarily associated with controlled, routine discharges from the site. During site preparation and construction, the primary effect pathway relates to the mobilization of suspended material into natural surface water features as the result of land disturbance and clearing. During operations and closure phases, excess water from the effluent monitoring ponds will be released to the environment. Routine discharge of this sort will be directed to Whitefish Lake only. Direct discharge of treated effluent to the natural environment has the potential to change surface water constituent concentrations and temperature. Potential effects to water quality as the result of project discharges to local receiving environments were assessed by way of conservative numerical modeling.

Modelling results support the conclusion that with the implementation of appropriate mitigation during the decommissioning and restoration phase of the Project, the residual effects of the Project on the intermediate Groundwater VC will not result in an adverse effect to surface water through construction, operation, decommissioning of the future centuries period. Dissolved constituent concentrations emanating over hundreds to thousands of years in the future from the deep Ore Zone to Whitefish Lake remain below fresh water environmental quality criteria in Whitefish Lake

To minimize residual effects of the Project on surface water quality, Denison will develop and implement a Surface Water Management Program that provides an integrated framework to manage water quality that includes provision for water management practices for each of the primary site aspects, as well as areas of the site where there is contact water. Water management will include maximizing the recycle and reuse of contact and process water to reduce freshwater intake and release to Whitefish Lake. They will also design discharge diffuser/outfall to provide effective mixing and dilution and to provide discharge flows that do not detrimentally impact water quality. Denison will develop site-specific effluent treatment to treat effluent to appropriate release limits in accordance with provincial standards and licence/permit conditions.

Residual adverse effects are expected to surface water quality due to the mobilization of solids and effluent discharge to Whitefish Lake. With the implementation of appropriate design criteria for site water management, design criteria for effluent discharge pipeline and diffuser, meeting provincial and federal criteria for discharge criteria, and as needed mine water treatment, the residual effects of the Project on surface water quality can be mitigated. Assessment of the significance of changes in water quality are assessed through the appropriate biological receptor VCs.

Monitoring programs are recommended for confirming the effectiveness of mitigation measures and predictions made in the assessment and will include measurement of radiological and non-radiological water quality parameters to meet regulatory criteria. Monitoring will occur within the collection ponds, and the receiving water (Whitefish Lake). Specific follow-up and monitoring plans will be prepared to refine and finalize approach in consultation with Indigenous groups, other stakeholders, and relevant federal and provincial agencies with interest in the development and implementation of this VC specific program.

8.2.10 References

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8.3 Fish and Fish Habitat

This section addresses the potential effects of the Project on the Fish and Fish Habitat VC. The following are discussed herein as part of the EA:

- scope of the assessment;
- summary of existing conditions relevant to the VCs;
- identification and description of potential interactions between the Project and the VCs;
- identification and description of mitigation measures applicable to the VCs to eliminate, reduce, or control the potential adverse Project-related effects;
- identification and characterization of predicted Project-related residual effects on the VCs after mitigation;
- characterization of significance and assignment of the level of confidence in the predictions; and
- identification and characterization of potential cumulative effects.

Figure 8.3-1 is a graphic representation of the assessment process used in this EIS.

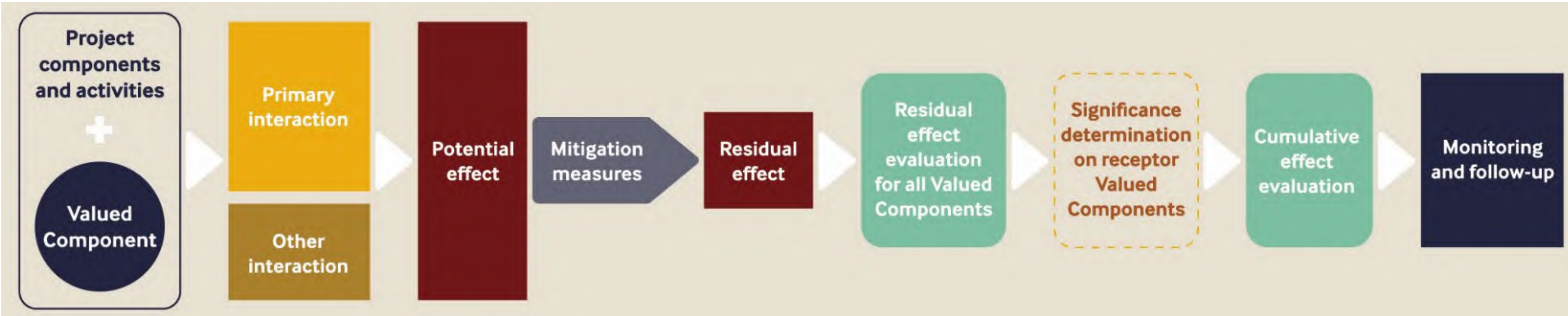

Figure 8.3-1: Environmental Assessment Process for the Wheeler River Project

8.3.1 Scope of the Assessment

The purpose of this assessment is to assess potential changes to fish and fish habitat (as represented by the Fish and Fish Habitat VC) in consideration of all phases of the Project at the Project Area, local, and regional study area scales. Pathways affecting Fish and Fish Habitat are directly associated with potential changes to the Surface Water Quantity (hydrology), Surface Water Quality, Sediment Quality, and Benthic Invertebrates VCs. Changes to hydrology, water quality, sediment quality, and benthic invertebrate communities may directly affect fish habitat and fish food resources. Fish and Fish Habitat is inclusive of wetland features within the LSA and for the purposes of this assessment the Fish and Fish Habitat VC should be considered in tandem with the Wetlands VC which is further discussed in Section 9. The Wetlands VC is further assessed as part of Appendix 8-F and the results of that assessment are incorporated in this section. Wetland habitats are variable with respect to their ability to hold water and the duration which a wetland holds a specific depth of water provides some level of classification (along with soils, sediment and vegetative communities). For the purposes of this assessment, wetlands which are inundated throughout the majority of the year have been considered as "waterbodies". Those that are variable in their period of inundation or are complex with respect to their groundwater/surface water interface (fens, bogs, etc.) are considered as wetland features herein.

The assessment approach reflects these connections within the aquatic environment, as the significance determination for the Surface Water Quantity and Surface Water Quality VCs was conducted at the receptor VC level (i.e., Fish and Fish Habitat Fish Health, Sediment Quality and Benthic Invertebrate VCs). Pathways that are of interest include those associated with site clearing and the potential for erosion-driven mobilization of suspended sediment into local surface waters (including surrounding wetlands); groundwater interactions with surface water features; the establishment of new subwatershed boundaries and the resulting effects on effluent discharge to the receiving environment; and the potential overprinting of fish habitat and wetlands by Project infrastructure. Secondary effects on fish communities within the vicinity of the Project resulting from an increase in access to fish-bearing waters are also considered as part of this assessment.

8.3.1.1 Valued Component Selection

The protection and management of fish and fish habitats are of high importance and regulated via federal and provincial legislation. An assessment of the pathways of effects and potential residual effects on Fish and Fish Habitat is a requirement of federal agency guidelines for completion of the EIS (see the concordance table in Section 1 Project Introduction and Overview). The regulatory framework associated with the Fish and Fish Habitat VC is described in Section 1. *The Fisheries (Saskatchewan) Act, 2020* (Government of Saskatchewan 2020) and the modernized federal *Fisheries Act* (Government of Canada 2019), and by extension the MDMER (Government of Canada 2022), provide regulation of development activities within and adjacent to waters frequented by fish.

The modernized federal *Fisheries Act* provides two core prohibitions related to fish and fish habitat protection: a prohibition against persons carrying out works, undertakings, or activities that result in the death of fish by means other than fishing (subsection 34.4(1)), and a prohibition against persons carrying out works, undertakings, or activities that result in the harmful alteration, disruption, or destruction (HADD) of fish habitat (subsection 35(1)) (Government of Canada 2019). The modernized federal *Fisheries Act* includes a more comprehensive definition of fish habitat under subsection 2(1): "water frequented by fish and any other areas on which fish depend directly or indirectly to carry out their life processes" (Government of Canada 2019). The types of areas that can directly or indirectly support life processes include, but are not limited to, spawning grounds and nursery, rearing, food supply, and migration areas.

The modernized federal *Fisheries Act* also includes a prohibition against the deposit of deleterious substances of any type in water frequented by fish (subsection 36(3)) (Government of Canada 2019), which is administered by Environment and Climate Change Canada. When death of fish or a HADD of fish habitat cannot be avoided or mitigated, an authorization under subsections 34.4(2) and 35(2), respectively, may be provided by the Minister of Fisheries and Oceans with the provision of appropriate offsetting of residual adverse effects. Factors that may be taken into account by the Minister when considering approval of an authorization include, but are not limited to, the following:

- contribution to the productivity of relevant fisheries by the fish or fish habitat that is likely to be affected;
- fisheries management objectives;
- whether there are measures and standards to avoid the death of fish or mitigate the extent of death or offset death, or to avoid, mitigate, or offset the HADD of fish habitat;
- whether any measures and standards to offset the HADD of fish habitat give priority to the restoration of degraded fish habitat;
- Traditional Knowledge of Indigenous peoples that has been provided to the Minister; and
- any other factor that the Minister considers relevant.

In support of the modernized federal *Fisheries Act*, the Department of Fisheries and Oceans (DFO) has published updated policy statement and guidance documents and interim standards and codes of practice. These include, but are not limited to, the following:

- *Fish and Fish Habitat Protection Policy Statement* (DFO 2019a);
- *Policy for Applying Measures to Offset Adverse Effects on Fish and Fish Habitat Under the Fisheries Act* (DFO 2019b); and
- *Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada* (DFO 2013).

The first two documents replace the previous policy with regards to fish and fish habitat protection and offsetting measures associated with the former version of the *Fisheries Act*.

Under a memorandum of understanding, DFO relies on the Canadian Nuclear Safety Commission to take on responsibilities for the assessment and monitoring of project-related effects on fish for Class I nuclear facilities and uranium mines and mills, including species listed under the *Species at Risk Act*, and to make recommendations to DFO related to authorizations under the *Fisheries Act*. As such, the Canadian Nuclear Safety Commission will be responsible for review of the potential effects of the Project on Fish and Fish Habitat.

The Metal Mining Effluent Regulations included under Section 36 of the *Fisheries Act* were amended in 2018 and are now known as the MDMER. The MDMER are administered by Environment and Climate Change Canada. The MDMER authorize the deposit of effluent in waters frequented by fish. The regulations form the basis of the federal mine effluent standards (among other requirements) by defining authorized limits for releasing selected deleterious substances outlined in the regulation (Schedule 4), including pH, arsenic, copper, cyanide, lead, nickel, zinc, suspended solids, and radium 226. The MDMER specify requirements for carrying out effluent sampling, reporting, and environmental effects monitoring. The MDMER also provide for authorization of mine waste disposal to waters frequented by fish (under Schedule 2) when certain conditions are met, including compensation (MDMER term similar to offsetting). The requirements of a compensation plan are provided under subsection 27.1 of the MDMER.

The process and rationale for the selection of VCs and the establishment of KIs and associated MPs are described in Section 5. Potential changes to water quantity and quality are key considerations within the EA process, as demonstrated by previous uranium mining development proposals in the Athabasca Basin, that draw a high level of concern from Interested Parties (see Sections 8.1.2 and 8.2.2). Changes to surface water quality have the potential to influence sediment particle size, chemistry, and distribution within the aquatic environment, which in turn may influence biodiversity and biological function of fish habitat and fish food resources. Such effects are of interest with respect to the cultural values of Indigenous groups, the public, and other stakeholders. In this context, the Fish and Fish Habitat VC is interrelated or linked, to varying extents, to other VCs that are considered in this EIS, including:

Intermediate Valued Components

Surface Water Quantity: Surface water flow volumes and periodicity directly influence the availability of the medium on which fish depend to sustain life. Changes in flow volumes can affect multiple life stages of fish species and influence fish movement. Changes in Surface Water Quantity can also affect drainage system water quality, bedload movement, and sediment deposition. Natural and seasonal changes in precipitation, and therefore Surface Water Quantity, are directly related to Surface Water Quality, Sediment Quality characteristics, and Benthic Invertebrate distribution, and, therefore, Fish and Fish Habitat.

Surface Water Quality: Changes in Surface Water Quality, and by extension Sediment Quality, constitute a direct change in Fish Habitat, which may affect fish and their forage base.

Groundwater Quantity and Quality: The quantity and quality of groundwater reporting to surface water through hydrologic connections can influence the water quality of surface waterbodies. Partitioning of chemicals from surface waters to sediments may further affect fish habitat and fish communities.

Receptor Valued Components

Terrestrial Environment: Fish and their habitat as a food resource and habitat medium, respectively, for terrestrial fauna are linked to the function and biodiversity of the terrestrial environment.

Sediment Quality: The sediment that fish and their food resources inhabit to carry out their life processes is a component of fish habitat. Aquatic sediments are inferred as part of the definition of fish habitat under subsection 2(1) of the *Fisheries Act* (Government of Canada 2019). Alterations to Sediment Quality or Benthic Invertebrate communities in an aquatic environment can directly affect Fish and Fish Habitat.

Benthic Invertebrates: Fish rely directly on Benthic Invertebrates during part or all of their life cycle (depending on species). Changes to benthic invertebrate communities affect the ecological integrity of the aquatic environment, including fish communities.

Fish Health: Health of fish within the aquatic environment is directly linked to the viability of fish populations. Changes to fish habitat via intermediate VCs can affect the ability for such habitat to support Fish Health and, ultimately, fish communities and populations.

Land and Resource Use: Indigenous and Other Land and Resource Use are influenced by Sediment Quality and Benthic Invertebrates as they contribute to the function and biodiversity of terrestrial and aquatic flora and fauna and, subsequently, their use as natural resources by communities.

Figure 8.3-2 is a graphic representation of the main linkages among the Fish and Fish Habitat VC and other VCs, illustrating the flow of assessment information into and from the Fish and Fish Habitat VC.

Figure 8.3-2: Integrated Assessment Approach - Key Connections between Fish and Fish Habitat and Other Valued Components

8.3.1.2 Key Indicators and Measurable Parameters

The KIs for the Fish and Fish Habitat VC include potential changes in surface water quantity, surface water quality, and available fish habitat from baseline conditions. The rationale for each KI and associated MPs is summarized in Table 8.3-1. Key indicators and measurable parameters associated with wetlands as fish habitat are further detailed in Appendix 8-F and Section 9.

Table 8.3-1: Key Indicators and Measurable Parameters for Fish and Fish Habitat

Valued Component	Key Indicator	Rationale for Key Indicator	Measurable Parameters
Fish and Fish Habitat	Change to water levels or flows from baseline conditions	Project activities are expected to result in changes to local hydrology. A reduction or increase in flows may result due to the elimination or redirection of subwatershed area and through Project water management (i.e., water taking, storage, and effluent discharge). These changes in flow to the aquatic environment may alter stream flows or lake levels required for fish mobility and productivity during all life stages.	Changes in water levels (m) or percent changes to flow conditions (%).
	Change in available fish habitat from baseline conditions	Overprinting of fish habitat by Project infrastructure may affect fish and fish habitat by: • fish mortality/death of fish by means other than fishing (subsection 34.4 of the *Fisheries Act*); and • direct physical HADD of fish habitat (subsection 35(1) of the *Fisheries Act*). Work in or around water may cause direct mortality of fish, which are protected under subsection 34.4(1) of the *Fisheries Act.* A HADD of fish habitat may occur as a result of physical alteration or loss of in-water and/or riparian habitat through the development of the Project	Aerial extent (m^2 or ha) of overprinted aquatic habitat.

Valued Component	Key Indicator	Rationale for Key Indicator	Measurable Parameters
		site, including the potential creation of barriers to fish passage.	
	Change in surface water quality from baseline conditions	Changes in water quality are regulated (subsection 36(1) of the *Fisheries Act* and the MDMER). Changes that may occur as a result of the Project include: • mobilization of solids into local watersheds; and • deposition of deleterious substances into the receiving environment as a result of mine effluent and/or surface runoff.	Change in the concentration of constituents that are directly related to Project activities, measured as a mass of a chemical per unit volume in water (e.g., mg/L).

8.3.1.3 Spatial and Temporal Boundaries

Generic considerations associated with the establishment of the spatial boundaries of the assessment are described in Section 5.3.3 in Section 5. As it pertains to the Fish and Fish Habitat VC, the following is noted:

- The **Project Area** is the direct footprint of the Project. The Project Area represents the area within which Project activities and components may occur and, as such, represents the area within which direct physical disturbance may occur as a result of the Project, either temporary or permanent. (i.e., the area of maximum physical disturbance). This area is not VC-specific, but consistent throughout the EIS for all VCs.
- The **LSA** is the area that surrounds the Project Area where both direct and indirect effects resulting from Project activities can be reasonably measured. The LSA was established to assess the potential, largely direct effects of the Project, and represents the extent to which there is a reasonable potential for the Project or Project-related activities to interact with and potentially adversely affect the VC. For the Fish and Fish Habitat VC, the LSA was derived from watershed boundaries within proximity of the Project Area, including portions of watersheds that overlap the Project site, as well as areas directly downstream that may be influenced by the Project site or effluent discharge. The subwatersheds within the LSA are presented in Figure 8.3-3. This area was selected based on important waterbodies (notably Whitefish and McGowan lakes) downstream of the Project where effects may occur through all Project phases. The LSA extends from those waterbodies down to their inflows to Russell Lake.
- The **RSA** is the area that surrounds and includes the LSA, and was established to assess the potential, largely indirect effects of the Project, as well as other activities, in a regional context. The RSA is large enough to capture the extent of potential effects (i.e., zone of influence) on a VC and defines the area within which cumulative effects may occur (i.e., cumulative effects assessment boundary). The RSA for the Fish and Fish Habitat VC is bounded by the regional watershed area within which the Project Area is located and extends downstream to include Russell Lake (Figure 8.3-3).

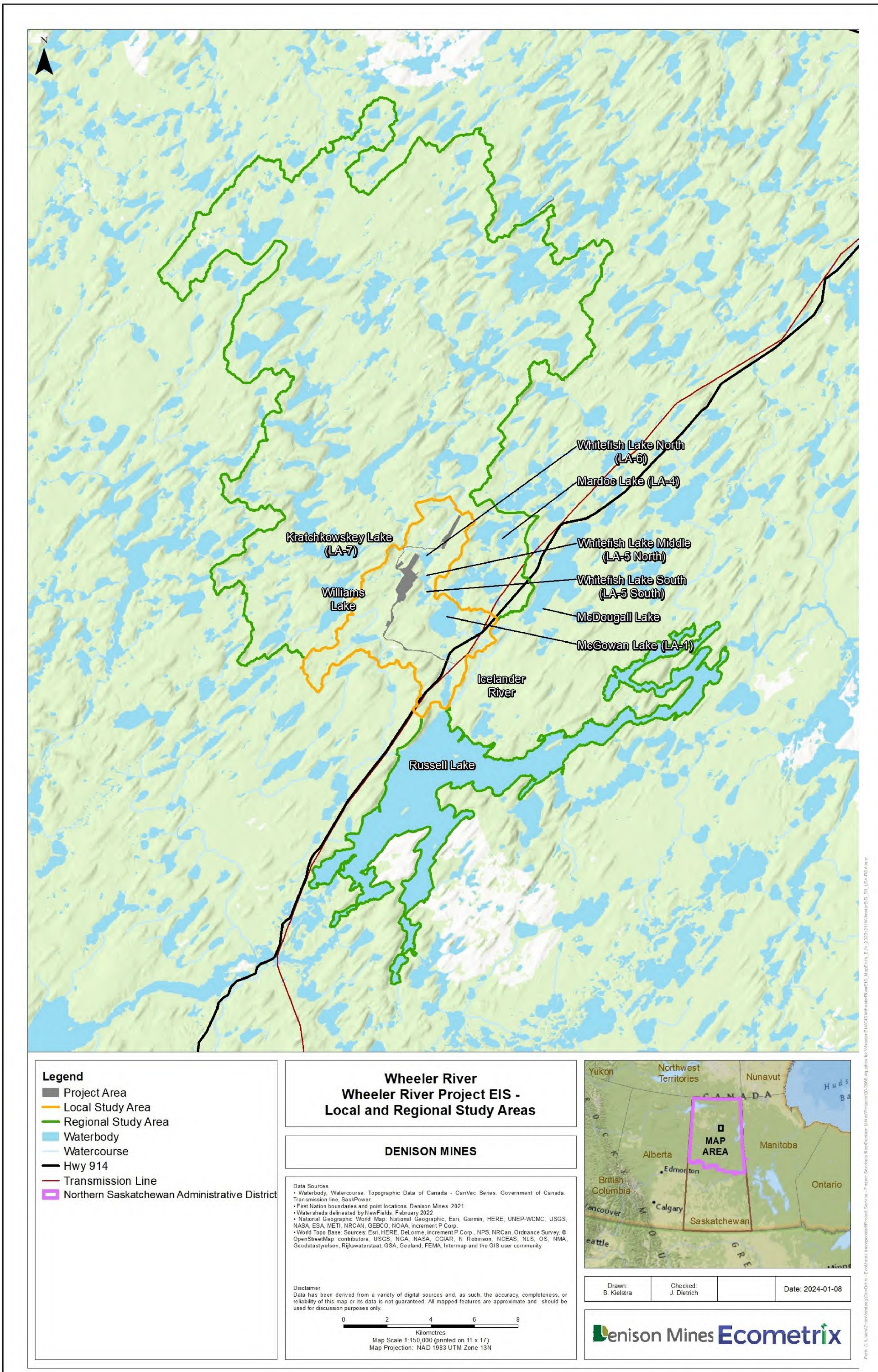

Figure 8.3-3: Spatial Boundaries for the Fish and Fish Habitat Valued Component

Temporal boundaries for the EIS are defined in Table 5.3.3 in Section 5. The temporal boundaries applicable to and considered in the EIS include the following Project phases:

- Construction (Year 1 to 3);
- Operation (Year 3 to 18);
- Decommissioning (Year 18 to 23); and
- Post-Decommissioning (Year 23 to 38).

Additionally, a 'future centuries' scenario is considered to assess the potential effects post-restoration (i.e., beyond the Project timeline of 0 to 38 years) and to reflect the time period over which the highest constituent concentrations in groundwater are predicted to migrate towards and interact with surface water (based on groundwater modeling). In this context, the future centuries scenario is considered with respect to the interaction of groundwater migration from the Project site and its potential influence on surface water in local waterbodies. The future centuries scenario prediction encompasses the long-term period during which slow migration of groundwater from the Phoenix Ore Zone area to the surface water environment is anticipated, and constitutes a bounding scenario of maximum concentrations of COPC.

8.3.2 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

At its broadest level, IK can be understood as the unique and collective knowledge of Indigenous peoples that may include, but is not limited to, the environmental, cultural, economic, political, and spiritual conditions of a community or region. In this section, IK and LK are viewed as complementary and influential alongside western science to produce a full understanding of the potential effects of the Project, whether measurable or perceived. Both forms of information have been given full and fair consideration.

Denison has recorded and stored information regarding IK, LK, and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 18-EN-ERFN-5.68). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment. Appendix 8-A provides a summary of unique identification numbers referenced within Section 8.3.

Indigenous Knowledge and LK quotes and citations were included in this section to provide readers with the information considered as the Project advanced throughout the EA process. Since 2016, Denison has engaged with Interested Parties (i.e., local and Indigenous communities, residents, businesses, organizations, land users, and various regulatory authorities) to support the development of positive relationships and a mutual commitment to collaboration.

The history of resource sharing between Indigenous peoples and Europeans in the Project RSA indicates the importance of natural resources to all peoples. Such partnerships were described during engagement with English River First Nation:

> "*The biggest body of water to be impacted is Russell Lake – "Big Poor Fish Lake" in Dené. A lot of Scandinavians and Norwegians went up there in the 1930s and partnered with First Nations in that territory*" (18-EN-ERFN-5.68).

The influence of IK, LK, and engagement on the assessment of the Fish and Fish Habitat VC has first and foremost shaped the shared value of water and its life-sustaining properties.

> "*The lands and waters, we are definitely connected as peoples of English River. If we don't have the lands, we are not connected. If we don't have the water... Water is life to us*" (ERFN and SVS 2022).

Comments associated with water management and discharge to the environment were significant in the engagement record[4], and these were considered within the context of community interest regarding surface waters remaining supportive of natural function for biota. To this end, Project-related water management and treatment are important to maintaining surface water quality and sediment quality within the LSA and RSA.

Indigenous peoples and LK holders were clear in their interest regarding current levels of constituents in the aquatic ecosystem and the potential for adverse changes resulting from the Project. For example:

> *"What is the plan for storing and cleaning the water and where does it flow? What is the impact of ISR mining on water quality?"* (21-EN-VILX-443.25).

This affirms the necessity to assess water quality and sediment quality as they inform assessments for benthic invertebrates, fish and fish habitat, human health, and Indigenous land and resource use components.

Indigenous peoples and LK holders were also interested in the potential for overfishing [from the mine and people accessing the area] (20-LK-LEASESUR-267.66).

Consultations with a local harvester provided confirmation and additional information in identifying fish presence/absence, and critical life history use habitats, within the LSA (Local Harvester Knowledge GIS Shapefiles). Information was reviewed by the local harvester to ensure accuracy, for example:

> *"Northern pike spawning area in creek south of Williams Lake (Figure 4) and in areas identified in Figure 5. Lake whitefish spawn in creeks/rivers. Trout spawning areas in*

[4] 19-EN-MN-SR3-1.2, 19-EN-ML82-1.3, 19-EN-MOE-1.4, 18-EN-VILX-3.33, 18-EN-VILX-3.35, 18-EN-VILX-3.39, and 18-EN-VILX-3.84.

> *Russell Lake: one south of LAB area (Figure 5); around island and rocky shoals to both north and south of island (Figure 4)*" (19-LK-ERFNTrap-134.72).

This quote speaks to figures previously used for engagement purposes and since represented in Figure 8.3-4.

Furthermore, mapping that was provided by Indigenous groups with respect to land and resource use were consulted when assessing potential impacts (i.e., KML and NVP 2022; ERFN and SVS 2022; YNLR 2022).

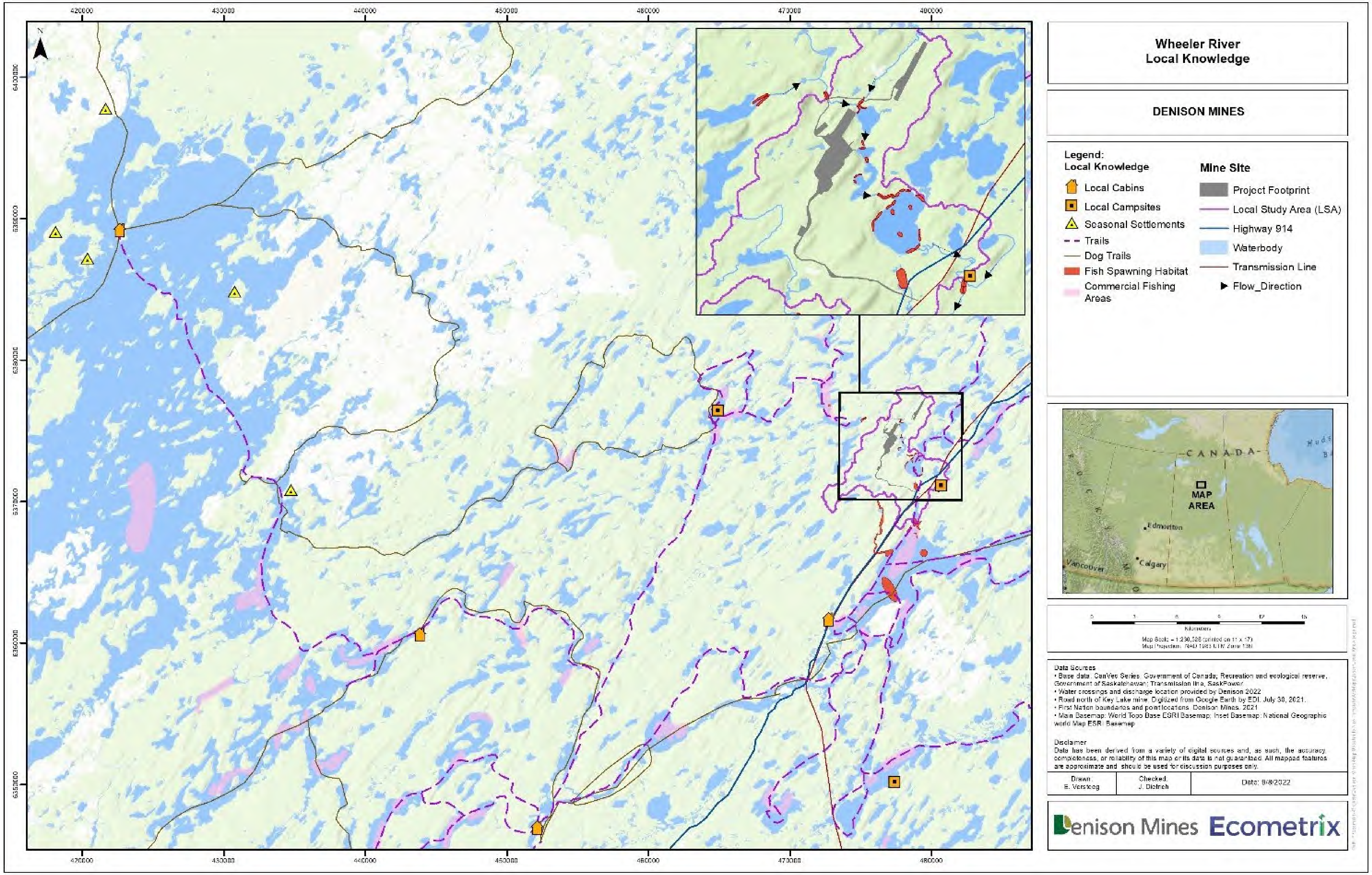

Figure 8.3-4: Local Harvester Knowledge in the Regional Study Area

8.3.3 Existing Environment

Details pertaining to existing conditions related to Surface Water Quantity (Section 8.1), Surface Water Quality, (Section 8.2), Sediment Quality and Benthic Invertebrates (Section 8.4), Fish Health (Section 8.5), Groundwater (Section 7) and Wetlands (Section 9) that are relevant to the Fish and Fish Habitat VC, as together they describe aquatic environment conditions, are presented elsewhere in the EIS. In this subsection, fish community and fish habitat data collected as part of the baseline aquatic environment program are summarized. These data have not been presented previously in this EIS but are relevant to the consideration of the Fish and Fish Habitat VC. Detailed information regarding fish and fish habitat baseline data collection and analyses are provided in Appendix 8-D. Additional baseline information pertaining to wetlands is provided in Appendix 8-F.

Baseline fish and fish habitat surveys for the Project were performed in a combination of lentic (lakes and ponds) and lotic (streams and rivers) environments. Aquatic habitat surveys were undertaken in September 2016, coincident with biological sampling (fish and benthos) that was conducted at that time, and included the collection of bathymetric and water quality data, as well as observations of physical shoreline and lake/pond/stream substrate features, and aquatic vegetation, fish, and benthic communities.

Critical locations of interest for this assessment include the following nodes, which are coincident with baseline monitoring stations and/or watersheds of interest for the assessment (Figure 8.3-5):

- SA-1 – Fish community and habitat survey location on the stream colloquially known as the Icelander River, which is located downstream of LA-1 (McGowan Lake);
- SA-2 – Fish community and habitat survey location situated downstream of the outflow from LA-5 (Whitefish Lake South) and upstream of the inflow to LA-1 (McGowan Lake);
- SA-4 – Fish community and habitat survey location situated upstream of the inflow to LA-6 (Whitefish Lake North), colloquially known as Kratchkowsky Creek;
- SA-5 – Fish community and habitat survey location situated upstream of the inflow to LA-6 (Whitefish Lake North), colloquially known as Hart Creek;
- SA-6 – Fish community and habitat survey location situated downstream of the outflow from LA-6 (Whitefish Lake North) and upstream of the inflow to LA-5 (Whitefish Lake South);
- LA-1 – McGowan Lake;
- LA-5 – Whitefish Lake South; and
- LA-6 – Whitefish Lake North.

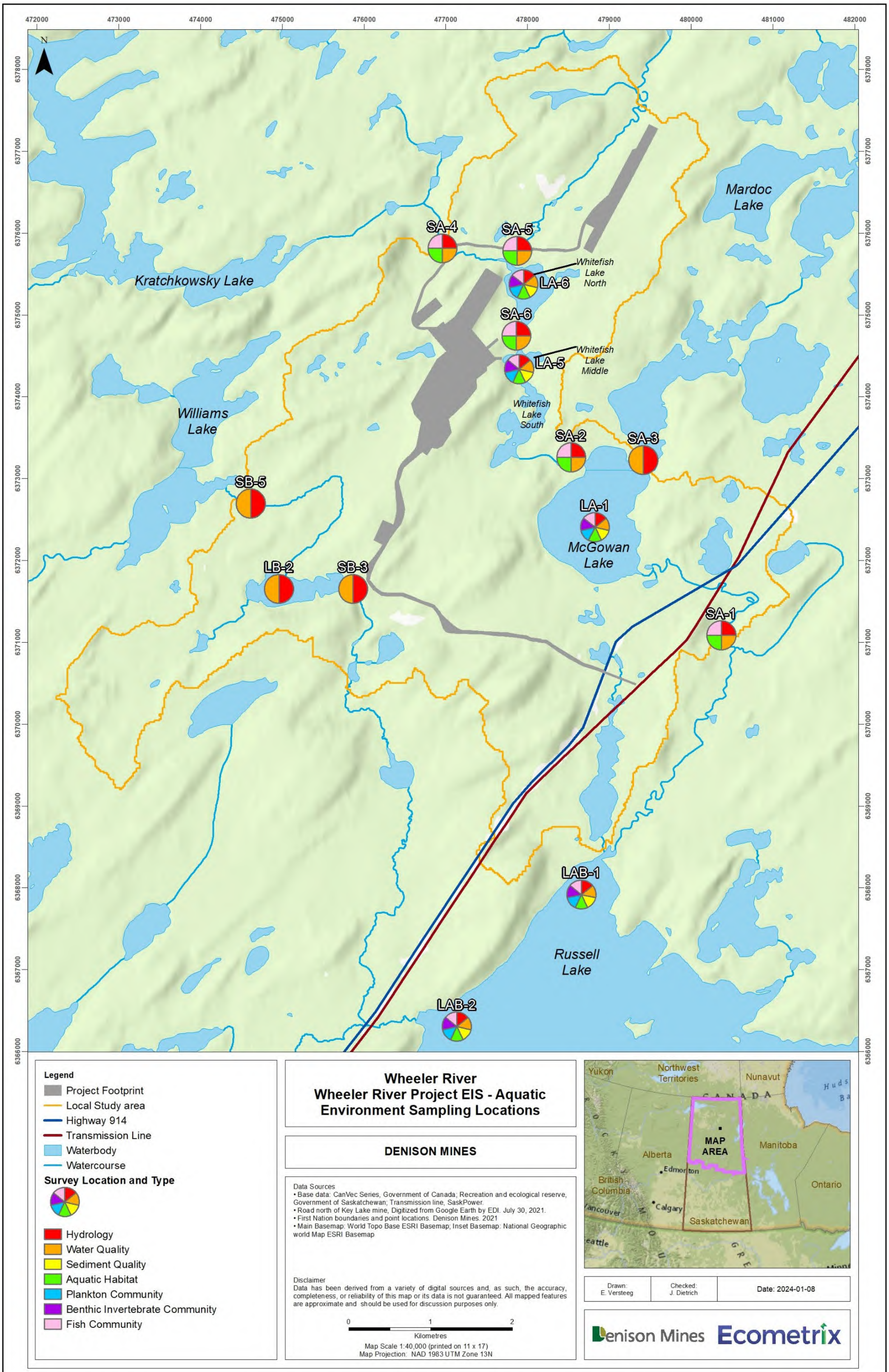

Figure 8.3-5: Water Quality, Biota, and Sediment Sampling Locations (2016 to 2018)

8.3.3.1 Methodology and Metrics

Fish Habitat

At lake and pond locations, aquatic habitat data collected included bathymetry, adjacent land uses and terrain, aquatic, riparian, and adjacent vegetation, and shoreline features, including locations and descriptions of inlets and outlets and substrate characterization. The distribution of aquatic macrophyte species in lake locations was documented, with distinction being made between emergent, floating, and submergent communities. Photographic documentation demonstrating the nature of the aquatic habitats present within the subject waterbodies was obtained and is provided in Appendix 8-C.

At stream locations, aquatic habitat characterization involved the assessment of physical, biological, and chemical characteristics. Recorded data included mean channel width, depth, and flow velocity, bank stability, stream morphology (i.e., pool, riffle, run, and flat), stream gradient, channel type, canopy cover, instream cover, and substrate type. Additional notes were collected on the surrounding terrain characteristics, dominant terrestrial vegetation, dominant aquatic vegetation, adjacent land use, amount of sediment overlaying substrates, and the amount of algae overlaying substrates. Weather conditions, including recent and current precipitation, air temperature, and cloud cover, were recorded. Finally, water colour and clarity were noted, as well as qualitative observations of benthic invertebrates encountered during fish surveys (Appendix 8-C).

Fish Communities

In the lakes and ponds, deeper areas offshore were fished with short duration (i.e., 4 to 8 hour) gill net sets. Where a distinct thermocline was evident (e.g., Kratchkowsky Lake), gill nets were set above and below the thermocline. Gill nets comprised varying mesh sizes such that all types of fish and age classes present could be collected. Nearshore fish collections were conducted by beach seines and/or minnow traps. Gear location coordinates were obtained with a GPS, and coordinates were recorded at each sampling station and expressed as degrees, minutes, and seconds (i.e., dd mm ss; WGS84 datum). Fish were identified to species and assigned an age class (i.e., young-of-year, juvenile, or adult). Length (to nearest mm) and weight (to nearest 0.01 kg) were measured for all fish at each location. All fish, live or dead, were returned to the same waterbody in which they were captured, with the exception of specimens retained for fish tissue chemical analysis (see Section 8.5).

In streams, the fish community was surveyed using a backpack electrofisher (Smith-Root Model LR-24) and dip net. Up to 300 m of stream were fished at the selected locations and captured fish were retained in a 25 L pail until the completion of electrofishing within the reach. With the exception of voucher specimens retained as a condition of the scientific collection permit, all fish were released to the same waterbody in which they were captured. Additional data were recorded, including date, time, location (i.e., coordinates, map datum), electrofisher settings (i.e., frequency and volts), fishing effort (seconds), reach length, mean width, and water temperature. Data were recorded on Fish Collection Forms (Appendix 8-C).

Large-bodied fish spawning surveys were undertaken during the fall of 2016 and spring of 2017 at selected lake and stream locations to determine the utilization of these areas for spawning. The fall survey was conducted during a period in which it was expected that fall spawners would be sexually mature and active. The spring survey was timed to take place shortly after ice-out, a period when spring spawning was expected to be underway. Fishing activities were conducted in a manner to maximize data collection and minimize incidental fish mortalities (i.e., visual when possible). If spawning activity was not directly observed, attempts to capture fish were undertaken to assess sexual condition (degree of ripeness) using the most effective method(s) for the habitat present (e.g., electrofishing, angling, gill netting, or seining). Gill nets were employed as seine nets to capture large-bodied fish observed at stream stations during the spring spawning survey. Captured fish were identified to species, sexed (if possible for live fish), assigned to an age class (i.e., juvenile, adult), assessed for spawning condition (i.e., immature, green [early or late development], ripe, partially spent, spent), measured (length to nearest mm, weight to nearest g), and released. Aging structures were collected, and sex was determined and sexual condition was verified from incidental mortalities. All live fish were returned to the same waterbody they were captured in.

A summary of fishing techniques employed by waterbody is provided in Table 8.3-2.

Table 8.3-2: Summary of Fish Survey Methods within the Local Study Area

Capture Methods	Lake and Pond Sample Stations			Stream Sample Stations				
	McGowan Lake (LA-1)	Whitefish Lake South (LA-5)	Whitefish Lake North (LA-6)	SA-1	SA-2	SA-4	SA-5	SA-6
Angling	X	X	X	X	-	-	-	-
Electrofishing	-	-	-	X	X	X	X	X
Gill Net	X	X	X	X	X	-	X	X
Minnow Trap	X	X	X	-	-	-	-	-
Seine Net	X	X	-	-	-	-	-	-
Visual	X	X	X	-	-	X	X	X

X Indicates that the species was either captured or observed.

\- Indicates that the species was neither captured nor observed.

8.3.3.2 Key Baseline Results and Existing Conditions

Existing fish habitat for each waterbody and watercourse within the LSA is summarized in Table 8.3-3. Results from habitat surveys completed for the aquatic environment baseline study, detailed descriptions of the areas surveyed, including representative photographs and tables summarizing habitat conditions within each waterbody and watercourse, are provided in Appendix 8-C.

Shoreline vegetation at most lakes primarily consisted of shrubs and black spruce with upland jack pine forests. The shoreline generally consisted of rocks with overhanging shrubs, transitioning from small boulders and cobbles to a sand or silty bottom, with patches of sandy beach and sparse emergent or submergent aquatic vegetation. The shoreline near the LA-9 lake inlet and outlet consisted of bog habitat. At some lakes submerged tree trunks were found in localized areas near shore. Typical nearshore substrates included boulders, cobbles, sand, and organic matter. Shoreline slopes ranged from shallow to steep with the presence of old and active erosional areas. Cover types for aquatic biota included emergent and submergent vegetation, interstitial spaces in coarse substrate, overhanging vegetation, and woody debris. Ponds supported emergent, submergent, and floating aquatic macrophyte beds along much of the nearshore area.

Stream habitats surveyed as part of the baseline study included 2nd and 3rd order streams in the Icelander River basin and the Williams Lake drainage. Stream channels were generally stable and portions of the channels within the reaches surveyed were braided, meandering, straight, or ponded.

Stream gradients within the reaches surveyed were high to low and characterized by riffles, runs, or pools, with some flats. No barriers to fish migration were observed.

A summary of fish habitat within lakes and rivers within the LSA is provided in Table 8.3-3 and Table 8.3-4.

Presence or absence of fish in the subwatersheds of the LSA is summarized in Table 8.3-5 and Figure 8.3-6 and Figure 8.3-7. These include a number of large-bodied species (i.e., Northern Pike [*Esox lucius*], White Sucker [*Catostomus commersonii*], Longnose Sucker [*Catostomus catostomus*], Artic Graying [*Thymallus arcticus*], Walleye [*Sander vitreus*], Lake Trout [*Salvelinus namaycush*], Lake Whitefish [*Coregonus clupeaformis*], and Burbot [*Lota lota*]), as well as small-bodied forage fish species (i.e., Ninespine Stickleback [*Pungitius pungitius*], Slimy Sculpin [*Cottus cognatus*], Spottail Shiner [*Notropis hudsonius*], and Yellow Perch [*Perca flavescens*]). Fish captured during baseline field studies showed no gross abnormalities.

As barriers to fish movement were not identified, the absence of a species in lake or river habitats does not necessarily confirm that the species does not inhabit that area; rather, that the species was not actively captured, or the area is not characteristic of preferred habitat for the species.

Fish spawning habitat for several species was confirmed in the LSA, both through LK and confirmatory field reconnaissance. This habitat is summarized in Table 8.3-3 and Table 8.3-4 and Figure 8.3-8**,** Figure 8.3-9**,** and Figure 8.3-10. Known spawning habitat occurs for Northern Pike, White Sucker, Longnose Sucker, Artic Graying, Walleye, Lake Trout, and Lake Whitefish in the LSA and Russell Lake, as well as upstream of the Project in the Icelander River system.

No species at risk were identified as part of baseline assessments or through engagement with LK or IK holders.

Table 8.3-3: Fish Habitat Associated with Rivers and Streams in the Local Study Area

Stream Reach	Length (m)	Flow Velocity (m/s)	Mean Wetted Width (m)	Mean Depth (m)	Fish Species	Fish Spawning Habitat Observed	In Water Cover	Riparian Cover	Substrate	Stream Morphology (%)	Riparian Habitat (%)
Icelander River (SA-1)	195	1.25	10	0.35	Lake Chub Longnose Sucker White Sucker Arctic Grayling Northern Pike Burbot Slimy Sculpin	Northern Pike Suckers Walleye	Pools Boulders Cobble Undercut banks Aquatic vegetation	Partial canopy cover Sedges	Gravel Sand	Pools – 15 Riffles – 65 Cascades – 0 Runs – 20 Flats – 5	Forested Upland – 75 Forested Lowland – 25
SA-2	285	1	9	0.35	Lake Chub White Sucker Arctic Grayling Northern Pike Burbot Slimy Sculpin Walleye	White Sucker Walleye Northern Pike	Pools Boulders Cobble Undercut banks Aquatic vegetation Large woody debris	Dense canopy cover Sedges	Gravel Some Sand Some Silt	Pools – 5 Riffles – 90 Cascades – 0 Runs – 5 Flats – 0	Forested Upland – 90 Forested Lowland – 10
SA-4	200	0.5	7	0.25	Lake Chub Spottail Shiner Longnose Sucker White Sucker Arctic Grayling Northern Pike Burbot Ninespine Stickleback Slimy Sculpin	White Sucker Lake Chub	Pools Boulders Cobble Undercut banks Aquatic vegetation Large woody debris	Dense canopy cover Sedges and emergent vegetation	Gravel Sand	Pools – 20 Riffles – 60 Cascades – 0 Runs – 20 Flats – 0	Forested Upland – 70 Forested Lowland – 30

Stream Reach	Length (m)	Flow Velocity (m/s)	Mean Wetted Width (m)	Mean Depth (m)	Fish Species	Fish Spawning Habitat Observed	In Water Cover	Riparian Cover	Substrate	Stream Morphology (%)	Riparian Habitat (%)
SA-5	300	0.4	15	0.4	Lake Chub Longnose Sucker White Sucker Burbot Ninespine Stickleback Slimy Sculpin Walleye	Suckers Lake Chub Walleye Northern Pike	Pools Boulders Cobble Undercut banks Aquatic vegetation	Dense canopy cover Sedges and emergent vegetation	Sand	Pools – 25 Riffles – 30 Cascades – 0 Runs – 40 Flats – 5	Forested Upland – 70 Forested Lowland – 30
SA-6	390	0.2	14	0.7	Spottail Shiner Longnose Sucker White Sucker Burbot Ninespine Stickleback Slimy Sculpin Walleye	Northern Pike	Pools Boulders Undercut banks Aquatic vegetation	Partial canopy cover	Silt	Pools – 20 Riffles – 0 Cascades – 0 Runs – 75 Flats – 5	Forested Upland – 50 Forested Lowland – 50

Table 8.3-4: Fish Habitat Associated with Lakes in the Local Study Area

Lake	Area (ha)	Volume (m^3)	Maximum Depth (m)	Mean Depth (m)	Secchi Depth (m)	Fish Species	Fish Spawning Habitat Observed	In Water Cover	Above Water Cover	Substrate
McGowan Lake (LA-1)	148.55	8,189,320	9.7	5.5	2.5	Spottail Shiner Longnose Sucker White Sucker Lake Whitefish Lake Trout Northern Pike Yellow Perch Walleye	Northern Pike Walleye Lake Whitefish Lake Trout White Sucker	Emergent vegetation Submergent vegetation Boulder Cobble	Emergent vegetation Riparian vegetation	Gravel Sand Mud
Whitefish Lake South (LA-5)	32.4	332,502	4.1	1.1	2.1	Spottail Shiner White Sucker Lake Whitefish Northern Pike Ninespine Stickleback Walleye	Northern Pike	Emergent vegetation Submergent vegetation Woody debris	Emergent vegetation Riparian vegetation	Sand Mud
Whitefish Lake North (LA-6)	26.27	413,505	2.7	1.6	2.2	Spottail Shiner White Sucker Lake Whitefish Northern Pike Walleye	Northern Pike Walleye Suckers	Emergent vegetation Submergent vegetation Woody debris	Emergent vegetation Riparian vegetation	Sand Mud
Russell Lake (LAB-1)	75.15	-	18.8	3	3.5	Spottail Shiner White Sucker Lake Whitefish Lake Trout Northern Pike Burbot Ninespine Stickleback Walleye	Northern Pike	Emergent vegetation Submergent vegetation Cobble	Emergent vegetation Riparian vegetation	Sand
Russell Lake (LAB-2)	151.66	6,079,370	20.6	4	2.9		Northern Pike	Submergent vegetation Cobble	Riparian vegetation	Sand

Table 8.3-5: Summary of Fish Survey Presence and Absence for Waterbodies in the Local Study Area

Fish Species	Lake and Pond Sample Stations			Stream Sample Stations				
	McGowan Lake (LA-1)	Whitefish Lake South (LA-5)	Whitefish Lake North (LA-6)	SA-1	SA-2	SA-4	SA-5	SA-6
Arctic Grayling	-	-	-	X	X	X	-	-
Burbot	-	-	-	X	X	X	X	X
Lake Chub	-	-	-	X	X	X	X	-
Lake Trout	X	X	X	-	-	-	-	-
Lake Whitefish	X	-	-	-	-	-	-	-
Longnose Sucker	X	-	-	X	-	X	X	X
Ninespine Stickleback	-	X	-	-	-	X	X	X
Northern Pike	X	X	X	X	X	X	-	X
Slimy Sculpin	-	-	-	X	X	X	X	-
Spottail Shiner	X	X	X	-	-	X	-	X
Walleye	X	X	X	-	X	-	X	X
White Sucker	X	X	X	X	X	X	X	X
Yellow Perch	X	-	-	-	-	-	-	-

Orange highlighted cells indicate potential spawning habitat is present for the associated species within that waterbody.

X Indicates that the species was either captured or observed.

\- Indicates that the species was neither captured nor observed.

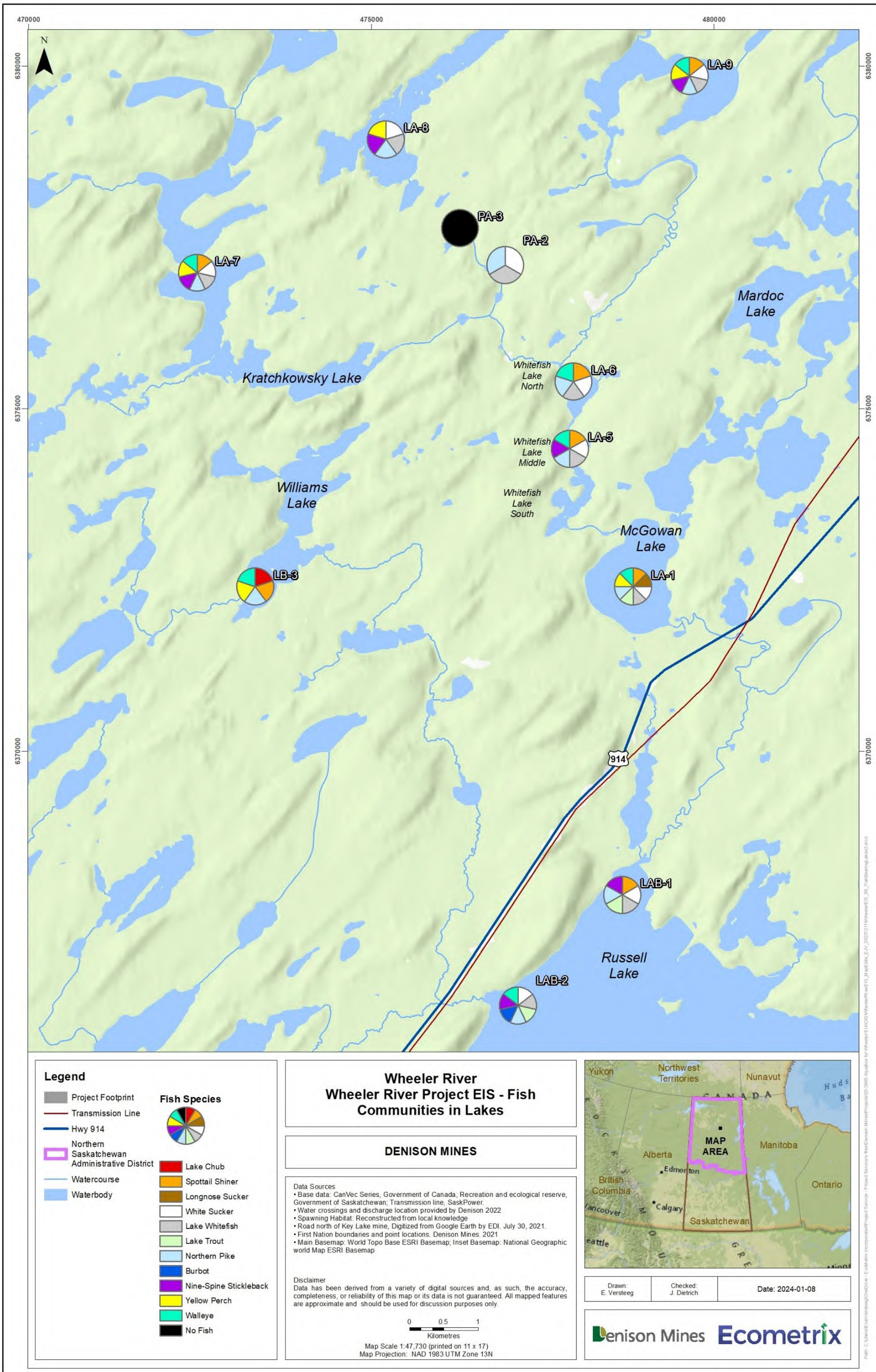

Figure 8.3-6: Fish Communities Associated with Lakes in the Local Study Area

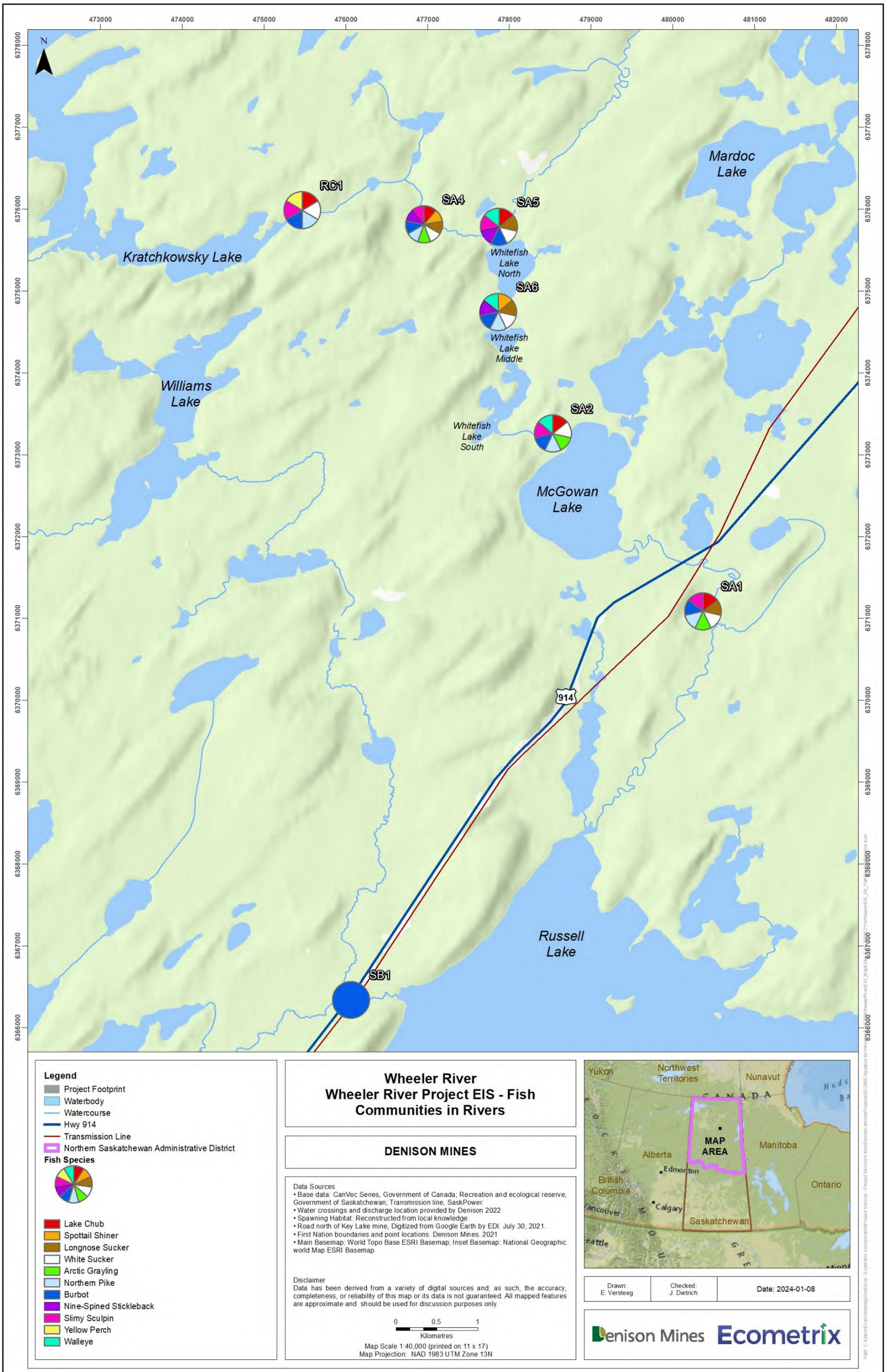

Figure 8.3-7: Fish Communities Associated with Rivers in the Local Study Area

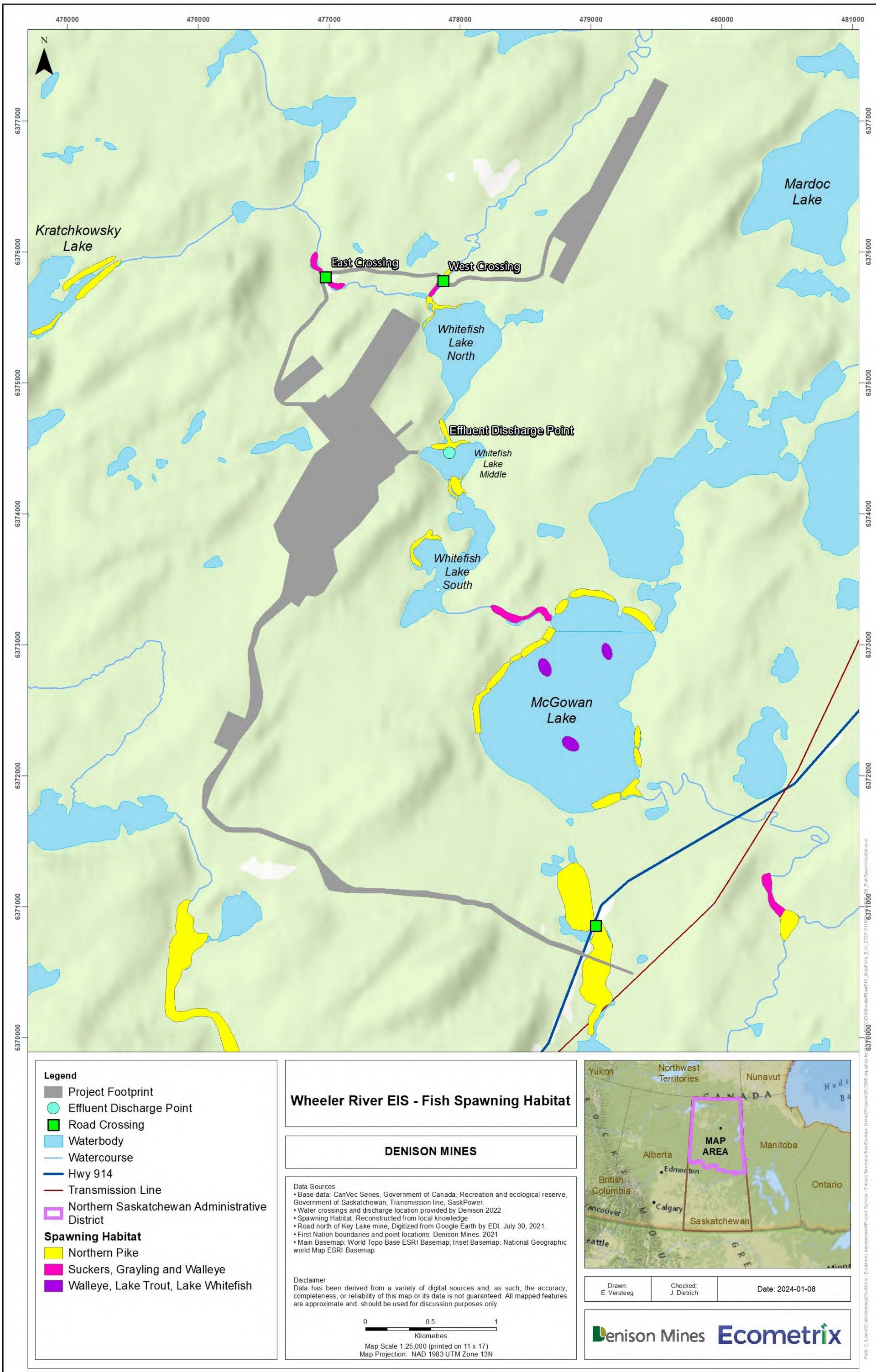

Figure 8.3-8: Fish Spawning Habitat in the Local Study Area

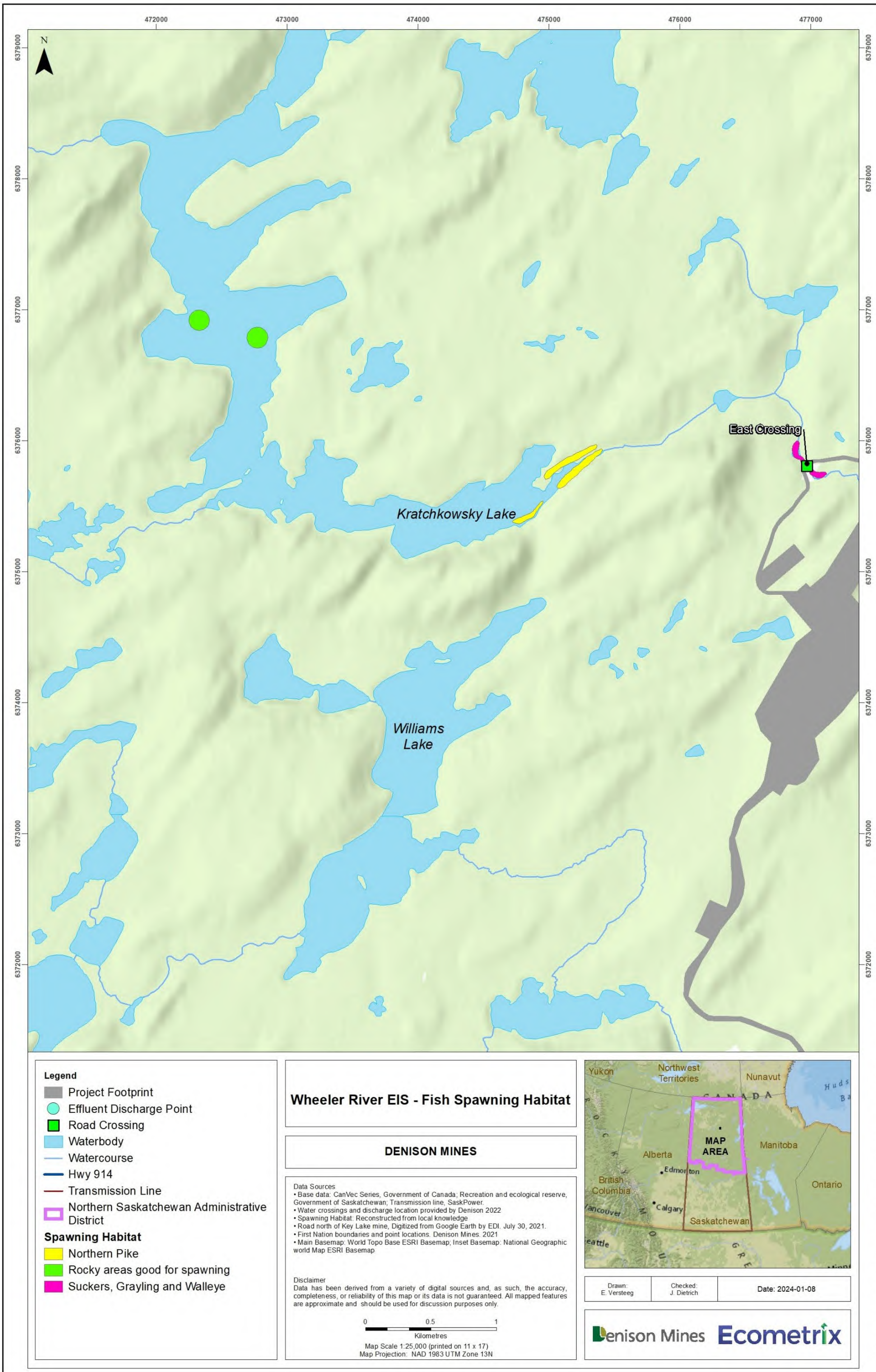

Figure 8.3-9: Fish Spawning Habitat West of the Local Study Area

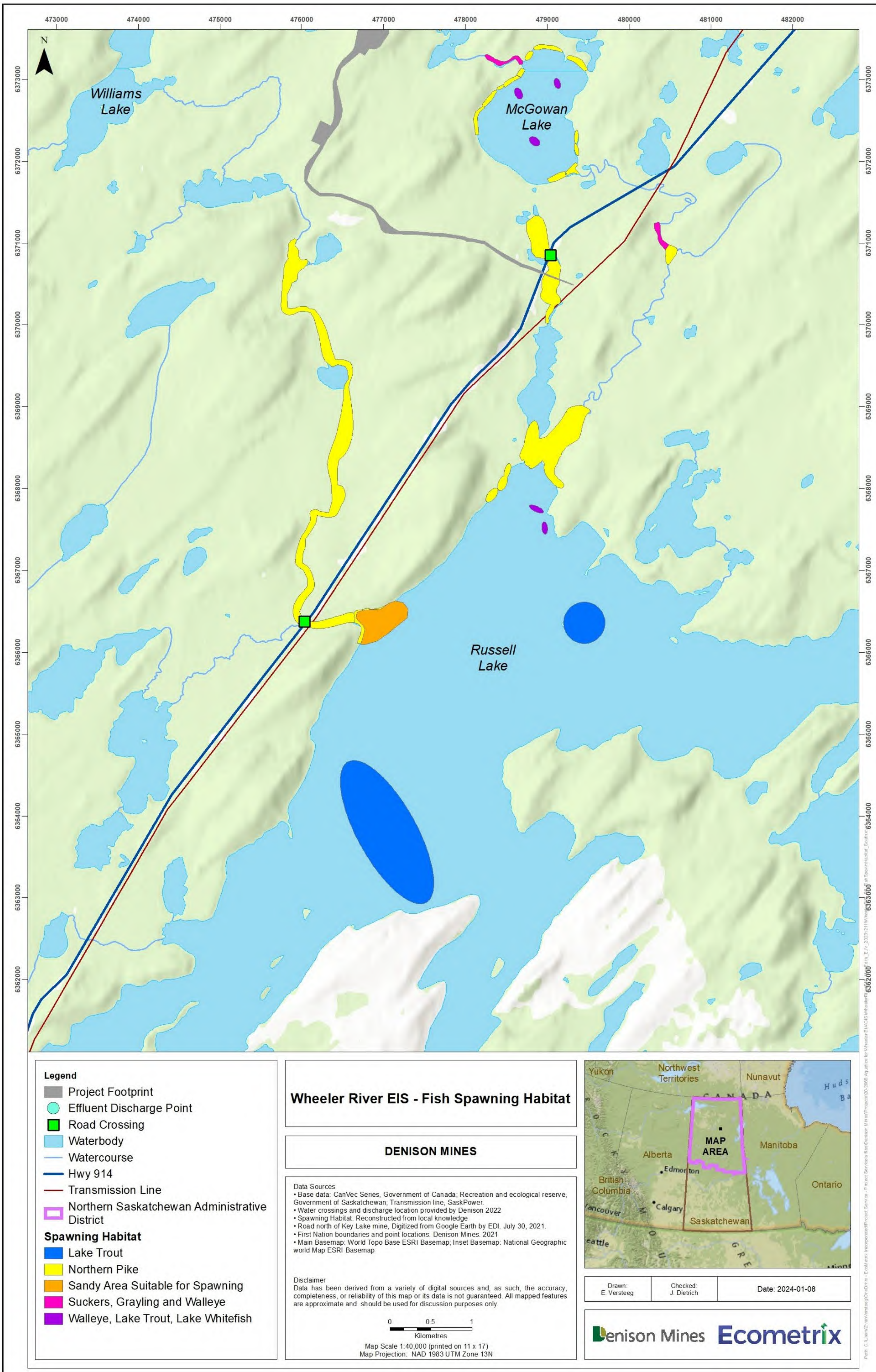

Figure 8.3-10: Fish Spawning Habitat in Russell Lake

8.3.4 Assessment of Project-related Effects

8.3.4.1 Potential Interactions Between the Project and Valued Component/Key Indicators

The Project will require the construction, operation, and decommissioning of several components (as described in Section 2). Potential interactions between Project activities and the Fish and Fish Habitat VC are summarized by Project phase in Table 8.3-6 and are ranked as:

- Primary Interaction (✓): Project activity is expected to interact with the VC/KI, which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- Other Interaction (✓): Project activity is expected to interact with the VC/KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- No Interaction: Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

Based on professional judgment and understanding of the nature of Project activities and their sequencing, the Project activity list was reviewed and the type of other interactions determined. Potential Project-related effects are discussed in Section 8.3.4.2. Primary Project activities with the potential for adverse effects on the Fish and Fish Habitat VC (i.e., flagged as 'primary interactions') are expected to involve surface land clearing, major earthworks, surface/grading preparations, changes to land cover, water management feature construction and operation, and water taking and effluent discharge. Other Project activities (i.e., flagged as 'other interactions') refer to those activities that may be associated with hydrogeological influence on local waterbodies and are expected to be secondary contributors to potential adverse effects. The remaining activities (e.g., power generation and supply) were deemed to have no interaction and were not carried forward in the assessment as they are not expected to result in detectable changes in the MPs associated with the Fish and Fish Habitat VC (which is inclusive of wetlands). Activities during Post-Decommissioning (e.g., site inspections; monitoring and on-site engagement with Interested Parties) were deemed to have no interaction because they do not involve any land clearing, surface preparations, or major earthworks.

Table 8.3-6: Potential Project Interactions for Fish and Fish Habitat

Project Phase/Activity	Fish and Fish Habitat		
	Surface Water Quantity	Surface Water Quality	Change in Habitat (Aerial Extent)
Construction Activities			
Development of access roads and air strip	✓	✓	✓
Site preparation and earthworks; clearing, levelling, and grading of the Project Area	✓	✓	

Project Phase/Activity	Fish and Fish Habitat		
	Surface Water Quantity	Surface Water Quality	Change in Habitat (Aerial Extent)
Power generation – generators			
Installation of main substation and distribution of power around site			
Wellfield and freeze hole drilling; ground freezing	✓	✓	
Batch plant operation (concrete); crusher at borrow area			
Development of surface infrastructure (camp, operations centre, plants, ponds, pads, and support facilities)	✓	✓	
Waste management (composting, domestic and industrial landfill operation, recycling)		✓	
Water management (including treatment and site runoff)	✓	✓	
Groundwater supply	✓	✓	
Surface water withdrawal	✓	✓	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)			
On-site and off-site operation of vehicles and transport of materials		✓	
Air transportation for workers			
Regulatory site inspections			
Engagement – site visit from Interested Parties			
Operation Activities			
Operation of the ISR wellfield	✓	✓	
Wellfield and freeze wall drilling	✓	✓	
Operation and expansion of freeze wall	✓	✓	
Batch plant operation (grout and cement); crusher in borrow area			
Expansion of pond and pads	✓	✓	
Operation of the processing plant and production of uranium concentrate	✓	✓	
Water withdrawal from groundwater or surface waterbody	✓	✓	✓
Management of surface water (including seepage and site runoff)	✓	✓	
Water treatment, both domestic and industrial		✓	
Water release to surface waterbody	✓	✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)		✓	
Hazardous waste management (temporary storage, handling, and off-site transportation)			

Project Phase/Activity	Fish and Fish Habitat		
	Surface Water Quantity	Surface Water Quality	Change in Habitat (Aerial Extent)
Storage and disposal of drill waste rock, process precipitates, and industrial wastewater treatment plant precipitates		✓	
On-site and off-site operation of vehicles and transport of materials		✓	
Power supply – primarily power from the grid, also generators and back-up generators			
Package and transport of nuclear substances			
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)			
Air transportation for workers			
Progressive decommissioning and reclamation	✓	✓	✓
Regulatory site inspections			
Engagement – site visit from Interested Parties			
Decommissioning Activities			
Site water management, treatment, and release	✓	✓	✓
Mining horizon remediation and thawing of freeze wall	✓	✓	
Process water treatment and release	✓	✓	✓
Closure of ISR and freeze wells and related infrastructure	✓	✓	
Decontamination of surface facilities and injection, recovery, and monitoring wells	✓	✓	
Asset removal (including site power transmission lines and electrical infrastructure)			
Demolition and disposal of non-salvageable surface infrastructure and materials		✓	
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	✓	✓	
Generators			
Waste management (composting and landfill operation)		✓	
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)		✓	
On-site and off-site operation of vehicles and transport of materials			
Reclamation of disturbed areas	✓	✓	
Regulatory site inspections			
Engagement – site visit from Interested Parties			
Post-Decommissioning Activities			
Environmental monitoring	✓	✓	✓

Project Phase/Activity	Fish and Fish Habitat		
	Surface Water Quantity	Surface Water Quality	Change in Habitat (Aerial Extent)
Regulatory site inspections			
Engagement – site visit from Interested Parties			

8.3.4.2 Potential Project-related Effects

Project activities may interact with the Fish and Fish Habitat VC during all Project phases. In general, the interactions can be characterized as being primarily associated with controlled, routine discharges from the site. During Construction, the primary effect pathway relates to the mobilization of suspended material into natural surface water features as a result of land disturbance and clearing. During Operation and Decommissioning, excess water from the effluent monitoring ponds will be released to the environment. Routine discharge of this sort will be directed to Whitefish Lake only. Direct discharge of treated effluent to the natural environment has the potential to change surface water constituent concentrations, which may be partitioned to sediments, potentially affecting fish communities and fish habitat via exposure. Post-Decommissioning will involve the restoration of natural site drainage to the Whitefish Lake receiver. Similar to Construction, Decommissioning and Post-Decommissioning activities have the potential to increase the mobilization of suspended solids into natural surface waters (including wetland features), increasing the potential for sedimentation of benthic invertebrate habitat. The following sections discuss each Project-related effect.

8.3.4.2.1 Mobilization of Suspended Materials

Construction

The primary effect pathway during Construction relates to the mobilization of suspended material into natural surface water features as a result of land disturbance and clearing. According to the site water balance (Figure 2.2-14 in Section 2), there is no planned discharge to Whitefish Lake during Construction. The mobilization of suspended material into natural surface water features is readily mitigatable by virtue of the mine development plan and through the implementation of standard water management and sediment control practices. Water management infrastructure (e.g., collection ditches, ponds, pumping stations) and various aspects of the water management and sediment control management systems will be put into place coincident with the initiation of construction activities. Waters (e.g., runoff) associated with areas under development will be collected and stored within management infrastructure (e.g., clean waste rock pond, see Figure 2.2-14 in Section 2). In the event that releases to the natural environment are necessary, they would only occur once it is safe to do so (i.e., suspended solid levels in the water would be at acceptable levels). No downstream effects on surface waterbodies, wetland natural sediments, or fish and fish habitat are expected.

Operation

During Operation, mobilization of suspended materials will be managed through the development and operation of water management infrastructure and implementation of surface water management through the Surface Water Management Program. Releases of contact water to the natural environment will be directed through applicable collection ponds, the IWWTP, and the Effluent Monitoring and Release Ponds. Discharge will only occur once it is safe to do so (i.e., suspended solids levels in the water would be at acceptable levels). Denison may employ active means (e.g., filtering), if required, to achieve low TSS levels in discharge, in addition to passive means, such as settling and clarification in the IWWTP to manage TSS in the effluent stream to low levels. No downstream effects on surface waters, natural sediments, fish and fish habitat including wetlands are expected.

Decommissioning and Post-Decommissioning

During Decommissioning and Post-Decommissioning, the site-wide water management system will continue to operate such that Denison will maintain control of the site aspect affected water through the IWWTP. Surface drainage during Decommissioning activities will continue to be directed to the system of collection ponds, the IWWTP, and the Effluent Monitoring and Release Ponds to facilitate the control of suspended solids and achieve low TSS levels in the discharge, thereby minimizing any potential for adverse changes to water quality, sediment quality, and fish and fish habitat (including wetlands).

8.3.4.2.2 Overprinting of Fish Habitat

For the purposes of this assessment the bogs and fens within the area can be assumed to provide supporting fish habitat to the adjacent lake and river water bodies in the vicinity of the LSA. Overprinting of fish habitat is only expected as a result of construction and commissioning of the effluent discharge/intake pipeline and diffuser at Whitefish Lake. The discharge pipeline and diffuser will terminate at an engineered, offshore, submerged, multiport diffuser, which will be designed to maximize the mixing potential and reduce the spatial extent of the mixing zone (as described in Section 8.2.4.1.1). Negligible aquatic habitat loss is predicted in Whitefish Lake due to the installation of a discharge pipeline and diffuser configuration. The total area of the lake substrate that would be overprinted by the pipeline is expected to be approximately 135 m^2, which will constitute less than 0.05% of the lake's surface area and, therefore, is not expected to require an Authorization under the *Fisheries Act*. The discharge point will be at a depth of approximately 3 m offshore so as not to interfere with known, nearshore Northern Pike spawning habitat in the vicinity. The exact design configuration will be optimized as required during the engineering design and permitting phase to facilitate optimal performance of the diffuser specific to site conditions. However, under the conceptual design (i.e., diffuser line with three evenly spaced nozzles, with each nozzle approximately 0.07 m in diameter, approximately 115 m offshore from the north shoreline of LA-5, at a depth of approximately 3 m [Appendix 8-E]) and maximum effluent discharge concentrations (as listed in Table 8.2-9 in Section 8.2.4.2.3 and Appendix 8-E), it is estimated that the extent of the mixing zone will be less than 5 m.

The pipeline and diffuser structure will remain in place during Operation and Decommissioning while the site-wide water management system continues to operate, such that Denison will maintain control of the site process and contact water through the IWWTP. The effects on Fish and Fish Habitat are expected to be confined to this area throughout the duration of the Project, but will be returned to pre-construction character following removal of the infrastructure, establishment of natural sediment distribution patterns in the lake, and recolonization of food resources (i.e., benthic invertebrates).

Two water crossings will be installed along the road from the Project site to the airstrip (see Figure 2.2-27 in Section 2 and Figure 8.3-8).

- At the airstrip access road west crossing, Kratchkowsky Creek. The crossing will be over a segment of the western sub-basin of the Icelander River drainage (downstream of Kratchkowsky Lake, LA-7).
- At the airstrip access road east crossing. The crossing will be over a segment of the northern sub-basin of the Icelander River drainage (downstream of LA-9). This creek has been previously referred to as Hart Creek.

The road crossings will be built in locations where crossings previously existed. The previous crossings were decommissioned by Cameco Corporation in 2015. The new crossing structures are proposed to be clear span solutions without in-water supports or buttresses. Vegetation removal, fill, and grading will be required only to the extent necessary to prepare footings for the bridge, which will remain above the high-water mark. Heavy construction equipment will be needed to prepare footing areas for concrete. Laydown areas will be kept adjacent to the roadway and above the flood-prone area. Crossings will be pre-assembled in the laydown area and lifted into place.

It is expected that the works proposed in and around water as part of the Project can be either conducted to avoid fish habitat or conducted over a short duration, at a small spatial scale, and during appropriate timing windows. As such, the proposed works are not expected to constitute a HADD under subsections 34(1) and 35(2) of the *Fisheries Act.*

Construction, operation, and maintenance of the airstrip access road crossings have the potential to increase access for recreational resource users to adjacent waterbodies. The phase of greatest impact due to fishing pressure on local fish populations is expected to occur during Construction when the peak in onsite workers occurs, followed by Operation and, to a lesser extent, Decommissioning (Section 11.3 in Section 11 Land and Resource Use).

Investigation of the potential overprinting of wetland features as a result of the Project it is evident that wetland loss is avoidable. The interaction of the Project with wetlands is isolated to those areas where stream crossings for access roads and hydro-line connections are proposed (Figure 3).

With the use of single span bridges and implementation of best management practices, direct wetland disturbance associated with the crossings of Kratchkowsky Creek and Hart Creek is expected to be avoided. It should be noted that SaskPower proposes to tap the existing I3P 138 kV line near Highway 914 and build approximately 4.5 km of new 138 kV line from the I3P tap to the Project site. SaskPower will be responsible for conducting activities such as line routing, environmental studies, and permitting, public consultation, and engineering design work as applicable to the load interconnection. As such, wetland disturbance related to the SaskPower Hydro Corridor is expected to be addressed through the SaskPower permitting process. (Appendix 8-F).

8.3.4.2.3 Controlled Discharge to Receiving Environments

Construction

Discharge to the environment is not expected during Construction. Site contact water will be collected and held in the Clean Waste Rock Pond (Figure 2.2-14 in Section 2). Therefore, potential effects of discharge on the Fish and Fish Habitat VC are not expected.

Operation

Denison does not intend to include constant freshwater withdrawal or effluent discharge throughout Operation; however, for the purpose of assessing the scenario of greatest potential effects, the Project was assessed as having a continuous freshwater withdrawal rate of 40.5 m^3/hr and a continuous effluent discharge rate of 36.5 m^3/hr (Figure 2.2-15 in Section 2).

With respect to the discharge of treated effluent, the Fish and Fish Habitat VC was assessed as an ecological receptor as part of the *Wheeler River Environmental Risk Assessment* (Appendix 10-A in Section 10). The potential effects on Fish and Fish Habitat were assessed based on pathways through surface water quality for both radiological and non-radiological constituents.

The estimation of potential changes in surface water quality as a result of effluent discharge to the environment is discussed in Sections 8.2.4.2.2, 8.2.4.2.3, and 8.2.4.2.4. These subsections discuss the methods, assumptions, and results of predictive models used to assess the potential effects on the receiving environment in the LSA.

The near-field analysis (Section 8.2.4.2.3) identified that under all flow regime scenarios (i.e., 7Q10, monthly low, and monthly average), constituents are expected to be well mixed within LA-5 yet parameters where the available assimilative capacity is less than the max predicted discharge concentration when screening criteria subject to background water quality include sulphate, chromium, molybdenum, and selenium. For chromium and selenium, the assessment was influenced by datapoints with values below the detection limit. However, these are conservative estimates which are not yet based on BATEA (Table 8.2-10 and Appendix 8-E). Additionally, the extent of the mixing zone in Whitefish Lake is estimated to be less than 5 m under average flow scenarios assessed (Table 8.2-11 and Appendix 8-E).

A regional surface water quality model was used to predict effects on surface water quality within Whitefish Lake outside the initial mixing zone (Section 8.2.4.2.4). When the treated effluent is released to Whitefish Lake (LA-5), surface water concentrations were predicted using IMPACT according to the equations outlined in the IMPACT model (Appendix 10-A in Section 10). The predicted maximum concentrations of COPC in water are summarized in Table 8.2-13. With the exception of copper where baseline concentrations exceed the FEQG (due to the copper analytical detection limit being equal to the FEQG) and the guideline does not consider conditions expected during operations, there are no predicted exceedances of water quality guidelines were identified for any of the COPC during Construction, Operation, or Decommissioning.

Other than LA-5 (Whitefish Lake) no other controlled discharge will occur to the natural environment and no wetlands will be impacted as a result (Appendix 8-F).

Decommissioning and Post-Decommissioning

Discharge to the aquatic environment of Whitefish Lake during some portion of Decommissioning is expected. Effluent rates during Decommissioning are expected to be less than during Operation. The effluent is also expected to have lower levels of COPC compared to Operation. Therefore, the analysis of the potential effects on the Fish and Fish Habitat VC via surface water quality pathways during Operation provided in Section 8.3.4.2.3 is considered the bounding scenario for Decommissioning as well.

8.3.4.2.4 Change in Water Levels and Flow

As detailed in Section 8.1, the projected withdrawal and discharge rates proposed for the Project are the largest influence on the hydrological effects of the Project. The largest predicted change in streamflow rate is -3.1% at the LA-5 and SA-2 nodes (immediately downstream of the Project) during Operation and Decommissioning, as projected against the 5^{th} percentile low flow dataset in March. Lake and wetland levels are expected to deviate less than ±0.01 m due to all Project influences. All Project influences on the environment are expected to return to baseline conditions during Post-Decommissioning. These changes are within the range of fluctuation of environmental flows and water levels and are unlikely to affect fish passage or life history environmental cues.

8.3.4.2.5 Long-Term Transport of Groundwater Solutes to Whitefish Lake in Future Centuries

During the ‘future centuries’ scenario as described in Section 8.3.1.3, remediation works will be completed and the site naturalized, thereby restoring drainage patterns to report to surface waterbodies. As indicated in Section 7, groundwater plumes may develop from residual mass remaining post-mining based on bench-scale lab tests of core flushing, and numerical modelling of reactive fate and transport.

Groundwater flow and reactive transport of dissolved constituents were modelled using three-dimensional modelling, whereby the reactions were computed using PHREEQC and transport was computed using FEFLOW (Appendix 9-C). Groundwater flow observed and simulated in the calibrated groundwater model travelled eastward from the mining zone within the Lower Sandstone Aquifer before moving upward through the Desilicified Zone in the Athabasca Sandstone and overlying overburden deposits toward Whitefish Lake. Modelled transport of dissolved constituents along the groundwater flow path allowed for interactions of the dissolved constituents with the geologic media through which they were flowing. Due to the relatively low groundwater velocities between the mining zone and Whitefish Lake, and chemical reactions along the groundwater flow pathway, the 'future centuries' scenario spans hundreds to thousands of years.

Although the precise location of the groundwater discharge to the surface is somewhat uncertain, the groundwater transport scenarios that have been evaluated (Appendix 7-C of the EIS) to date suggest groundwater discharge impacted from mining will most likely be relegated to Whitefish Lake. The discharge to Whitefish Lake is generally predicted to occur along the eastern shore of the lake, as this is interpreted to be the eastern edge of the underlying desilicified zone. The Labrador Tea Shrubby Bog habitat located on the eastern shore of Whitefish Lake may be in the zone of influence of groundwater discharge, yet chemically will remain below freshwater environmental quality criteria. Groundwater impacts to other surrounding wetlands will be negligible as groundwater is not predicted to discharge within any area beyond the central portion of Whitefish Lake. (Appendix 8-F).

The results of the numerical modelling (as provided in Section 7 and Appendix 10-A in Section 10) support the conclusion that with the implementation of appropriate mitigation during the decommissioning and restoration phases of the Project, the residual effects of the Project on the intermediate Groundwater VC will not result in an adverse effect on surface water. Dissolved constituent concentrations emanating over hundreds to thousands of years in the future from the deep Ore Zone to Whitefish Lake are expected to remain below fresh water environmental quality criteria in Whitefish Lake.

For the COPC identified in the effluent, the predicted mass flux from groundwater (Table 8.3-7) into Whitefish Lake starting 200 years after the Project phases during the future centuries scenario was added into the IMPACT model to predict the surface water concentrations over time at the exposed locations. As shown in the *Wheeler River Environmental Risk Assessment* (Appendix 10-A in Section 10), predicted surface water concentrations at all locations are expected to be below water guidelines for the protection of aquatic life, except for copper where baseline concentrations exceed the FEQG (due to the copper analytical detection limit being equal to the FEQG). An incremental increase in concentration is predicted such that the predicted copper concentration (~0.0006 mg/L) would be greater than the FEQG of 0.0002 mg/L under baseline conditions, indicating a slight increased level of risk to the most sensitive aquatic biota.

Table 8.3-7: Summary of Predicted Mass Flux of Constituents of Potential Concern in Groundwater During the Future Centuries Scenario

Mass Flux (mg/s or Bq/s)									
Year After Project Phases	200	300	400	500	600	700	800	900	1000
General Chemistry (mg/s)									
Chloride	1.26E+02	1.28E+02	1.29E+02	1.29E+02	1.29E+02	1.29E+02	1.29E+02	1.28E+02	1.28E+02
Sulphate	4.08E+01	4.47E+01	4.69E+01	4.62E+01	4.44E+01	4.28E+01	4.16E+01	4.07E+01	3.99E+01
Metals and Metalloids (mg/s)									
Arsenic	5.73E-03	5.73E-03	5.73E-03	5.73E-03	5.73E-03	5.73E-03	5.73E-03	5.73E-03	5.74E-03
Cadmium	1.89E-04	1.89E-04	1.89E-04	1.89E-04	1.89E-04	1.89E-04	1.89E-04	1.88E-04	1.88E-04
Chromium	9.45E-03	9.45E-03	9.44E-03	9.43E-03	9.42E-03	9.42E-03	9.41E-03	9.40E-03	9.40E-03
Cobalt	7.51E-03	7.50E-03	7.49E-03	7.47E-03	7.46E-03	7.44E-03	7.43E-03	7.41E-03	7.40E-03
Copper	1.15E-02	1.15E-02	1.14E-02	1.14E-02	1.14E-02	1.14E-02	1.14E-02	1.14E-02	1.14E-02
Molybdenum	1.34E-02	1.34E-02	1.35E-02	1.35E-02	1.35E-02	1.35E-02	1.35E-02	1.35E-02	1.35E-02
Selenium	1.52E-02	1.52E-02	1.51E-02	1.51E-02	1.51E-02	1.51E-02	1.51E-02	1.51E-02	1.51E-02
Uranium	9.47E-03	9.47E-03	9.47E-03	9.46E-03	9.46E-03	9.45E-03	9.45E-03	9.45E-03	9.45E-03
Zinc	8.30E-02	8.30E-02	8.30E-02	8.29E-02	8.29E-02	8.28E-02	8.28E-02	8.28E-02	8.28E-02
Radionuclides (Bq/s)									
Uranium-238 [1]	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01
Uranium-234 [1]	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01
Thorium-230 [2]	3.69E-01	3.70E-01	3.71E-01	3.71E-01	3.72E-01	3.72E-01	3.72E-01	3.73E-01	3.73E-01
Radium-226 [3]	1.14E+00	1.14E+00	1.15E+00	1.15E+00	1.15E+00	1.15E+00	1.15E+00	1.15E+00	1.15E+00
Lead-210 [4]	1.14E+00	1.14E+00	1.15E+00	1.15E+00	1.15E+00	1.15E+00	1.15E+00	1.15E+00	1.15E+00
Polonium-210 [5]	1.16E+00	1.16E+00	1.17E+00	1.17E+00	1.17E+00	1.17E+00	1.17E+00	1.17E+00	1.17E+00

Notes:

1 Estimated from uranium using the specific activity of 12,356 Bq/g and assuming secular equilibrium between uranium-238 and uranium-234.

2 Unit conversion from mg/s to Bq/s using the specific activity of 7.47E+08 Bq/g, which was calculated from its half-life of 77,000 y.

3 Unit conversion from mg/s to Bq/s using the specific activity of 3.66E+10 Bq/g, which was calculated from its half-life of 1,600 y.

4 Assuming equilibrium between radium-226 and lead-210 due to the long half-life of radium-226.

5 Calculated from lead-210 assuming transient equilibrium between lead-210 and polonium-210.

8.3.5 Mitigation Measures

Measures to mitigate adverse effects on the Fish and Fish Habitat VC are consistent with those to mitigate adverse effects on the Surface Water Quantity, Surface Water Quality, Sediment Quality and Benthic Invertebrates, and Fish Health VCs. These measures are repeated in this section for completeness, with additional measures added as applicable to the Fish and Fish Habitat VC.

- Avoid more sensitive habitats (spawning, nursery and overwintering habitats to the extent practicable.
- Maintain existing drainage patterns with the use of culverts, where applicable.
- Maintain access roads by periodically re-grading and ditching to improve water flow, reduce erosion, and manage vegetation growth.
- Inspect culverts periodically. Remove accumulated material and debris upstream and downstream of the culverts to prevent erosion, flooding, habitat damage, property damage, and mobilization of sediment.
- Attenuate peak discharges and augment baseflows to the environment through the use of Project water storage features (i.e., runoff, process water, contact water, monitoring/effluent ponds).
- Develop and implement a Surface Water Management Program that provides an integrated framework to manage water quality and includes provision for water management practices for each of the primary site aspects, as well as areas of the site where there is contact water.
- Maximize the recycle and re-use of process water to reduce freshwater intake and release to Whitefish Lake.
- Design the discharge diffuser/outfall to have the smallest footprint possible while still providing effective mixing and dilution and discharge flows that do not detrimentally affect sediments.
- Adhere, as applicable, to the *Interim Code of Practice: End-of-Pipe Fish Protection Screens for Small Water Intakes in Freshwater* (DFO 2020a).
- Adhere, as applicable, to the *Interim Code of Practice for Temporary Cofferdams and Diversion Channels* (DFO 2020b).
- Adhere, as applicable, to the *Interim Code of Practice for Temporary Stream Crossings* (DFO 2020c).
- Plan in-water works, undertakings, or activities to respect timing windows to protect fish and fish habitat, including their eggs, juveniles, spawning adults, the organisms upon which they feed, and the areas where they migrate. In-water works should be deferred based on the specific waterbody and known species that inhabit the waterbody (*Saskatchewan Restricted Activity Timing Windows for the Protection of Fish and Fish Habitat* [DFO 2020d]).
  - Spring spawning species (northern Saskatchewan) – avoid work between May 1 and July 15.
  - Fall spawning species (northern Saskatchewan – Lake Trout present) – avoid work between September 1 and July 15).
  - Fall spawning species (northern Saskatchewan – Lake Trout absent) – avoid work between October 1 and July 15).
- Where possible, conduct instream work during periods of low flow (e.g., summer or winter) to further reduce risk to fish.

- In discussion with responsible authorities, prepare a fish salvage plan to relocate fish prior to in-water works.
- Design treated effluent discharge or freshwater intake infrastructure to prevent entrainment or impingement of fish.
- Implement an erosion and sediment control plan for the site to reduce potential sedimentation of waterbodies and potential lethal affects to fish, larvae, and eggs. Ensure erosion and sedimentation measures are maintained as applicable throughout the duration of the Project.
- Develop site-specific effluent treatment to treat COPC to appropriate release limits in accordance with provincial standards and licence/permit conditions.
- Discharge effluent under a scenario that will meet provincial and federal discharge criteria, as identified through permitting. Scenarios may include:
  - discharging at a fixed rate while maintaining an appropriate minimum dilution ratio (i.e., discharge when able to meet the required dilution ratio and cease discharge during periods when unable to meet the necessary dilution ratio);
  - discharging under a variable waste load allocation (i.e., discharge an appropriate effluent volume based on flow in the receiver to maintain a minimum dilution ratio); and
  - managing discharge via a hybrid of the two previous options (i.e., discharge effluent at a fixed rate to maintain the required dilution ratio, but the fixed rate is varied on a seasonal basis based on flow).
- Collect and monitor contact water to determine whether treatment is required prior to release to the environment. This will inform optimal levels of treatment.
- Maintain the water management system in place during Decommissioning until such time that water quality is suitable to release to the environment.
- Monitor and manage effluent, including contingency for effluent treatment as may be required, so that water discharge objectives are achieved, as defined by applicable provincial and federal regulatory instruments.
- Design and implement an environmental code of practice that defines actions levels and appropriate steps to mitigate elevated concentrations of chemical and radiological constituents in treated effluent discharge to acceptable levels.
- Workforce members will be transported to/from site via a fly-in/fly-out rotation and will, therefore, not use ground travel options during shift changes, which will eliminate fishing on local lakes during commutes to/from the site and during time off work. Denison site vehicles will not be available for recreational purposes. While at the Project site and off duty, workers may opt to fish local waterbodies. To protect sustainable use of resources, only catch and release of fish will be encouraged, and fish storage or cooking facilities will not be provided.

- Implement Project-specific monitoring programs (e.g., effluent monitoring plan, environmental monitoring plan) that include monitoring treated effluent, surface water, and sediment quality and applying adaptive management if necessary.
- Work with the associated communities to develop and implement the Project-specific monitoring programs and a framework to share the results for the purpose of assessing the performance of the water management system.
- Develop and implement a decommissioning and reclamation plan to decommission and transfer the site to the Province of Saskatchewan under the Institutional Control Program.

Additional mitigation measures are presented in Appendix 8-F with respect to mitigating potential effects to wetlands as they relate to providing fish habitat. Wherever possible, wetlands will be avoided through Project design and instituting proper buffers.

8.3.6 Residual Effects Evaluation

8.3.6.1 Residual Effects Characterization

This section describes the likely residual effects of the Project on the VC of Fish and Fish Habitat and its associated KIs. Residual effects are effects that remain after the implementation of mitigation measures and management strategies and are the expected consequences of the Project. The approach to assessing residual Project effects on the Fish and Fish Habitat VC follows the methodology outlined in Section 5.8 in Section 5. For each VC and associated KI, each residual effect is characterized in the context of the Project activities that will occur within each Project phase. A residual adverse effect on the Fish and Fish Habitat VC is defined as a measurable change in the concentrations of a surface water quality parameter(s) that exceed relevant water quality assessment benchmarks that represent concentrations that are protective of aquatic biota and water uses in watercourse and waterbodies that receive mine-affected drainage. Additionally, a change in water level or flow greater than 5% from baseline environmental flows, and a change in available fish habitat, are also considered residual adverse effects on Fish and Fish Habitat. Residual effect characteristics specific to Fish and Fish Habitat are defined in Table 8.3-8.

Construction

The primary potential change in the Fish and Fish Habitat VC associated with Construction is related to the mobilization of suspended material into natural surface water features as a result of land clearing activities and road crossing construction. According to the site water balance (Figure 2.2-14 in Section 2), there is no planned discharge to Whitefish Lake during Construction. However, the potential influence of such discharge, if it were to occur, would be bounded by the analysis of water quality in Whitefish Lake during Operation.

Mobilization of suspended material into natural surface water features is readily mitigatable by virtue of the mine development plan and through the implementation of standard water management and sediment control practices. Water management infrastructure (e.g., collection pads, ponds, pumping stations), as well as various aspects of the water management and sediment control management systems, will be put into place coincident with the initiation of construction activities. Runoff associated with areas under development will be collected and either stored within management infrastructure (e.g., water management ponds) or potentially released into natural surface water features once it is safe to do so (i.e., suspended solid levels in the water would be at acceptable levels). No downstream effects on local sediment quality or benthic invertebrate communities are expected.

Negligible aquatic habitat loss is predicted in Whitefish Lake due to the installation of a discharge pipeline and diffuser configuration. The total area of the lake substrate that would be overprinted by the pipeline is expected to be approximately 135 m^2, which will constitute less than 0.05% of the lake's surface area.

Two road crossings will be built in locations where crossings previously existed. The previous crossing were decommissioned by Cameco Corporation in 2015. The new crossing will be constructed as clear span bridges, thereby avoiding in-water works, and standard mitigations will be undertaken to minimize potential effects on Fish and Fish Habitat.

It is expected that the works proposed in and around water as part of the Project can be either conducted to avoid fish habitat or conducted over a short duration, at a small spatial scale, and during appropriate timing windows. As such, the proposed works are not expected to constitute a HADD under subsection 34(1) or 35(2) of the *Fisheries Act.*

Construction, operation, and maintenance of the airstrip access road crossings have the potential to increase access for recreational resource users to adjacent waterbodies. The phase of greatest impact due to fishing pressure on local fish populations is expected to occur during Construction when the peak in onsite workers occurs. Given the mitigations, increased pressure on resources is expected to be limited due to a lack of transportation to fishing locations beyond walking distance and a prohibition on firearms/hunting. Given that fishing on LA-5 has not been documented, and the effect is expected to be of low magnitude, changes in fish abundance or distribution are not expected to be detectable to Indigenous land users.

Operation

During Operation, the primary potential water quality effect from the Project is the discharge of excess water from the site water management system to Whitefish Lake (Figure 2.2-14 in Section 2). Discharge to Whitefish Lake has the potential to change the concentrations of water and sediment quality constituents from background and, therefore, affect fish through direct exposure, as well as via secondary pathways.

For planning purposes, a continuous (year-round) discharge at an expected average effluent rate of 0.0101 m^3/s (36.5 m^3/hr) has been used to characterize Operation, despite the likelihood that effluent discharge will not be continuous and will only discharge when the site water balance requires, based on water storage capabilities. The water storage capability of the Effluent Monitoring and Release Ponds has been designed to enable contingency in water storage (i.e., three ponds of 3,300 m^3 capacity).

No other routine mine-related discharges to other receiving environments are proposed during Operation. Water management infrastructure will collect and divert all site process and contact water, as well as water associated with the ISR process, through the site IWWTP. Any excess water not required for the ISR process will be directed to the IWWTP. Treated water from the IWWTP will be pumped to the Effluent Monitoring and Release Ponds.

Parameters where the available assimilative capacity is less than the maximum predicted discharge concentration when screening criteria subject to background water quality include sulphate, chromium, molybdenum, and selenium. For chromium and selenium, the assessment was influenced by datapoints with values below the detection limit. However, these are conservative estimates which are not yet based on BATEA. Treated water in the Effluent Monitoring and Release Ponds will be monitored prior to release to Whitefish Lake. The treated effluent discharge line will be heated and have secondary containment in place. Estimated total hazard quotients (HQs) for all COPCs, with the exception of copper, for all aquatic biota are predicted to remain below the HQ benchmark of 1. HQs for copper remain below 1 for forage fish. HQs slightly exceed 1 for benthic invertebrates (all locations) and predatory fish (Whitefish Lake Middle and South) under baseline conditions (for hardness and pH). Under site operational conditions during periods of treated effluent discharge, the HQs for copper are below 1 for all locations and aquatic biota. These results indicate an acceptable level of risk via the direct exposure pathway to the receptors (Appendix 10-A in Section 10).

Local Indigenous communities have expressed direct concern with respect to mercury. Mercury has not been identified as a COPC for the Project as it is currently not present in the receiving environment (i.e., background condition) at detectable concentrations and will not be produced as part of the mine process; therefore, it will not be discharged to the aquatic environment.

As described above, the site-wide water management strategy involves care and control of all site process and contact water, and no discharge is proposed beyond that to Whitefish Lake. In practice, it may be necessary at times to manage runoff from disturbed areas that are either outside the water management system or are yet to be integrated into the water management system. In these cases, the areas would be isolated and specific water and sediment control management practices would be implemented to make sure any water released to natural surface water drainages is suitable for release such that the water quality in these natural surface water drainages is protected.

Changes in surface water levels (±0.01 m) and flows (maximum of -3.1% occurring at the LA-5 and SA-2 nodes during Operation) are expected to be less than the variation of natural environmental flows. As such, these changes are not expected to have a significant effect on sediment movement and/or benthic invertebrate habitats.

The effluent pipeline and diffuser will be operational during Operation and continue to constitute a less than 0.05% overprint of the receiving lake's (i.e., Whitefish Lake South) surface area.

Decommissioning/Post-Decommissioning

Following the cessation of mining operations, discharge to Whitefish Lake will continue until the end of Decommissioning upon which it will cease. Water quality in Whitefish Lake is expected to return to pre-mining conditions following Decommissioning.

The site-wide water management system will continue to operate during Decommissioning such that Denison will remain in control of site aspect affected water via the IWWTP. At that time, water (runoff) from the ISR wellfield, and contact water from the developed portion of the site (e.g., contaminated runoff pond, landfill pond, process water pond), will continue to be collected and diverted to the IWWTP. From the IWWTP, the water will be directed back to the ISR wellfield to be pumped as clean water to ground or pumped to the Effluent Monitoring and Release Ponds for monitoring prior to discharge to Whitefish Lake.

Following Decommissioning, piping infrastructure will be removed and discharge to surface water will cease. Therefore, effects on sediment quality and the benthic invertebrate community are bounded by the Operation scenario. Partitioning of COPC from surface waters to sediment will cease and any changes to sediment will be monitored during Decommissioning.

Residual effect characteristics specific to the Fish and Fish Habitat VC are defined in Table 8.3-8 with evaluation of residual effects provided in Table 8.3-9, Table 8.3-10, Table 8.3-11.

Table 8.3-8: Fish and Fish Habitat – Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Effect moves MPs in a direction detrimental to Fish and Fish Habitat that may affect ecological integrity (i.e., fish populations). *Water Quantity* – Effect moves MPs (flow or water level) in a direction detrimental to water quantity relative to baseline conditions. A Project-related increase in surface water flows and levels during flooding, or a decrease in surface water flow below environmental flow requirements. *Water Quality* – An increase in constituent concentrations attributable to the Project in comparison to baseline conditions and trends. *Fish Habitat* – A physical loss of available fish habitat (aerial extent) in comparison to baseline conditions. **Positive** – Effect moves MPs in a direction beneficial to Fish and Fish Habitat. An improvement in water quality in comparison to baseline conditions and trends or an increase in the aerial extent of fish habitat.
Magnitude	The amount of change in a MP relative to baseline conditions.	**Low** – A measurable change that is not within the variability of baseline conditions but below relevant water quality objectives and criteria. A Project-related change in hydrology (flows or levels) compared to baseline

Residual Effect Characteristic	Definition	Rating
		conditions, but where the change is <5% from baseline conditions, or a small measurable change in habitat (ha). **Moderate** – A measurable change in habitat area (ha). A measurable change in water quality that is not within the variability of baseline conditions and not within applicable guidelines, legislated requirements, and/or federal and provincial management objectives. A Project-related change in hydrology (flows or levels) compared to baseline conditions, but where the change is >5% from baseline conditions, and could, therefore, have an adverse effect on Fish and Fish Habitat within the LSA. **High** – A measurable change in habitat area (ha), monthly flows (>10%), or lake surface elevation (m) in a waterbody or watercourse that is greater than the range of natural variability and large enough that fish can no longer rely on this habitat to carry out one or more of their life processes. A measurable change in water quality that is not within the variability of baseline conditions and not within applicable guidelines, legislated requirements, and/or federal and provincial management objectives and is likely to have an adverse effect on Fish and Fish Habitat within the LSA, with the effect extending beyond the LSA.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is expected to be limited to the Project Area. **Local** – Effect is expected to be limited to the Fish and Fish Habitat LSA. **Regional** – Effect is expected to extend beyond the Fish and Fish Habitat LSA into the Fish and Fish Habitat RSA. **Beyond Regional** – Effect is expected to extend beyond the Fish and Fish Habitat RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect predicted to happen during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect predicted to happen from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect predicted to extend beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect expected to occur several times at sporadic intervals. Effect not expected to occur during critical life stages (e.g., outside of the fish migration, spawning, and nursery [larval] stages). **Frequent** – Effect expected to occur many times on a regular basis. Effect may occur during a lower sensitive period of a critical life stage; for many species, this is the start (e.g., during early phases of the migration period). **Continuous** – Effect expected to occur continuously and, therefore, during critical life stages (e.g., the fish migration, spawning, and nursery [larval] stages).
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that is expected to diminish to baseline conditions. **Partially Reversible** – A residual effect that is expected to partially diminish to baseline conditions. **Irreversible** – A residual effect that is not expected to diminish to baseline conditions.
Context	The extent to which the VC or KI has been affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-	**Low** – VC/KI is predicted to have a high resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or a lack of historic and ongoing anthropogenic or natural disturbance. **Moderate** – VC/KI is predicted to have a moderate resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or an intermediate level of

Residual Effect Characteristic	Definition	Rating
	related residual effect, and its ability to recover from that effect (i.e., resilience).	historic or ongoing anthropogenic or natural disturbance with the capacity to assimilate more change. **High** – VC/KI is predicted to have a weak resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or a high level of historic or ongoing anthropogenic or natural disturbance.
Likelihood	Likelihood that the residual effect will occur, including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability that the residual effect will occur. **Unlikely** – A low probability that the residual effect will occur.

Table 8.3-9: Fish and Fish Habitat – Summary of the Residual Effect Characteristics for Surface Water Quality

Residual Effect Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project (specifically the discharge of effluent to the natural environment) will cause a change in the concentration of constituents, as measured as a mass of a chemical per unit volume in water (e.g., mg/L). Surface water quality in the local receiving environment will be adversely affected by effluent discharge to the aquatic environment, thereby providing a pathway to adversely affect Fish and Fish Habitat.
Magnitude	Moderate	The magnitude of the residual effect is predicted to be low overall as the vast majority of constituents that may be introduced as part of Project activities are expected to remain below criteria for the protection of aquatic life and human health. However, with the exceedance of the Cu FEQG and in response to Round 4 IR-114, the overall rating was conservatively changed to moderate. We note that the copper values in the EIS have been overpredicted in the models for a number of reasons including the fact that the baseline water quality analytical detection limit for copper was equal to the Cu FEQG. Additionally under site operational conditions (hardness and pH) during periods of treated effluent discharge, HQs for all COPCs for all aquatic biota are predicted to remain below the HQ benchmark of 1, indicating an acceptable level of risk via the direct exposure pathway to the receptors.
Geographic Extent	Local	The geographic extent of the residual effect is predicted to be confined to the immediate waterbody adjacent to the Project (i.e., Whitefish Lake). The estimated mixing zone is less than 5 m, implementing an effluent discharge configuration that promotes mixing.
Duration	Long-term	The residual effect is expected to last between 3 to 38 years (i.e., effect expected during Construction through to the end of Post-Decommissioning).
Frequency	Continuous	For the purposes of this EIS, a conservative scenario was identified, with effluent discharge being considered as continuous during Operation and Decommissioning.
Reversibility	Fully reversible	Surface water quality is expected to return to pre-development levels following Post-Decommissioning as Project-related sources will cease to operate.
Context	Low	Fish health is expected to be resilient to changes in surface water quality in the context of this assessment, as COPC meet protective criteria even at the extreme low water scenario. Therefore, under applicable mitigative measures and average flow conditions, the contextual resilience of the aquatic system to respond to change is considered to be great.

Residual Effect Characteristic	Rating	Summary Rationale for Rating
Likelihood	Likely	A high probability exists that a change in water quality from background conditions will occur.

Table 8.3-10: Fish and Fish Habitat – Summary of the Residual Effect Characteristics for Change in Fish Habitat

Residual Effect Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	A reduction of fish habitat by 135 m^2 is expected due to the construction of pipeline and diffuser infrastructure at LA-5.
Magnitude	Low	The magnitude of the residual effect is predicted to be low. The change in available benthic invertebrate habitat by the overprinting of substrates in LA-5 constitutes less than 0.05% of the surface area of the waterbody.
Geographic Extent	Local	The residual effect is expected to be limited to the LSA, specifically a small portion of LA-5.
Duration	Medium-term	The residual effect is expected to last between 3 to 38 years (i.e., effect expected during Construction through to the end of Post-Decommissioning).
Frequency	Continuously	Although the mine is unlikely to require water taking on a continuous basis, this has been assessed as a bounding scenario and, as such, must be considered as a continuous effect.
Reversibility	Fully reversible	Following decommissioning and removal of the pipeline and diffuser, the available habitat will be restored to natural conditions.
Context	Low	The Fish and Fish Habitat VC is expected to have a high resiliency with respect to physical disturbance in the context of a small, localized area being altered or disturbed. It is not expected that the ecological integrity of the areas adjacent to the infrastructure will be affected and, as such, will provide for sources of re-distribution and recolonization following Post-Decommissioning.
Likelihood	Likely	The infrastructure associated with the pipeline and diffuser are likely to affect the localized area for which they overprint.

Table 8.3-11: Fish and Fish Habitat – Summary of the Residual Effect Characteristics for Change in Surface Water Quantity (Hydrology)

Residual Effect Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Water quantity (flow and level) will be reduced in LA-5 as a result of the overprinting of its reporting drainage area by mine infrastructure and through site water balance. Water taking has an additional potential to reduce water levels in LA-5.
Magnitude	Low	The magnitude of the residual effect is predicted to be low. Under all scenarios, the Project-related change in hydrology (flows or levels) compared to baseline conditions is less than 5% of baseline conditions, and generally less than 3%.
Geographic Extent	Local	The residual effect is expected to be limited to the LSA, specifically the lakes within proximity to the Project site (i.e., LA-5, LA-6, and LA-1).
Duration	Moderate	The residual effect is expected to last between 3 to 38 years (i.e., effect expected during Construction through to the end of Post-Decommissioning).

Residual Effect Characteristic	Rating	Summary Rationale for Rating
Frequency	Continuously	Although the mine is unlikely to require water taking on a continuous basis, this has been assessed as a bounding scenario and, as such, must be considered as a continuous effect.
Reversibility	Fully reversible	Surface water hydrology is expected to return to pre-development levels following Post-Decommissioning.
Context	Moderate	Surface water flow regimes are variable, and it is this variability that provides for morphological form to be maintained and for ecological reliance (i.e., fish habitat, fish movement, and life-cycle success). Some change to environmental flows is tolerated by fish populations.
Likelihood	Low	Due to the localized nature and low magnitude of the effect on surface water hydrology, the likelihood of an effect is considered to be very low; therefore, the likelihood of an effect on Fish and Fish Habitat is expected to be low.

8.3.6.2 Significance and Confidence

The significance of the residual effect is rated as **not significant** or **significant**, based on the following:

Not significant – a residual effect that is not expected to result in a change to a VC/KI that would alter its population viability or persistence beyond an acceptable level (e.g., where it is not sustainable or is unavailable to contribute to biodiversity and ecosystem function).

Significant – a residual effect that is expected to result in a change to a VC/KI that would alter its population viability or persistence beyond an acceptable level (e.g., where it is not sustainable or is unavailable to contribute to biodiversity and ecosystem function).

The threshold for significance for the Fish and Fish Habitat VC relates to predicted changes in the concentrations of water quality parameters, where changes could result in exceedances of relevant water quality benchmarks that are protective of aquatic biota in waterbodies that receive mine-affected drainage. The threshold for significance for Fish and Fish Habitat also includes predicted changes in surface water flows greater than baseline environmental flows and direct habitat loss.

The significance of the residual effects on the Fish and Fish Habitat VC has been deemed **not significant.** Following mitigation, the residual effects are not expected to cause a change in Fish and Fish Habitat (or associated KIs) to the extent that they might alter the ecological integrity of the VC in the LSA beyond an acceptable level.

The predicted confidence with respect to the Fish and Fish Habitat VC is high as the mobilization of suspended materials can be readily mitigated, making the effects prediction relative to this effect pathway easily understood.

Confidence in the assessment of predicted effects on water levels or flow is quite high due to available hydrological data for the LSA. Uncertainty is minimal with the assumptions that the water withdrawal and discharge scenarios presented herein represent the bounding case, and hydrogeological modelling projections are not changed (Section 8.1).

Potential effects on water quality as a result of Project discharges to local receiving environments were assessed by way of numerical modeling. These predictions are generally considered conservative in nature because the assumptions on which they are based are conservative. For example:

- The assessment is based on a continuous (year-round) discharge at an expected average effluent rate of 0.0101 m^3/s (36.5 m^3/hr) throughout Construction, Operation, and Decommissioning, despite the likelihood that effluent discharge will not be continuous and will only discharge when site water balance requires, based on water storage capabilities.
- The constituents in effluent discharge have been estimated conservatively. Presented discharge concentrations provided herein include contingency factors of one to three times.
- Baseline water quality is defined by the 95th percentile concentrations of individual constituents. Such an assumption is conservative as it constrains the assimilative capacity associated with the receiving environment. By definition, the assimilative capacity of a receiving environment is equal to the incremental difference between the existing baseline condition and the assessment benchmark (i.e., water quality criterion) on which the evaluation is based. Use of the 95th percentile concentration, rather than a measure of central tendency (i.e., 50th percentile, geomean), means that the incremental change in a given constituent concentration that can be assimilated by the receiving environment (whereby use of the receiving environment is protected) is relatively small in magnitude.

Due to the conservative nature of the assumptions on which the numerical assumptions are based, a high degree of confidence can be assumed.

8.3.6.3 Summary of Project-related Residual Adverse Effects on Fish and Fish Habitat

Residual adverse effects on Fish and Fish Habitat are expected to occur during Construction, Operation, and Decommissioning through pathways previously identified. A summary of the Project-related residual effects on Fish and Fish Habitat is provided in Table 8.3-12.

Table 8.3-12: Project-related Residual Effects on Fish and Fish Habitat

Residual Effect	Residual Effect Characterization									
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance Determination
Change in Water Quality	C, O, D	A	M	L	LT	C	FR	L	L	NS
Change in Aquatic Habitat (Area)	C, O, D	A	L	L	MT	C	FR	L	L	NS
Change in Water Level or Flow	C, O, D	A	L	L	MT	C	FR	M	L	NS

Notes:

Project Phase: Construction (C), Operation (O), Decommissioning (D)
Direction: Adverse (A), Positive (P)
Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Project Area (PA), Local (L), Regional (R), Beyond Regional (BR)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (I), Frequent (F), Continuous (C)
Reversibility: Reversible (FR), Partially Reversible (PR), Irreversible (I)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (U), Likely (L)
Significance: Not Significant (NS), Significant (S)

8.3.7 Cumulative Effects

The spatial and temporal boundaries of the Project specific to the Fish and Fish Habitat VC are provided in Section 8.3.1.3. A description of the methods used in assessing cumulative effects is provided in Section 5.9 in Section 5. Cumulative effects associated with changes to wetlands are further discussed in Section 9.2.7 in Section 9.

8.3.7.1 Potential Cumulative Effects

Existing projects within the Wheeler River system have been considered for their potential to interact with the Fish and Fish Habitat VC for the Project. These include reasonably foreseeable projects that are listed in Section 5.9.

The Cameco Key Lake Operation has the potential to interact with the Fish and Fish Habitat VC for the Project (Figure 5.9.1) via the surface water quality pathway. The site has been in operation since 1983. In 2018, sustained low uranium prices resulted in a decision to curtail production for the foreseeable future and place the operation into safe care and maintenance. On February 9, 2022, Cameco announced plans for the operation's gradual return to production. Cameco's Key Lake Operation will overlap spatially and temporally with the Project.

The Project is situated approximately 35 km northeast of the Key Lake Operation and both are located in watersheds that ultimately report to Russell Lake. Releases to the aquatic environment from the Key Lake Operation are received by the David Creek, McDonald Creek, and Outlet Creek drainages. These three drainages join the Wheeler River, which then flows to Russell Lake (Cameco 2020). Therefore, a potential spatial overlap was identified for the Project and the Key Lake Operation and further assessed or cumulative effects.

The assessment of cumulative effects on the Surface Water Quality VC considered releases from the Project and the Key Lake Operation during all phases of the Project. The key Project component contributing to potential cumulative effects is the discharge of treated effluent to the aquatic environment during Operation and Decommissioning which may interact with Cameco's current releases to water including treated water released to David Creek drainage, treated groundwater and diverted surface water to the McDonald Creek drainage (Cameco 2020).

The key potential cumulative effect pathway as it concerns the Fish and Fish Habitat VC is the surface water exposure pathway. The assessment of potential cumulative effects on the Fish and Fish Habitat VC considered releases to surface water from the Project and the Key Lake Operation during all phases of the Project.

Temporal overlap of the Key Lake Operation and the Project will also occur during 'future centuries' as described as 'post-decommissioning phase' in the Key Lake Extension Project EIS (Cameco 2020). There is potential for increased contaminant transport via groundwater to surface water during the long-term, post-decommissioning phase (i.e., 10,000 years after operations cease and the site has been reclaimed) for the Key Lake Operation. The long-term storage of tailings at a higher elevation has the potential to influence contaminants in the groundwater and incrementally add to the effect on surface water quality in the Outlet Creek Drainage.

Operation and Decommissioning

The assessment of cumulative effects on the aquatic environment considered releases from the Key Lake Operation and proposed Project during all phases of the Project. The primary Key Lake

Operation component contributing to potential cumulative effects is the placement of tailings to a higher elevation in the Deilmann Tailings Management Facility (DTMF). The increased loadings from the DTMF are anticipated to result in an incremental (i.e., existing conditions plus the Project) increase of concentrations of COPCs in the aquatic environment (Cameco 2013). The spatial extent of any significant adverse effects on the aquatic environment from the Key Lake Operation were anticipated to be localized and not to extend to the Wheeler River and Russell Lake during any phase of the Project (Cameco 2013). The 2010 Status of the Environment report for the Key Lake Operation identified that no adverse effects to individual fish or fish populations are present in the Wheeler River (EcoMetrix 2010 as cited in Cameco 2020).

Potential Project residual effects on surface water quality relate to changes (increases) in constituent concentrations that are related to the controlled discharge of Project site waters into local receiving environments (Whitefish Lake). Such changes are predicted to be negligible to low in magnitude and limited to the LSA. For example, during Construction, no discharge from the Project site is planned. During Operation, treated effluent will be discharged to Whitefish Lake. The Whitefish Lake discharge will be the only routine discharge location during Operation. Water quality and sediment quality in Whitefish Lake and, by extension, sediment quality downstream of Whitefish Lake, are expected to meet appropriate benchmarks for the protection of aquatic life in consideration of a small mixing zone in the lake, which is anticipated to remain within tolerable HQs for fish. Following Decommissioning and the restoration of drainage patterns that are similar to pre-mining conditions, water quality is expected to meet appropriate benchmarks for the protection of aquatic life in Whitefish Lake and downstream. This includes Russell Lake of which the Icelander River system is associated.

In consideration of the above discussion, effects on the aquatic environment due to changes in surface water quality from the Key Lake Operation are not anticipated to spatially overlap with those from the Project and therefore a cumulative effect is not expected.

Future Centuries

The 2013 Key Lake ERA indicated that during the 10,000-year post-decommissioning period, predicted exposure levels may affect lower trophic level aquatic biota on a population or community level within some isolated lakes in the SSA, but adverse effects on the ecology of the Outlet Creek drainage, and therefore further downstream were not expected during the post-decommissioning phase (Cameco 2013). The results of the 2020 ERA for the Key Lake Operation were consistent with the findings from the 2013 ERA in that there were limited significant risks posed to aquatic receptors situated in the area surrounding the Operation, but not to areas farther downstream. The 2020 ERA concluded that environmental health in the vicinity of the Key Lake Operation will remain protected (Cameco 2020).

The results of the numerical modelling for the Project, as provided in Section 7 and Appendix 10-A in Section 10, support the conclusion that with the implementation of appropriate mitigation during the decommissioning and mining area remediation phase of the Project, the residual effects of the Project on the intermediate Groundwater VC will not result in an adverse effect to surface water or fish. Dissolved constituent concentrations emanating over hundreds to thousands of years in the future ("Future Centuries") from the mining area to Whitefish Lake will be localized to that waterbody and remain below fresh water environmental quality criteria. As such, impacts to downstream portions of the drainage and fish and fish habitat therein and including Russell Lake are not expected.

In consideration of the above discussion, effects on the aquatic environment due to changes in surface water quality from the Key Lake Operation are not anticipated to spatially overlap with those from the Project and therefore a cumulative effect is not expected.

8.3.7.2 Additional Mitigation Measures

Additional mitigation measures are not warranted as no cumulative effects are expected on the Fish and Fish Habitat VC.

8.3.7.3 Cumulative Effects Characterization and Determination of Significance

A determination of significance is not warranted as no cumulative effects are expected on the Fish and Fish Habitat VC.

8.3.7.4 Cumulative Effects Assessment Summary

Effects to Fish and Fish Habitat VC due to changes in surface water quality from the Key Lake Operation are expected to remain localized and not extend to the Wheeler River system or Russell Lake. Likewise, impacts on surface water quality from the Project are expected to remain localized (Whitefish Lake) and not extend to Russell Lake. Effects on the aquatic environment due to changes in surface water quality associated with the Key Lake Operation are not anticipated to spatially overlap with those from the Project during operation/decommissioning or during "future centuries" and therefore a cumulative effect is not expected.

8.3.7.5 Environmental Monitoring and Follow-up

Specific monitoring and follow-up for Fish and Fish Habitat related to cumulative effects is not warranted as no cumulative effects are expected on the Fish and Fish Health VC. Monitoring and follow-up specific to the Project is detailed in Section 8.3.8.

8.3.7.6 Climate Change Considerations

As discussed in Section 8.1.7.5, the frequency and magnitude of extreme precipitation events have the potential to change water levels and flows in the RSA, which may affect water quality, sediment transport, deposition, and, therefore, fish habitat. Changes to average and upper and lower bounds of ambient temperatures may also affect aquatic habitat, which in turn may affect fish and their food resources. Climate change over the life of the Project (i.e., 35 to 40 years) will be monitored as part of the Project's environmental monitoring programs, and influences on water quality, sediment quality, benthic invertebrates, and fish and fish habitat will require adaptive management to mitigate any potential effects of the Project that may be exacerbated by climate-related changes on the aquatic environment.

8.3.8 Monitoring and Follow-up

For the purposes of this EIS, monitoring and follow-up are defined as follows:

- monitoring programs are designed to meet regulatory requirements (e.g., permit or license conditions) and/or to demonstrate compliance with environmental commitments made in the EIS; and
- follow-up programs are designed to address any uncertainties identified during the EA process (e.g., to verify predictions made during the EA; determine the effectiveness of proposed and implemented mitigation measures) and to determine if and when to implement adaptive management measures.

Monitoring and follow-up are proposed for the Fish and Fish Habitat VC to verify the accuracy of the predicted effects and the effectiveness of the proposed mitigation measures. The fish and fish habitat monitoring program should be considered in conjunction with the surface water quantity (hydrology) (Section 8.1.8), surface water quality (Section 8.2.8), sediment quality and benthic invertebrates (Section 8.4.8), and fish health (Section 8.5.8) monitoring programs as it is specifically tied to these monitoring programs from the perspective of pathways of effects. Specifically, monitoring of water quality in the effluent monitoring ponds and other catchment ponds prior to discharge to the environment will be important to provide context to further evaluate Project-related effects on Fish and Fish Habitat in the receiving water environment (i.e., Whitefish Lake).

The fish and fish habitat monitoring and follow-up program will have the following objectives:

- collecting and recording surface water quality data to confirm that source and receiving water quality predictions for mobilization of solids are consistent with those presented in the EIS;
- monitoring to confirm that effluent and receiving water quality meet applicable regulation criteria;
- monitoring changes in fish communities/populations within the Project LSA; and
- monitoring changes in physical fish habitat within the receiving environment of LA-5.

Fish and fish habitat monitoring will occur in tandem with water quality, sediment quality, benthic invertebrate, and fish health sampling. Sampling locations will be co-located to facilitate comparison to water quantity, water quality, and sediment quality characteristics.

Changes in fish communities/populations will be assessed through comparison of Construction, Operation, and Decommissioning results to pre-development conditions, as well as through contemporaneous comparison of “exposure area” versus “reference area” data. In this context an “exposure area” is an area downstream of potential mine influence and a “reference area” is an area outside of potential mine influence. Where possible, the reference area would be located in the same drainage, upstream of mine influence where conditions closely mimic those downstream as is possible and where there is no, or reduced likelihood that exposure and reference fish populations can co-mingle. Fish and fish habitat monitoring will include collection of metrics associated with species presence, abundance, and life history parameters (e.g., survival, condition, growth) to meet applicable agency guidance (i.e., MDMER and CSA N288.4-19 [CSA Group 2019]).

Specific monitoring and follow-up plans for the Fish and Fish Habitat VC will be prepared to refine and finalize the approach and specific metrics following consultation with Indigenous groups, other stakeholders, and relevant federal and provincial agencies with interest in the development and implementation of this VC-specific program

8.3.9 Fish and Fish Habitat Summary

The Fish and Fish Habitat VC was selected for inclusion in the assessment as Project activities have the potential to cause erosion-driven mobilization of suspended sediment. Project activities are also expected to discharge effluent to the natural environment, overprint fish habitat, and locally increase access to fisheries resources throughout multiple phases of the Project. Furthermore, inclusion of the Fish and Fish Habitat VC is vital due to its importance to Indigenous peoples from a cultural and subsistence perspective.

Fish and fish habitat surveys were completed in the LSA and RSA for identified river, stream, and lake features that support a variety of fish species, including Lake Trout, Lake Whitefish, Northern Pike, Walleye, Yellow Perch, Arctic Grayling, and several sucker and forage fish species. With the help of IK, LK, and in-field surveys, critical spawning and nursery habitats for keystone species were identified and summarized for the LSA, specifically for Whitefish Lake and Russell Lake. Baseline conditions for the Fish and Fish Habitat VC were assessed in conjunction with baseline information specific to the Surface Water Quantity and Surface Water Quality VCs due to the interconnected nature of these VCs.

Project activities may interact with the Fish and Fish Habitat VC including wetlands during all Project phases. In general, the interactions were characterized as being primarily associated with controlled, routine discharges from the site and mobilization of suspended material into natural surface water features as a result of land disturbance and clearing. During Operation and Decommissioning, excess water from the effluent monitoring ponds will be released to the environment. Routine discharge of this sort will be directed to Whitefish Lake only. Changes in surface water quality due to effluent discharge may affect the water chemistry and temperature of Whitefish Lake. The installation of the pipeline and diffuser structure will result in the overprinting of a small proportion of the Whitefish Lake substrate (less than 0.05%). No other alteration, disruption, or destruction of aquatic habitat in the LSA is expected. Changes in fish populations resulting from increased fishing pressure following improved accessibility due to the development of access roads are possible.

To minimize the residual effects of the Project on the Fish and Fish Habitat and Wetlands VCs, Denison will develop and implement a Surface Water Management Program that includes an integrated framework to manage water quality and water management practices for each of the primary site aspects and areas of the site where contact water is expected. This plan will include the collection and monitoring of contact water to determine whether treatment is required prior to release to the environment, which will inform optimal levels of treatment. This plan will also include the monitoring and management of effluent, including contingency for effluent treatment as may be required so that water discharge objectives are achieved as defined by applicable provincial and federal regulatory instruments. These measures are expected to mitigate effects associated with mobilization of solids and changes to water and sediment quality that may affect the Fish and Fish Habitat VC. Denison will design the discharge diffuser/outfall to have the smallest footprint possible while still providing effective mixing and dilution such that discharge flows do not detrimentally affect fish lifecycle processes.

Construction of the access road will involve the installation of two stream crossings. These stream crossings are located at the historical watercourse crossings along the proposed airstrip access road. These crossings will be constructed as clear-span bridges, and their mitigative design will provide for protection of the Fish and Fish Habitat and Wetlands VCs. A lack of transportation to fishing areas will minimize the geographic extent of any workforce fishing, and a lack of facilities to store or cook fish will limit the quantity of harvest.

The assessment predicted residual effects on the Fish and Fish Habitat VC due to change in water quality (including temperature), change in sediment quality, change in aquatic habitat (aerial extent), and change in fish harvest. However, with the implementation of appropriate mitigation measures, the predicted residual effects were characterized as low magnitude, localized, and fully reversible, and are, therefore, anticipated to be **not significant**.

Potential residual effects from releases of treated mine water or from potential releases associated with solids mobilization from the Project Area are expected to be spatially limited to LA-5 (Whitefish Lake) and are not expected to extend downstream to the Wheeler River. Alteration of fish habitat is expected to be localized and of small spatial extent. No interactions with existing and reasonably foreseeable activities are expected over the Project timeline; therefore, no cumulative effects are expected on Fish and Fish Habitat.

Monitoring for the Fish and Fish Habitat VC including wetland features will occur to verify the accuracy of the predicted effects and the effectiveness of the proposed mitigation measures. Effluent and receiving water quality monitoring will be conducted as per federal and provincial regulations and will include radiological and non-radiological parameters. Monitoring of the biological environment will be undertaken to meet federal and provincial regulations (e.g., MDMER environmental effects monitoring program) and will occur in consultation with Indigenous groups. Monitoring of worker habits in relation to fisheries resources may be applicable to allow for adaptive management of the Fish and Fish Habitat VC.

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8.4 Sediment Quality and Benthic Invertebrates

This section addresses the potential effects of the Project on the Sediment Quality and Benthic Invertebrates VCs. The following are discussed herein as part of the EA:

- scope of the assessment;
- summary of existing conditions relevant to the VCs;
- identification and description of potential interactions between the Project and the VCs;
- identification and description of mitigation measures applicable to the VCs to eliminate, reduce, or control the potential adverse Project-related effects;
- identification and characterization of predicted Project-related residual effects on the VCs after mitigation;
- characterization of significance and assignment of the level of confidence in the predictions; and
- identification and characterization of potential cumulative effects.

Figure 8.4-1 is a graphic representation of the assessment process used in this EIS.

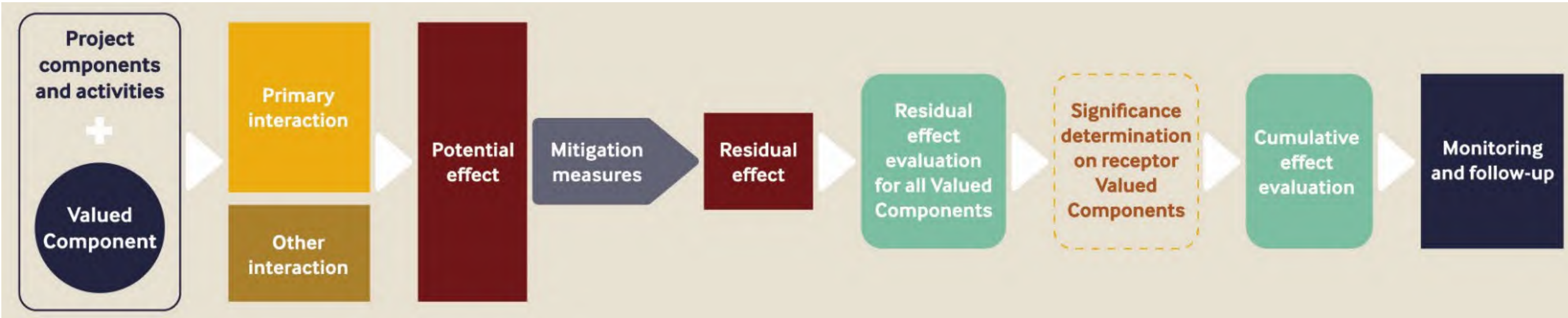

Figure 8.4-1: Environmental Assessment Process for the Wheeler River Project

8.4.1 Scope of the Assessment

The purpose of this assessment is to assess potential changes to sediment quality and benthic invertebrate communities (as represented by the Sediment Quality and Benthic Invertebrates VCs) in consideration of all Project phases at the Project, local, and regional study area scales. Pathways affecting Sediment Quality and Benthic Invertebrates are directly associated with potential changes to the Surface Water Quantity (hydrology) and Surface Water Quality VCs. Changes to flow and water quality may directly or indirectly affect how constituents partition sediments. Similarly, benthic invertebrates may be directly or indirectly affected by changes to flow and water quality, as well as changes to sediment quality arising thereof. The assessment approach reflects these connections within the aquatic environment, as the significance determination for Surface Water Quality and Water Quantity VCs are conducted at the Sediment Quality and Benthic Invertebrate VCs and also the Fish Health, and Fish and Fish Habitat VCs. Pathways that are of interest include those associated with site clearing and the potential for erosion-driven mobilization of suspended sediment into local surface waters, groundwater interactions with surface water features, and effluent discharge to the receiving environment.

8.4.1.1 Valued Component Selection

The process and rationale for the selection of VCs and the establishment of KIs and associated MPs is described in Section 5. This section addresses Sediment Quality and Benthic Invertebrates together as they are directly associated with one another. Benthic sediments are the medium benthic invertebrates inhabit for all or a considerable portion of their life cycles, and benthic sediments provide a forage base for benthic invertebrates. The physical and chemical attributes of benthic sediments directly influence benthic invertebrate community distribution, diversity, abundance, and health. The Sediment Quality and Benthic Invertebrates VCs were selected for inclusion as it has the potential to be affected by Project-related activities that result in erosion-driven mobilization of suspended sediment, groundwater interactions with surface water features, and effluent discharge to the natural environment. Potential changes to water quantity and quality are key considerations within the EA process, as demonstrated by previous uranium mining development proposals in the Athabasca Basin, that draw a high level of concern from Interested Parties (see Section 8.1.2 and 8.2.2). Changes to surface water quality have the potential to influence sediment particle size, chemistry, and distribution within the aquatic environment, which in turn may influence biodiversity and biological function. Such effects are of interest with respect to cultural values of Indigenous groups, the public, and other stakeholders. In this context, the

Sediment Quality and Benthic Invertebrates VCs are interrelated or linked, to varying extents, to other VCs that are considered in this EIS, including:

Intermediate Valued Components

Surface Water Quantity: Surface water flow volumes and periodicity directly influence water quality, bedload movement, and sediment deposition in a waterbody. Natural and seasonal changes in precipitation, and therefore water quantity, are directly related to water quality, sediment characteristics, and benthic invertebrate distribution. Project changes to surface drainage patterns, site water balance, and effluent discharge may influence water quantity, which in turn may influence the assimilative capacity of receiving waters, the movement of sediment, and available habitat for benthic invertebrates.

Surface Water Quality: Surface water quality can affect the concentrations of constituents in sediments and may directly affect the distribution, abundance, and health of benthic invertebrates through direct exposure.

Groundwater Quantity and Quality: The quantity and quality of groundwater reporting to surface water through hydrologic connections can influence the Surface Water Quality of surface waterbodies. Partitioning of chemicals from surface waters to sediments may further affect benthic invertebrate habitat and communities.

Receptor Valued Components

Terrestrial Environment: Sediment as a habitat medium and benthic invertebrates as a food resource for terrestrial fauna are linked to the function and biodiversity of the terrestrial environment.

Fish and Fish Habitat: The sediment that benthic invertebrates inhabit is the medium responsible for their ability to carry out their life processes. Benthic invertebrates provide an important forage base for fish species. Aquatic sediments are inferred as part of the definition of fish habitat under subsection 2(1) of the *Fisheries Act, 1985* (Government of Canada 2019). Alterations to Sediment Quality or Benthic Invertebrate communities in an aquatic environment can directly affect Fish and Fish Habitat.

Fish Health: Sediment act as a habitat medium and benthic invertebrates as a food resources and, therefore, have the potential to be taken up by fish through processes such as respiration, ingestion, and absorption. As such, they can directly affect the receptor VC of Fish Health.

Land and Resource Use: Indigenous Land and Resource Use and Other Land and Resource Use are influenced by Sediment Quality and Benthic Invertebrates as they contribute to the function and biodiversity of terrestrial and aquatic flora and fauna and, subsequently, their use as natural resources by communities.

Figure 8.4-2 and Figure 8.4-3 are graphic representations of the main linkages among the Sediment Quality and Benthic Invertebrates VCs and other VCs, illustrating the flow of assessment information into and from the Sediment Quality and Benthic Invertebrates VCs.

Figure 8.4-2: Integrated Assessment Approach - Key Connections between Sediment Quality and Other Valued Components

Figure 8.4-3: Integrated Assessment Approach - Key Connections between Benthic Invertebrates and Other Valued Components

8.4.1.2 Key Indicators and Measurable Parameters

The KIs for the Sediment Quality and Benthic Invertebrates VCs are any potential changes in sediment quality (e.g., a change in the concentration or level of a constituent in sediment) or benthic invertebrate community structure and/or abundance (e.g., changes in the amount of available habitat and the quality of that habitat) from baseline conditions. The rationale and MPs for the Sediment Quality and Benthic Invertebrates VCs are provided in Table 8.4-1.

Table 8.4-1: Key Indicators and Measurable Parameters for Sediment Quality and Benthic Invertebrates

Valued Component	Key Indicator	Rationale for Key Indicator	Measurable Parameters
Sediment Quality	Sediment quantity and physical quality (particle size) from baseline conditions	Introduction of depositional solids (sedimentation) into the sediments of waterbodies as a result of the Project that are of magnitude to negatively affect aquatic biota, non-aquatic biota, or other potential uses of those waterbodies.	Change in the quantity of solids deposited on aquatic sediments directly related to the Project.
	Change in sediment quality (chemical) from baseline concentrations	Introduction of constituents into the sediments of waterbodies as a result of the Project that are of magnitude to negatively affect aquatic biota, non-aquatic biota, or other potential uses of those waterbodies.	Change in the concentration of constituents in aquatic sediments directly related to Project activities.
Benthic Invertebrates	Change in available aquatic habitat from baseline conditions	The quantitative estimation of the areal extent of fish habitat that is affected (disturbed or overprinted) by Project infrastructure (direct loss of benthic invertebrate habitat).	Aerial extent (m^2 or ha) of overprinted aquatic habitat.
	Change in sediment quality (chemical) from baseline concentrations	Introduction of constituents into the sediments of waterbodies as a result of the Project that are of magnitude to negatively affect aquatic biota of those waterbodies.	Change in the concentration of constituents in aquatic sediments directly related to Project activities, which may affect benthic invertebrate communities.
	Change to water levels or flows from baseline conditions	Project activities will result in changes to the local hydrology. A reduction or increase in flows may result due to the elimination or redirection of subwatershed area and through Project water management (i.e., water taking, storage and effluent discharge). Changes to water levels or flow may affect sediment transport and influence benthic invertebrate community structure and abundance.	Changes in water levels (m) or percent changes to flow conditions (%).

8.4.1.3 Spatial and Temporal Boundaries

Generic considerations associated with the establishment of the spatial boundaries of the assessment are described in Section 5.3.3. As it pertains to the Sediment Quality and Benthic Invertebrates VCs, the following is noted.

- The **Project Area** is the direct footprint of the Project. The Project Area represents the area within which Project activities and components may occur and, as such, represents the area within which direct physical disturbance may occur as a result of the Project, either temporary or permanent (i.e., the area of maximum physical disturbance). This area is not VC-specific, but consistent throughout the EIS for all VCs.

- The **LSA** is the area that surrounds the Project Area where both direct and indirect effects resulting from Project activities can be reasonably measured. The LSA was established to assess the potential, largely direct effects of the Project and represents the extent to which there is a reasonable potential for Project-related activities to interact with and potentially adversely affect the VC. For the Sediment Quality and Benthic Invertebrates VCs, the LSA was derived from watershed boundaries within proximity of the Project Area, including portions of watersheds that overlap the Project site, as well as areas directly downstream that may be influenced by the Project site or effluent discharge. The subwatersheds within the LSA are presented in Figure 8.4-4. This area was selected based on important waterbodies (notably Whitefish and McGowan lakes) downstream of the Project where effects may occur through all Project phases. The LSA extends from those waterbodies down to their inflows to Russell Lake.
- The **RSA** is the area that surrounds and includes the LSA and was established to assess the potential, largely indirect effects of the Project, as well as other activities, in a regional context. The RSA is large enough to capture the extent of potential effects (i.e., zone of influence) on a VC and defines the area within which cumulative effects may occur (i.e., cumulative effects assessment boundary). The RSA for the Sediment Quality and Benthic Invertebrates VCs is bounded by the regional watershed area within which the Project Area is located. The RSA for this assessment is based on the whole watershed within which the Project is located and extends downstream to include Russell Lake (Figure 8.4-4).

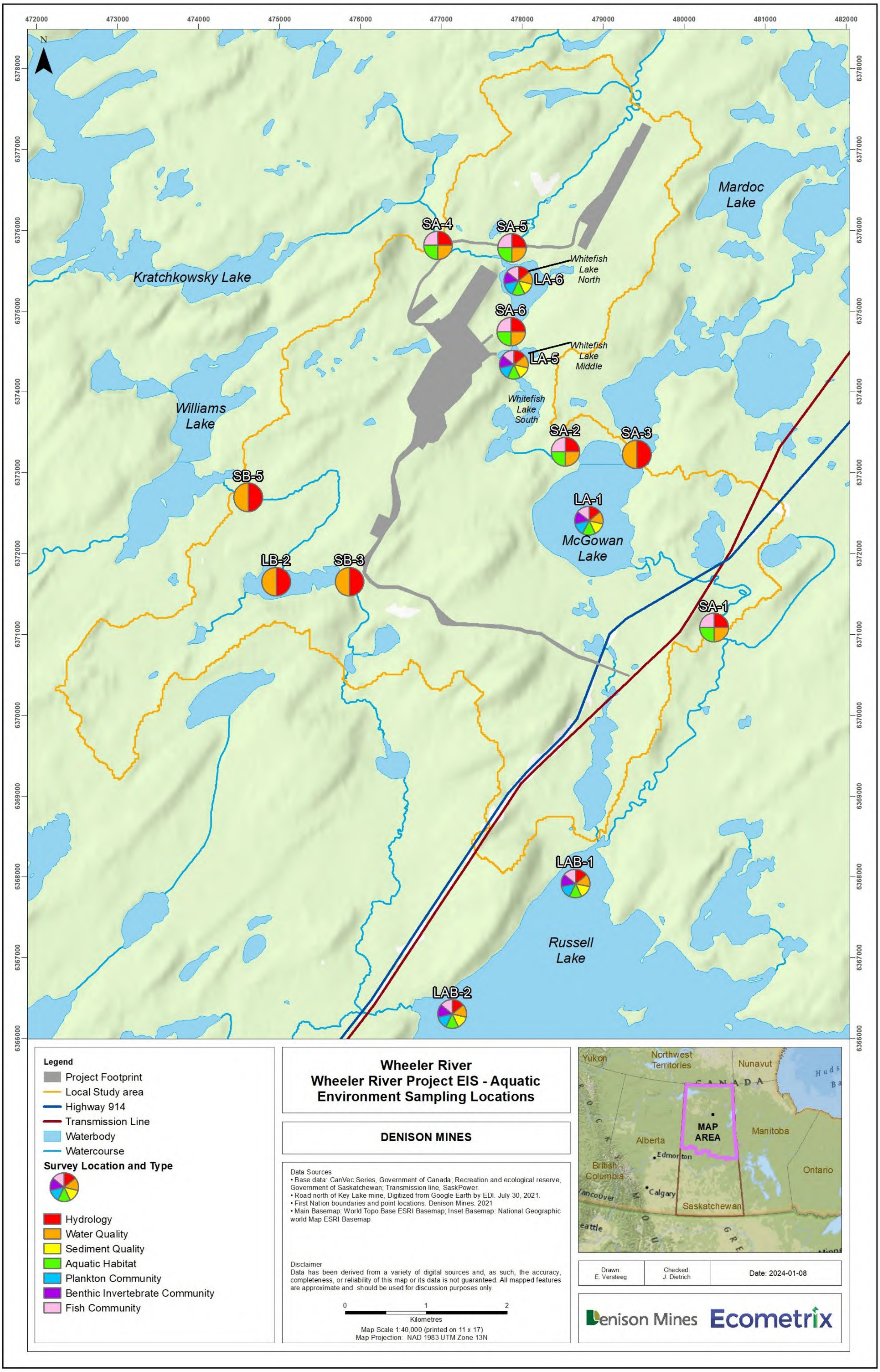

Figure 8.4-4: Spatial Boundaries for the Sediment Quality and Benthic Invertebrates Valued Components

Temporal boundaries for the EIS are defined in Table 5.3-3 in Section 5.3.4. The temporal boundaries applicable to and considered in the EIS include the following Project phases:

- Construction (Year 1 to 3);
- Operation (Year 3 to 18);
- Decommissioning (Year 18 to 23); and
- Post-Decommissioning (Year 23 to 38).

Additionally, a “future centuries” scenario is considered to assess the potential effects post-restoration (i.e., beyond the Project timeline of 0-38 years) and to reflect the time period over which the highest constituent concentrations in groundwater are predicted to migrate towards and interact with surface water.

This period represents the time where the highest constituent concentrations in groundwater are predicted to interact with surface water based on groundwater modeling. In this context, the future centuries scenario is considered with respect to the interaction of groundwater migration from the Project site and its potential influence on surface water in local water bodies. The future centuries projection encompasses the long-term period during which slow migration of groundwater from the Phoenix Ore Zone area to the surface water environment is anticipated and constitutes a bounding scenario of maximum concentrations of COPC.

8.4.2 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

The influence of IK, LK, and engagement on the Sediment Quality and Benthic Invertebrates VCs is consistent with that provided in Sections 8.1.2 and 8.2.2 (i.e., the value placed on the waterbodies and watercourses within the RSA is directly associated with the inclusive value placed on the Sediment Quality and Benthic Invertebrates VCs as parts of the aquatic environment). The intrinsic understanding and importance of aquatic environment systems to the environmental, cultural, economic, political, and spiritual conditions of Indigenous peoples were consistently reflected in the information they shared through the engagement process. In this section, IK and LK are viewed as complementary and influential alongside western science to produce a full understanding of the potential effects of the Project, whether measurable or perceived. Both forms of information have been given full and fair consideration.

The influence of IK, LK, and engagement on the assessment of the Surface Water Quantity and Quality VCs, and by extension the Sediment Quality and Benthic Invertebrates VCs, has first and foremost shaped the shared value of the aquatic environment and its life-sustaining properties.

> *“The lands and waters, we are definitely connected as peoples of English River. If we don't have the lands, we are not connected. If we don't have the water... Water is life to us”* (ERFN and SVS 2022).

Comments associated with water management and discharge to the environment were significant in the engagement record[5], and these were considered within the context of community interest regarding surface waters remaining supportive of natural function for biota. To this end, Project-related water management and treatment are important to maintaining Surface Water Quality and Sediment Quality within the LSA and RSA.

Indigenous peoples and LK holders were clear in their interest regarding current levels of constituents in the aquatic ecosystem and the potential for adverse changes resulting from the Project. For example:

> *"What is the plan for storing and cleaning the water and where does it flow? What is the impact of ISR mining on water quality?"* (21-EN-VILX-443.25).

This affirms the necessity to assess water quality and sediment quality as they inform assessments for the VCs of Benthic Invertebrates, Fish and Fish Habitat, Human Health, and Indigenous Land and Resource Use.

Denison has recorded and stored information regarding IK, LK and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 21-EN-VILX-443.25). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment. Appendix 8-A provides a summary of unique identification numbers referenced within Section 8.4.

8.4.3 Existing Environment

8.4.3.1 Methodology and Metrics

Sediment samples for physical and chemical characterization were collected in 2016 coincident with benthic invertebrate sampling in depositional environments of selected lakes. Three replicate sediment samples were collected from each lake. Sampling location coordinates were obtained with a global positioning system. Coordinates were recorded at each sampling station and expressed as degrees, minutes, and seconds (i.e., dd mm ss; WGS84 datum).

Wherever possible, surficial sediment samples were collected by coring. The surficial sediment (top 6 cm) of each core was sectioned into 2 cm increments, with the 0 to 2 cm fraction sent for analysis. A minimum of three sectioned core samples were composited at each sampling location to ensure sufficient material for analysis. Where coring was not possible due to the nature of the sediments, surficial sediment samples were collected using a petit Ponar grab, and the top 0 to 2 cm was carefully collected manually for analysis.

[5] 19-EN-MN-SR3-1.2, 19-EN-ML82-1.3, 19-EN-MOE-1.4, 18-EN-VILX-3.33, 18-EN-VILX-3.35, 18-EN-VILX-3.39, and 18-EN-VILX-3.84.

Sediments were stored in large Ziploc bags labelled with the date, depth fraction, and sample location. Excess air was removed from the bags, and the bags were kept in coolers until delivery to the Project camp where they were kept refrigerated or frozen. Samples were analyzed for the full series of chemical constituents, including:

- total organic carbon (TOC);
- nutrients (nitrogen, total kjeldahl nitrogen, and phosphorus);
- total metals (acid extractable by inductively coupled plasma); and
- grain size.

The specific parameters of interest for this assessment included grain size, TOC, phosphorus, lead, selenium, and arsenic. Sediment grain size classification followed the Wentworth scale for geometric grain size, where particles less than 4 µm are classified as clay, particles between 4 to 62 µm are classified as silt, particles between 63 to 2,000 µm are classified as sand, and particles larger than 2,000 µm are classified as gravel.

Benthic macroinvertebrate samples were collected from selected lakes for taxonomic analysis in 2016. As noted, samples were collected at the same locations from which sediment quality samples were collected. Supporting environmental/limnology measurements, including pH, water temperature, conductivity, secchi depth, and general sediment descriptions, were recorded at each location. Sampling location coordinates were obtained with a global positioning system, and coordinates were recorded at each sampling station and expressed as degrees, minutes, and seconds (i.e., dd mm ss; WGS84 datum). Detailed benthic invertebrate collection data are provided in Ecometrix (2020).

Three to five replicate samples were collected at each location, with each replicate sample comprised of a three-grab composite. Samples were collected using a petite Ponar, sieved through a 500 µm mesh, and preserved in labelled (date, sampling area) containers with 10% buffered formalin in the field. Collected samples were kept at ambient temperature until delivery to the taxonomic laboratory. Benthic invertebrate samples were processed according to standard protocols based on recommendations in Environment Canada (2012), the details of which are provided in Ecometrix (2020).

Benthic invertebrates were identified to genus for most samples. Damaged organisms and early instar invertebrates were identified to the lowest level possible (generally to family). The most common taxa were distinguishable based on gross morphology and only required a few slide mounts (five to ten) for verification. Organisms that required detailed microscopic examination for identification (i.e., Chironomidae and Oligocheata) were mounted on microscope slides using appropriate medium. All rare or less commonly occurring taxa were mounted on microscope slides for identification. Identifications were made using recognized taxonomic keys. The following benthic invertebrate community metrics were calculated:

- total invertebrate density (i.e., number of individuals per m^2);
- invertebrate richness (i.e., number of unique families);
- Simpson's Diversity (D);
- Bray-Curtis Dissimilarity Index (B-C);
- Simpson's Evenness (E);
- relative and absolute density of invertebrate taxa groups based on their feeding strategy (i.e., functional feeding groups);
- density of major invertebrate taxonomic groups (i.e., sum of individuals within each group); and
- relative density of major invertebrate taxonomic groups (i.e., proportion of individuals within each group relative to the total).

Benthic invertebrate tissue samples were collected for analysis of metals and radionuclides at selected locations in September 2016. Composite samples of multiple organisms of a common order were collected for each of the selected waterbodies. Sufficient fresh weight tissue samples of abundant macroinvertebrates were collected to ensure sufficient mass for dry weight tissue analysis. Caddisfly larvae were collected from McGowan Lake (LA-1), Whitefish Lake South (LA-5), Whitefish Lake North (LA-6), and Russell Lake (LAB-1 and LAB-2). For caddisflies, only larvae tissue was retained for analyses; casings were manually removed and discarded. Tissue samples were collected in re-sealable plastic bags and frozen until delivery to the analytical laboratory.

8.4.3.2 Key Baseline Results and Existing Conditions

Critical locations of interest for this assessment are displayed on Figure 8.4-5 and include McGowan Lake, Whitefish Lake South, and Whitefish Lake North. These locations represent lakes within the LSA that may potentially be affected by the Project. Sediment grain size results for these locations are summarized in Table 8.4-2, and sediment chemical composition results are summarized in Table 8.4-3. Detailed sediment results are provided in Ecometrix (2020). Benthic invertebrate community data are summarized in Table 8.4-4 and benthic invertebrate tissue chemistry data are summarized in Table 8.4-5.

8.4.3.2.1 Grain Size

In all three waterbodies, clay-sized fractions made up the largest proportion of the sediment (Table 8.4-2). For McGowan Lake and Whitefish Lake North, silt was the next largest proportion followed by sand. In Whitefish Lake South, sand made up the second largest proportion followed by silt. None of the samples from any of the three lakes contained gravel.

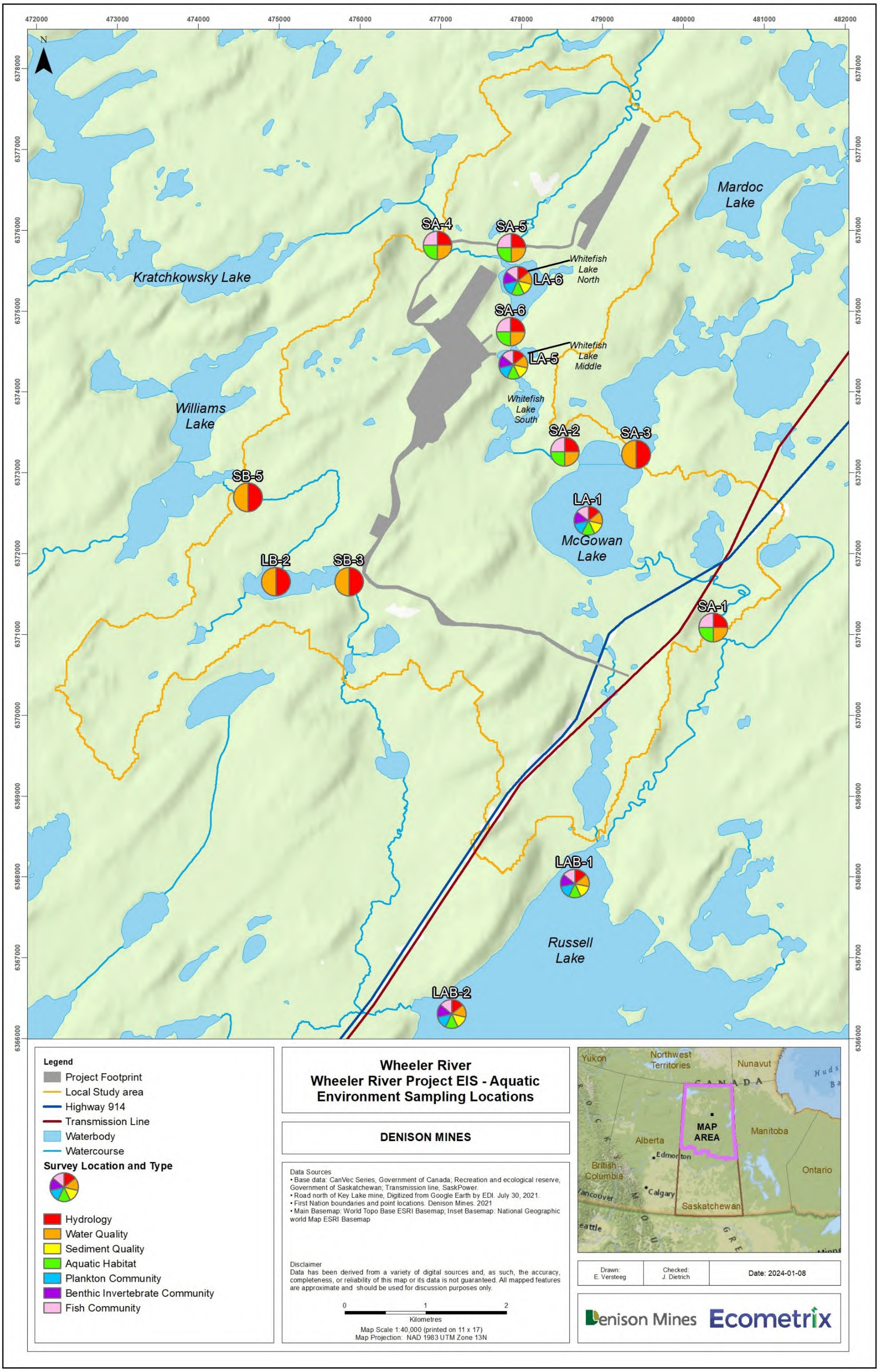

Figure 8.4-5: Water Quality, Biota, and Sediment Sampling Locations (2016 to 2018)

Table 8.4-2: Summary of Baseline Benthic Sediment Soil Classification Results for Select Lakes Within the Local Study Area

Sample Area	Soil Classification	n	Max	Min	Mean	SD
McGowan Lake (LA-1)	Gravel	3	0.0%	0.0%	0.0%	0.0
	Sand	3	0.3%	0.1%	0.2%	0.1
	Silt	3	21.6%	17.7%	20.0%	2.0
	Clay	3	82.2%	78.2%	79.8%	2.1
Whitefish Lake South (LA-5)	Gravel	5	0.0%	0.0%	0.0%	0.0
	Sand	5	77.2%	0.1%	30.8%	40.3
	Silt	5	21.7%	12.8%	17.7%	3.7
	Clay	5	82.0%	10.0%	51.4%	36.9
Whitefish Lake North (LA-6)	Gravel	5	0.0%	0.0%	0.0%	0.0
	Sand	5	12.0%	0.4%	4.0%	4.9
	Silt	5	41.8%	20.8%	27.8%	8.7
	Clay	5	78.8%	46.2%	68.2%	13.6
Russell Lake (LAB-1)	Gravel	3	0.0%	0.0%	0.0%	0.0%
	Sand	3	2.8%	0.3%	1.2%	1.3%
	Silt	3	26.8%	22.0%	24.9%	2.4%
	Clay	3	77.8%	70.4%	73.8%	3.7%

Notes:

n = number of samples; max = maximum; min = minimum; SD = standard deviation.

8.4.3.2.2 Total Organic Carbon

Average TOC was similar between McGowan Lake and Whitefish Lake North at 16% and 17.4%, respectively (Table 8.4-3). Whitefish Lake South had the lowest TOC at 10.6%. Notably, both the lowest (0.4%) and highest (18.8%) sample values came from Whitefish Lake South, indicating a higher degree of spatial heterogeneity of TOC deposition within that lake.

8.4.3.2.3 Metals

Average sediment phosphorus concentrations were nearly identical between McGowan Lake and Whitefish Lake North (1,233 ug/g and 1,232 ug/g, respectively) (Table 8.4-3). Phosphorus levels in Whitefish Lake South were significantly lower than the other lakes at 796 ug/g. Similar to TOC, samples from Whitefish Lake South contained both the lowest (50 ug/g) and highest (1,600 ug/g) levels of phosphorus of all three lakes. Average sediment lead concentrations were highest in McGowan Lake (8.9 ug/g) followed by Whitefish Lake North (7.8 ug/g) and Whitefish Lake South (4.8 ug/g). Whitefish Lake South had the lowest average sediment arsenic concentrations at 2.5 ug/g, while arsenic levels in Whitefish Lake North and McGowan Lake were 3.6 ug/g and 5.3 ug/g, respectively. Out of all metals and nutrients that were examined in the sediment samples, Whitefish Lake South contained the lowest average concentrations out of the three lakes, except for iron and sodium. Thorium isotopes (228, 230, and 232) were below the detection limit (0.02 ug/g) in every sample from all three lakes.

For parameters where sediment quality guidelines are available, all constituent concentrations were at or below their respective reference value, interim sediment quality guideline, or lowest effect level in each of the lakes.

Table 8.4-3: Summary of Baseline Benthic Sediment Chemical Composition Results for Select Lakes Within the Local Study Area

Sample Area	Parameter	Units	Sediment Quality Benchmark				n	Count Less than RDL	Min	Max	Mean
			REF/ISQG	NE2/PEL	LEL	PEL					
McGowan Lake (LA-1)	Moisture	%					3	0	96.8	97.24	96.97
	Total Organic Carbon	%					3	0	13.3	17.4	16
	Aluminum	µg/g					3	0	4,010	4,740	4,397
	Antimony	µg/g					3	0	0.2	0.3	0.2
	Arsenic	µg/g	20.8	522			3	0	5	5.7	5.3
	Barium	µg/g					3	0	30	42	35
	Beryllium	µg/g					3	0	0.2	0.3	0.3
	Boron	µg/g					3	0	5	8	7
	Cadmium	µg/g	0.6	3.5			3	0	0.3	0.5	0.4
	Chromium	µg/g	31.5	26.2			3	0	6.7	16	11
	Cobalt	µg/g					3	0	1.6	2.3	2
	Copper	µg/g	9.1	11.3			3	0	2.7	4.6	3.6
	Iron	µg/g					3	0	7,800	12,100	9,933
	Lead	µg/g	16.3	19.7			3	0	8.2	10	9
	Manganese	µg/g					3	0	140	170	153
	Molybdenum	µg/g	22.6	245			3	0	0.8	2	1
	Nickel	µg/g	21.4	326			3	0	6	12	9
	Selenium	µg/g	3.6	29.7			3	0	1	1.5	1.3
	Silver	µg/g					3	2	0.1	0.2	0.1
	Strontium	µg/g					3	0	21	25	23
	Thallium	µg/g					3	3	0.2	0.2	0.2
	Tin	µg/g					3	0	0.2	0.2	0.2

Sample Area	Parameter	Units	Sediment Quality Benchmark				n	Count Less than RDL	Min	Max	Mean
			REF/ISQG	NE2/PEL	LEL	PEL					
	Titanium	µg/g					3	0	200	280	243
	Uranium	µg/g	96.7	2296			3	0	0.7	0.8	0.8
	Vanadium	µg/g	35.1	31.8			3	0	18	22	20
	Zinc	µg/g	123	315			3	0	20	27	24
	Lead-210	Bq/g			0.9	20.8	3	0	0.54	0.75	0.67
	Polonium-210	Bq/g			0.8	12.1	3	0	0.52	0.76	0.64
	Radium-226	Bq/g			0.6	14.4	3	0	0.02	0.04	0.03
	Thorium-228	Bq/g					3	3	0.02	0.02	0.02
	Thorium-230	Bq/g					3	3	0.02	0.02	0.02
	Thorium-232	Bq/g					3	3	0.02	0.02	0.02
	Calcium	µg/g					3	0	1,400	1,600	1,533
	Magnesium	µg/g					3	0	690	830	767
	Phosphorus	µg/g					3	0	1,000	1,400	1,233
	Potassium	µg/g					3	0	820	1,000	933
Whitefish Lake South (LA-5)	Moisture	%					5	0	28.92	96.81	70.07
	Total Organic Carbon	%					5	0	0.44	18.8	10.6
	Aluminum	µg/g					5	0	1990	5,800	4,080
	Antimony	µg/g					5	5	0.2	0.2	0.2
	Arsenic	µg/g	20.8	522			5	0	0.6	4.4	2.6
	Barium	µg/g					5	0	33	49	43
	Beryllium	µg/g					5	2	0.1	0.3	0.2
	Boron	µg/g					5	2	1	6	3
	Cadmium	µg/g	0.6	3.5			5	1	0.1	0.4	0.3

Sample Area	Parameter	Units	Sediment Quality Benchmark				n	Count Less than RDL	Min	Max	Mean
			REF/ISQG	NE2/PEL	LEL	PEL					
	Chromium	µg/g	31.5	26.2			5	0	1	11	7
	Cobalt	µg/g					5	1	0.2	2.3	1.3
	Copper	µg/g	9.1	11.3			5	2	0.5	2	1
	Iron	µg/g					5	0	1980	23,500	12,486
	Lead	µg/g	16.3	19.7			5	0	1.3	7.5	4.9
	Manganese	µg/g					5	0	33	320	170
	Molybdenum	µg/g	22.6	245			5	1	0.1	0.7	0.4
	Nickel	µg/g	21.4	326			5	0	0.9	6.3	4.1
	Selenium	µg/g	3.6	29.7			5	2	0.1	0.9	0.5
	Silver	µg/g					5	3	0.1	0.7	0.2
	Strontium	µg/g					5	0	19	33	26
	Thallium	µg/g					5	5	0.2	0.2	0.2
	Tin	µg/g					5	2	0.1	0.2	0.1
	Titanium	µg/g					5	0	45	200	128
	Uranium	µg/g	96.7	2296			5	0	0.2	0.8	0.6
	Vanadium	µg/g	35.1	31.8			5	0	1.3	20	12
	Zinc	µg/g	123	315			5	1	0.5	28	16
	Lead-210	Bq/g			0.9	20.8	5	2	0.04	0.43	0.23
	Polonium-210	Bq/g			0.8	12.1	5	0	0.02	0.52	0.26
	Radium-226	Bq/g			0.6	14.4	5	1	0.01	0.03	0.02
	Thorium-228	Bq/g					5	4	0.02	0.02	0.02
	Thorium-230	Bq/g					5	5	0.02	0.02	0.02
	Thorium-232	Bq/g					5	5	0.02	0.02	0.02

Sample Area	Parameter	Units	Sediment Quality Benchmark				n	Count Less than RDL	Min	Max	Mean
			REF/ISQG	NE2/PEL	LEL	PEL					
	Calcium	µg/g					5	0	270	2100	1,186
	Magnesium	µg/g					5	0	110	910	524
	Phosphorus	µg/g					5	0	60	1,600	800
	Potassium	µg/g					5	0	840	1,400	1,068
Whitefish Lake North (LA-6)	Moisture	%					5	0	95.56	96.72	95.94
	Total Organic Carbon	%					5	0	15.9	18.7	17.4
	Aluminum	µg/g					5	0	3,820	5,900	4,842
	Antimony	µg/g					5	1	0.2	0.2	0.2
	Arsenic	µg/g	20.8	522			5	0	3.1	4.2	3.6
	Barium	µg/g					5	0	37	56	45
	Beryllium	µg/g					5	0	0.3	0.3	0.3
	Boron	µg/g					5	0	4	7	6
	Cadmium	µg/g	0.6	3.5			5	0	0.4	0.5	0.4
	Chromium	µg/g	31.5	26.2			5	0	7.5	10	9
	Cobalt	µg/g					5	0	1.4	2.1	1.7
	Copper	µg/g	9.1	11.3			5	0	1.4	3	2
	Iron	µg/g					5	0	13,200	22,600	15,900
	Lead	µg/g	16.3	19.7			5	0	7	8.5	7.8
	Manganese	µg/g					5	0	140	390	226
	Molybdenum	µg/g	22.6	245			5	0	0.4	0.7	0.5
	Nickel	µg/g	21.4	326			5	0	4.2	6.4	5.1
	Selenium	µg/g	3.6	29.7			5	0	0.8	0.9	0.8
	Silver	µg/g					5	1	0.1	0.2	0.1

Sample Area	Parameter	Units	Sediment Quality Benchmark				n	Count Less than RDL	Min	Max	Mean
			REF/ISQG	NE2/PEL	LEL	PEL					
	Strontium	µg/g					5	0	26	34	29
	Thallium	µg/g					5	1	0.2	0.2	0.2
	Tin	µg/g					5	0	0.2	0.2	0.2
	Titanium	µg/g					5	0	180	310	254
	Uranium	µg/g	96.7	2296			5	0	0.6	0.7	0.7
	Vanadium	µg/g	35.1	31.8			5	0	18	19	18
	Zinc	µg/g	123	315			5	0	22	28	25
	Lead-210	Bq/g			0.9	20.8	5	0	0.31	0.59	0.44
	Polonium-210	Bq/g			0.8	12.1	5	0	0.31	0.57	0.45
	Radium-226	Bq/g			0.6	14.4	5	0	0.01	0.04	0.03
	Thorium-228	Bq/g					5	1	0.02	0.02	0.02
	Thorium-230	Bq/g					5	1	0.02	0.02	0.02
	Thorium-232	Bq/g					5	1	0.02	0.02	0.02
	Calcium	µg/g					5	0	1,700	2,500	1960
	Magnesium	µg/g					5	0	650	880	758
	Phosphorus	µg/g					5	0	960	1,500	1,232
	Potassium	µg/g					5	0	800	970	906
Russell Lake (LAB-1)	Moisture	%					3	0	92.8	95.38	94.03
	Total Organic Carbon	%					3	0	12.9	14.9	13.6
	Aluminum	µg/g					3	0	4,810	9,200	7,137
	Antimony	µg/g					3	1	0.2	0.3	0.2
	Arsenic	µg/g	20.8	522			3	0	2.6	5.6	4.3
	Barium	µg/g					3	0	45	71	59

Sample Area	Parameter	Units	Sediment Quality Benchmark				n	Count Less than RDL	Min	Max	Mean
			REF/ISQG	NE2/PEL	LEL	PEL					
	Beryllium	µg/g					3	0	0.3	0.4	0.3
	Boron	µg/g					3	0	7	11	10
	Cadmium	µg/g	0.6	3.5			3	0	0.3	0.5	0.4
	Chromium	µg/g	31.5	26.2			3	0	8	15	12
	Cobalt	µg/g					3	0	1.4	2.7	2
	Copper	µg/g	9.1	11.3			3	0	1.7	5	3
	Iron	µg/g					3	0	11,900	33,000	23,967
	Lead	µg/g	16.3	19.7			3	0	5.4	13	9
	Manganese	µg/g					3	0	290	360	317
	Molybdenum	µg/g	22.6	245			3	0	6.3	13	10
	Nickel	µg/g	21.4	326			3	0	6.5	12	9
	Selenium	µg/g	3.6	29.7			3	0	1	1.6	1.3
	Silver	µg/g					3	2	0.1	0.3	0.2
	Strontium	µg/g					3	0	28	42	35
	Thallium	µg/g					3	1	0.2	0.2	0.2
	Tin	µg/g					3	0	0.3	0.4	0.4
	Titanium	µg/g					3	0	380	480	437
	Uranium	µg/g	96.7	2296			3	0	1.1	1.5	1.3
	Vanadium	µg/g	35.1	31.8			3	0	16	27	22
	Zinc	µg/g	123	315			3	0	18	44	31
	Lead-210	Bq/g			0.9	20.8	3	0	0.55	0.63	0.58
	Polonium-210	Bq/g			0.8	12.1	3	0	0.55	0.68	0.59
	Radium-226	Bq/g			0.6	14.4	3	0	0.03	0.05	0.04

Sample Area	Parameter	Units	Sediment Quality Benchmark				n	Count Less than RDL	Min	Max	Mean
			REF/ISQG	NE2/PEL	LEL	PEL					
	Thorium-228	Bq/g					3	2	0.02	0.02	0.02
	Thorium-230	Bq/g					3	2	0.02	0.03	0.02
	Thorium-232	Bq/g					3	3	0.02	0.02	0.02
	Calcium	µg/g					3	0	2,800	3500	3,100
	Magnesium	µg/g					3	0	960	1,200	1,087
	Phosphorus	µg/g					3	0	820	1,200	993
	Potassium	µg/g					3	0	960	1,400	1,153
Russell Lake (LAB-2)	Moisture	%					1	0	93.08	93.08	93.08
	Total Organic Carbon	%					1	0	11.8	11.8	11.8
	Aluminum	µg/g					1	0	9,300	9,300	9,300
	Antimony	µg/g					1	1	0.2	0.2	0.2
	Arsenic	µg/g	20.8	522			1	0	7.2	7.2	7.2
	Barium	µg/g					1	0	100	100	100
	Beryllium	µg/g					1	0	0.5	0.5	0.5
	Boron	µg/g					1	0	12	12	12
	Cadmium	µg/g	0.6	3.5			1	0	0.6	0.6	0.6
	Chromium	µg/g	31.5	26.2			1	0	13	13	13
	Cobalt	µg/g					1	0	3.8	3.8	3.8
	Copper	µg/g	9.1	11.3			1	0	3.9	3.9	3.9
	Iron	µg/g					1	0	91,300	91,300	91,300
	Lead	µg/g	16.3	19.7			1	0	10	10	10
	Manganese	µg/g					1	0	1,270	1,270	1,270
	Molybdenum	µg/g	22.6	245			1	0	12	12	12

Sample Area	Parameter	Units	Sediment Quality Benchmark				n	Count Less than RDL	Min	Max	Mean
			REF/ISQG	NE2/PEL	LEL	PEL					
	Nickel	µg/g	21.4	326			1	0	9.9	9.9	9.9
	Selenium	µg/g	3.6	29.7			1	0	1.3	1.3	1.3
	Silver	µg/g					1	0	0.1	0.1	0.1
	Strontium	µg/g					1	0	40	40	40
	Thallium	µg/g					1	1	0.2	0.2	0.2
	Tin	µg/g					1	0	0.4	0.4	0.4
	Titanium	µg/g					1	0	360	360	360
	Uranium	µg/g	96.7	2296			1	0	1.4	1.4	1.4
	Vanadium	µg/g	35.1	31.8			1	0	30	30	30
	Zinc	µg/g	123	315			1	0	62	62	62
	Lead-210	Bq/g			0.9	20.8	1	0	0.45	0.45	0.45
	Polonium-210	Bq/g			0.8	12.1	1	0	0.42	0.42	0.42
	Radium-226	Bq/g			0.6	14.4	1	0	0.05	0.05	0.05
	Thorium-228	Bq/g					1	1	0.02	0.02	0.02
	Thorium-230	Bq/g					1	0	0.02	0.02	0.02
	Thorium-232	Bq/g					1	1	0.02	0.02	0.02
	Calcium	µg/g					1	0	2,800	2,800	2,800
	Magnesium	µg/g					1	0	1,000	1,000	1,000
	Phosphorus	µg/g					1	0	1,400	1,400	1,400
	Potassium	µg/g					1	0	1,200	1,200	1,200

Notes

Chemical analysis is reported on a dry weight basis; **bold** value exceeds REF/ISQG; shaded value exceeds NE2/PEL

REF and NE2 values from Burnett-Seidel and Liber (2013). REF = Reference, NE2 = No Effect Level based on benthic invertebrate abundance, richness and evenness

ISQG and PEL values from Canadian Sediment Quality Guidelines for the Protection of Freshwater Aquatic Life (CCME 2024b). ISQG = Interim Sediment Quality Guideline, PEL = Probable Effects Level.

Chemical analysis is reported on a dry weight basis; **bold** value exceeds LEL; shaded value exceeds SEL

LEL and SEL values from Thompson *et al*. (2005). LEL = Lowest Effect Level, SEL = Severe Effect Level

8.4.3.2.4 Benthic Invertebrate Community

Taxa dominance varied between sampled lakes in the Icelander River system. The most dominant taxa in order abundance in McGowan Lake (LA-1) were chironomids (44%), phantom midges (33%) and water fleas (11%). In Whitefish Lake North (LA-6) these were water fleas (65%) and chironomids (16%). While in Whitefish Lake South (LA-5) the proportions of dominant taxa were water fleas (55%) and chironomids (20%). Russell Lake was dominated by chironomids at both LAB-1 and LAB-2 (59% and 75%), respectively. Secondary dominant taxa found at LAB-1 and LAB-2 were Naidid worms (19%) and rust flies (13%), respectively (Table 8.4-4).

McGowan Lake had the most diverse benthic invertebrate community (D = 0.76) with a family richness of 12. Whitefish Lake South had similar diversity (D = 0.76) while Whitefish Lake North was the least diverse (D = 0.65). While relatively lower in richness than the other sample areas, McGowan Lake had the highest Simpson's Evenness score (E = 0.44), where a score of 0 indicates that one family comprises all of the density, and a score of 1 indicates that all families are equally abundant. Whitefish Lake South had the highest taxonomic richness at 22 families but was less even (E = 0.23). Whitefish Lake North was the least even (E = 0.18) of the three sample areas with a mean family richness of 17. McGowan Lake had a higher B-C index, where a score of 0 indicates sample stations have identical community structure, and a score of 1 indicates sample stations have completely dissimilar community structure. The higher B-C score, along with higher diversity and evenness, indicate that McGowan Lake is likely the most sensitive of the three lakes to environmental stressors, followed by Whitefish Lake South and Whitefish Lake North.

Table 8.4-4: Summary of Benthic Invertebrate Endpoints for Lakes Within the Local Study Area

Sample Area	Mean Simpson's Diversity	Mean Simpson's Evenness	Mean Family Richness	Mean Density (Individuals per m^2)	Bray-Curtis Dissimilarity	Dominant Taxa
McGowan Lake (LA-1)	0.76	0.44	12	981	0.50	Chironomids 44% Phantom Midges 33% Water Fleas 11%
Whitefish Lake South (LA-5)	0.73	0.23	22	9,597	0.39	Water Fleas 55% Chironomids 20%
Whitefish Lake North (LA-6)	0.65	0.18	17	10,163	0.37	Water Fleas 65% Chironomids 16%
Russell Lake (LAB-1)	0.85	0.34	16	3,505	0.71	Chironomids 59% Naidid Worms 19%
Russell Lake (LAB-2)	0.82	0.25	21	5,295	0.87	Chironomids 75% Rust Flies 13%

Notes:

Bray-Curtis calculations for Whitefish Lake South and Whitefish Lake North used mean of condition values from the small lakes (i.e., LA-5 and LA-6) while calculations for McGowan Lake used mean of condition values from the large lakes (i.e., LA-1, LA-7, LA-7A, LA-8, LA-9, LAB-1, and LAB-2.

8.4.3.2.5 Benthic Invertebrate Chemistry

Radionuclide and metal concentrations for caddisfly larvae collected from McGowan Lake, Whitefish Lake South, Whitefish Lake North, and Russell Lake are presented in Table 8.4-5.

Table 8.4-5: Baseline Benthic Invertebrate Chemistry for Lakes within the Local Study Area

Parameters	Unit	Location				
		McGowan Lake (LA-1)	Whitefish Lake South (LA-5)	Whitefish Lake North (LA-6)	Russell Lake (LAB-1)	Russell Lake (LAB-2)
Moisture	%	91	87	87	89	89
Aluminum	ug/g	93	120	140	250	220
Antimony	ug/g	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	ug/g	1.8	1.5	2.6	0.9	0.81
Barium	ug/g	142	85	167	111	164
Beryllium	ug/g	0.01	<0.01	0.02	0.03	0.01
Boron	ug/g	4.0	1.0	3.0	6.0	7.0
Cadmium	ug/g	0.19	0.18	0.25	0.16	0.2
Chromium	ug/g	<0.5	0.6	<0.5	<0.5	<0.5
Cobalt	ug/g	0.99	0.48	0.68	2	3.7
Copper	ug/g	7.1	6.3	5.3	6.8	6.6
Iron	ug/g	1300	1,000	1,800	1,800	1,400
Lead	ug/g	0.17	0.34	0.33	0.16	0.13
Manganese	ug/g	1900	790	1,030	1,850	1,710
Molybdenum	ug/g	0.5	0.4	0.6	1.2	0.7
Nickel	ug/g	2.7	0.75	1.3	2.3	2.7
Selenium	ug/g	0.53	0.5	0.52	0.37	0.36
Silver	ug/g	0.02	0.06	0.03	0.02	0.03
Strontium	ug/g	10	11	10	14	20
Thallium	ug/g	<0.05	<0.05	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05	<0.05	<0.05
Titanium	ug/g	2.6	3.0	4.1	5.6	6.4
Uranium	ug/g	0.081	0.062	0.087	0.099	0.16
Vanadium	ug/g	0.4	0.4	0.4	0.7	0.7
Zinc	ug/g	150	150	110	150	190
Lead-210	Bq/g	<0.05	<0.04	<0.02	0.03	<0.04
Polonium-210	Bq/g	0.06	0.09	0.061	0.06	0.03
Radium-226	Bq/g	0.02	0.01	0.015	0.02	0.02
Thorium-228	Bq/g	<0.02	<0.02	<0.009	<0.02	<0.02
Thorium-230	Bq/g	<0.02	<0.02	<0.009	<0.02	<0.02
Thorium-232	Bq/g	<0.02	<0.02	<0.009	<0.02	<0.02

Notes:

- Results are for one sample per lake assessed.
- Samples were collected between September 18 and 21, 2016.
- Results are on a dry weight basis.

8.4.4 Assessment of Project-related Effects

8.4.4.1 Potential Interactions Between the Project and Valued Component / Key Indicators

The Project will require the construction, operation, and decommissioning of several components (as described in Section 2). Potential interactions between Project activities and the Sediment Quality and Benthic Invertebrates VCs are summarized by Project Phase in Table 8.4-6 and are ranked as:

- Primary Interaction (✓): Project activity is expected to interact with the VC / KI, which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- Other Interaction (✓): Project activity is expected to interact with the VC / KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- No Interaction: Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

Based on professional judgment and understanding of the nature of Project activities and their sequencing, the Project activity list was reviewed and the type of interactions determined. Potential Project-related effects are then discussed in Section 8.4.4.2. Primary Project activities with the potential for adverse effects on Sediment Quality and Benthic Invertebrates (i.e., flagged as 'Primary Interactions') are expected to involve surface land clearing, major earthworks, surface/grading preparations, changes to land cover, water management feature construction and operation, and water taking and effluent discharge. Other Project activities (i.e., flagged as 'Other Interactions') refer to those activities that may be associated with hydrogeological influence to local waterbodies and are expected to be secondary contributors to potential adverse effects. The remaining activities (e.g., power generation and supply) were deemed to have no interaction and were not carried forward in the assessment as they are not expected to result in detectable changes in the MPs associated with Sediment Quality and Benthic Invertebrates. Activities during Post-Decommissioning (e.g., site inspections; monitoring and on-site engagement with Interested Parties) were deemed to have no interaction because they do not involve any land clearing, surface preparations, or major earthworks.

Table 8.4-6: Potential Project Interactions for Sediment Quality and Benthic Invertebrates

Project Phase/Activity	Sediment Quality		Benthic Invertebrates		
	Sediment Quantity and Physical Quality	Sediment Chemical Quality	Change in Aerial Habitat	Sediment Quality	Water Quantity
Construction Activities					
Development of access roads and air strip	✓	✓		✓	✓
Site preparation and earthworks; clearing, levelling, and grading of the project area	✓	✓		✓	✓
Power generation – generators					
Installation of main substation and distribution of power around site					
Wellfield and freeze hole drilling; ground freezing	✓	✓		✓	✓
Batch plant operation (concrete); crusher at borrow area					
Development of surface infrastructure (camp, operations centre, plants, ponds, pads, and support facilities)	✓	✓		✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	✓	✓		✓	
Water management (including treatment and site runoff)	✓	✓		✓	✓
Groundwater supply	✓	✓		✓	✓
Surface water withdrawal	✓	✓		✓	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)					
On-site and off-site operation of vehicles and transport of materials	✓	✓		✓	
Air transportation for workers					
Regulatory site inspections					
Engagement – site visit from Interested Parties					
Operation Activities					
Operation of the ISR wellfield	✓	✓		✓	✓
Wellfield and freeze wall drilling	✓	✓		✓	✓
Operation and expansion of freeze wall	✓	✓		✓	✓
Batch plant operation (grout and cement); crusher in borrow area					
Expansion of pond and pads	✓	✓		✓	✓
Operation of the processing plant and production of uranium concentrate	✓	✓		✓	✓

Project Phase/Activity	Sediment Quality		Benthic Invertebrates		
	Sediment Quantity and Physical Quality	Sediment Chemical Quality	Change in Aerial Habitat	Sediment Quality	Water Quantity
Water withdrawal from groundwater or surface waterbody	✓	✓	✓	✓	✓
Management of surface water (including seepage and site runoff)	✓	✓		✓	✓
Water treatment, both domestic and industrial	✓	✓		✓	✓
Water release to surface waterbody	✓	✓	✓	✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	✓	✓		✓	
Hazardous waste management (temporary storage, handling, and off-site transportation)					
Storage and disposal of drill waste rock, process precipitates, and industrial wastewater treatment plant precipitates	✓	✓		✓	
On-site and off-site operation of vehicles and transport of materials	✓	✓		✓	
Power supply – primarily power from the grid, also generators and back-up generators					
Package and transport of nuclear substances					
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)					
Air transportation for workers					
Progressive decommissioning and reclamation	✓	✓		✓	✓
Regulatory site inspections					
Engagement – site visit from Interested Parties					
Decommissioning Activities					
Site water management, treatment, and release	✓	✓	✓	✓	✓
Mining horizon remediation and thawing of freeze wall	✓	✓		✓	✓
Process water treatment and release	✓	✓		✓	✓
Closure of ISR and freeze wells and related infrastructure	✓	✓		✓	✓
Decontamination of surface facilities and injection, recovery, and monitoring wells	✓	✓		✓	✓
Asset removal (including site power transmission lines and electrical infrastructure)					
Demolition and disposal of non-salvageable surface infrastructure and materials	✓	✓		✓	

Project Phase/Activity	Sediment Quality		Benthic Invertebrates		
	Sediment Quantity and Physical Quality	Sediment Chemical Quality	Change in Aerial Habitat	Sediment Quality	Water Quantity
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	✓	✓		✓	✓
Generators					
Waste management (composting and landfill operation)	✓	✓		✓	
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)	✓	✓		✓	
On-site and off-site operation of vehicles and transport of materials					
Reclamation of disturbed areas	✓	✓		✓	✓
Regulatory site inspections					
Engagement – site visit from Interested Parties					
Post-Decommissioning Activities					
Environmental monitoring	✓	✓		✓	
Regulatory site inspections					
Engagement – site visit from Interested Parties					

Interactions between the Project and Sediment Quality and Benthic Invertebrates during the future centuries phase would be considered an indirect (secondary) interaction associated with changes in groundwater migration from the restored mining theater to the surface water environment. Such interactions and their potential for residual effects are discussed in Section 8.4.4.2.5.

8.4.4.2 Potential Project-related Effects

Project activities may interact with Sediment Quality and Benthic Invertebrates during all Project phases. In general, the interactions can be characterized as being primarily associated with controlled, routine discharges from the site. During Construction, the primary effect pathway relates to the mobilization of suspended material into natural surface water features as the result of land disturbance and clearing. During Operation and Decommissioning, excess water from the effluent monitoring ponds will be released to the environment. Routine discharge of this sort will be directed to Whitefish Lake only. Direct discharge of treated effluent to the natural environment has the potential to change surface water constituent concentrations, which may be partitioned to sediments, potentially affecting benthic invertebrate communities via exposure. Post-Decommissioning will involve the restoration of natural site drainage to the Whitefish Lake receiver. Similar to Construction, Decommissioning and Post-Decommissioning activities have the potential to increase the mobilization of suspended solids into natural surface waters, increasing the potential for sedimentation of benthic invertebrate habitat. The following sections discuss each Project-related effect.

8.4.4.2.1 *Mobilization of Suspended Materials*

Construction

The primary effect pathway during Construction relates to the mobilization of suspended material into natural surface water features as a result of land disturbance and clearing. According to the site water balance (Figure 2.2-14 in Section 2), there is no planned discharge to Whitefish Lake during Construction. The mitigation of potential mobilization of suspended material into natural surface water features is readily mitigatable by virtue of the mine development plan and through the implementation of standard water management and sediment control practices. Water management infrastructure (e.g., collection ditches, ponds, pumping, stations), as well as various aspects of the water management and sediment control management systems, will be put into place coincident with the initiation of construction activities. Waters (e.g., runoff) associated with areas under development will be collected and stored within management infrastructure (e.g., clean waste rock pond, Figure 2.2-14 in Section 2). In the event that releases into the natural environment are necessary, they would only occur once it is safe to do so (i.e., suspended solids levels in the water would be at acceptable levels). No downstream effects on surface waters, natural sediments, or benthic invertebrate habitats are expected.

Operation

During Operation, mobilization of suspended materials will be managed through the water management infrastructure and the Surface Water Management Program. Releases of contact water to the natural environment will be directed through the applicable collection ponds, IWWTP, and Effluent Monitoring and Release Ponds. Discharge will only occur once it is safe to do so (i.e., suspended solid levels in the water would be at acceptable levels). Management of TSS levels in the final discharge will be implemented to make sure discharge quality can be maintained consistently to avoid effects on sediment quantity and quality and benthic invertebrates. As necessary, Denison may employ active means (e.g., filtering), if required, to achieve low TSS levels in discharge, in addition to passive means such as settling and clarification in the IWWTP to manage TSS in the effluent stream to low levels. No downstream effects on surface waters, natural sediments, and benthic invertebrate habitats are expected.

Decommissioning

During Decommissioning, the site-wide water management system will continue to operate such that Denison will maintain control of the site process and contact water through the IWWTP. Surface drainage during Decommissioning activities will continue to be directed to the system of collection ponds, IWWTP, and Effluent Monitoring and Release Ponds to control suspended solids and achieve low TSS levels in the discharge, minimizing any potential for sedimentation of existing benthic habitat.

8.4.4.2.2 Overprinting of Aquatic Habitat

Overprinting of aquatic habitat is only expected as a result of construction and commissioning of the effluent discharge/intake pipeline and diffuser at Whitefish Lake. The discharge pipeline and diffuser will terminate at an engineered, offshore, submerged, multiport diffuser, which will be designed to maximize the mixing potential and reduce the spatial extent of the mixing zone (as described in Section 8.2.4.1.1). Negligible aquatic habitat loss is predicted in Whitefish Lake due to the installation of a discharge pipeline and diffuser configuration. The total area of the lake substrate that would be overprinted by the pipeline is expected to be approximately 135 m^2, which will constitute less than 0.05% of the lake's surface area. The structure will remain in place during Operation and Decommissioning while the site-wide water management system continues to operate such that Denison will maintain control of the site process and contact water through the IWWTP. The effects on benthic invertebrates and their physical habitat (sediments) will be confined to this area throughout the duration of the Project but will be returned to pre-construction character following removal of the infrastructure, establishment of natural sediment distribution patterns in the lake, and recolonization of benthic invertebrates.

8.4.4.2.3 Controlled Discharge to Receiving Environments

Construction

Discharge to the environment is not expected during Construction. Site contact water will be collected and held in the clean waste rock pond (Figure 2.2-14 in Section 2). Therefore, potential effects of discharge on the Sediment Quality and Benthic Invertebrates VCs are not expected.

Operation

Denison does not intend to include constant freshwater withdrawal or effluent discharge throughout Operation; however, for the purposes of assessing the scenario of greatest potential effects, the Project has been assessed as having a continuous freshwater withdrawal rate of 40.5 m^3/hr and a continuous effluent discharge rate of 36.5 m^3/hr.

Benthic invertebrates were assessed as an ecological receptor as part of the *Wheeler River Environmental Risk Assessment* (Appendix 10-A in Section 10). The effects on Benthic Invertebrates were assessed based on pathways through Surface Water Quality and Sediment Quality (radiological and non-radiological constituents).

Surface water and sediment quality modeling were completed using IMPACT version 5.6.0., which is consistent with the COPC transport equations outlined in CSA N288.1-20 (CSA Group 2020). The modeling is discussed in detail in the *IMPACT Model Report for the Wheeler River Project* (Appendix A of Appendix 10-A in Section 10). Waterbodies from Whitefish Lake to the Russell Lake inlet were modelled in IMPACT to assess the effects of the Project on the downstream environment. This included the following distinct water polygons: Whitefish Lake Middle, Whitefish Lake South, McGowan Lake, and Russell Lake. Kratchkowsky Lake and Whitefish Lake North were modelled as reference locations. Surface water quality modelling included predicting water and sediment concentrations in Whitefish Lake (the lake to which treated effluent will be released), as well as locations farther downstream. The geometric mean of measured water concentrations from baseline studies performed between 2011 and 2019 (Ecometrix 2020) was selected as the water baseline concentration for constituents that had measured data over the detection limit. Sediment baseline concentrations were predicted from surface water concentrations using the partitioning coefficients (Kd), which consist of regional published values that have been calibrated on similar sites in northern Saskatchewan and checked against Wheeler River measurement data. The estimated effluent concentrations of COPC are presented in Table 8.2-9 (Section 8.2.4.2.3).

Predicted maximum concentrations of constituents of interest in sediment were compared against sediment quality guidelines for the protection of aquatic life and other relevant screening values. Sediment quality screening values were selected based on the following of sources:

- reference (REF) and no-effect (NE2) sediment quality values from Burnett-Seidel and Liber (2013);
- lowest effect levels and severe effect levels from Thompson et al. (2005); and
- Canadian interim sediment quality guidelines and probable effect levels from the Canadian Council of Ministers of the Environment (1999).

Sediment screening (Table 8.4-7) focused on COPC identified during surface water screening as exceeding screening values, and on other constituents of interest from other uranium mining and milling operations. Based on a comparison of maximum predicted sediment quality in Whitefish Lake against the REF values from Burnett-Seidel and Liber (2013), molybdenum and selenium were predicted to exceed the REF values; however, they are not predicted to exceed the NE2 values. Molybdenum and selenium were already identified as COPC based on the surface water screening, and are assessed further in the quantitative environmental risk assessment, considering both water and sediment concentrations.

There is no sediment screening value for cobalt; however, cobalt has already been identified as a COPC in surface water. As such, it will be subject to further quantitative assessment in the environmental risk assessment, considering both water and sediment concentrations.

Predicted concentrations of most COPC did not exceed sediment quality guidelines; however, molybdenum and selenium exceeded REF values from Burnett-Seidel and Liber (2013), but not NE2 values (Appendix 10-A in Section 10). As such, these constituents were carried forward as part of the ecological risk assessment. The ecological risk assessment estimated dose and risk to representative aquatic receptors, including benthic invertebrates, during all Project phases, and included the pathway through Surface Water Quality and Sediment Quality. The potential for ecological effects was assessed by comparing exposure levels to toxicological benchmarks, and characterized quantitatively in terms of total HQs. A total HQ greater than 1 indicates adverse effects may be possible for a given ecological receptor and further investigation is warranted.

As discussed in Section 8.3.6.1, based on water concentrations, the estimated total HQs for all COPCs for aquatic biota are predicted to remain below the HQ benchmark of 1 (Table 8.4-8), with the exception of HQs for copper that are predicted to exceed 1 for benthic invertebrates (at reference and exposure locations) under baseline conditions (for hardness and pH). Under site operational conditions during periods of treated effluent discharge, the HQs for copper are below 1 for all downstream exposure locations for benthic invertebrates.

There were no predicted exceedances of the 9.6 mGy/d radiation dose benchmark for aquatic biota during any Project phase (Appendix 10-A).

Table 8.4-7: Maximum Concentration of Surface Water Constituents of Potential Concern in Sediment

Location	Maximum Concentration of COPCs During Project Phases										
	Arsenic (mg/kg dw)	Cadmium (mg/kg dw)	Chloride	Cobalt (mg/kg dw)	Chromium (mg/kg dw)	Copper (mg/kg dw)	Molybdenum (mg/kg dw)	Sulphate	Selenium (mg/kg dw)	Uranium (mg/kg dw)	Vanadium (mg/kg dw)
Quality Guideline	2.10E+01	6.00E-01	n/a	n/a	3.15E+01	2.20E+01	2.30E+01	n/a	3.60E+00	9.70E+01	3.50E+01
Kratchkowsky Lake (Reference)	8.35E+00	3.38E-01	n/a	2.52E-01	5.86E+00	1.85E+00	3.37E-01	n/a	6.22E-01	5.78E-01	1.12E+01
Whitefish Lake North	8.35E+00	3.38E-01	n/a	2.52E-01	5.86E+00	1.85E+00	3.37E-01	n/a	6.22E-01	5.78E-01	1.12E+01
Whitefish Lake Middle	1.07E+01	4.79E-01	n/a	3.02E-01	7.41E+00	2.28E+00	5.40E+01	n/a	4.90E+00	6.39E+00	**3.72E+01**
Whitefish Lake South	1.03E+01	4.73E-01	n/a	3.02E-01	7.35E+00	2.28E+00	5.30E+01	n/a	4.70E+00	6.12E+00	3.33E+01
McGowan Lake	9.33E+00	4.30E-01	n/a	2.88E-01	6.90E+00	2.16E+00	3.88E+01	n/a	3.33E+00	4.26E+00	2.22E+01
Russell Lake Inlet	8.95E+00	4.06E-01	n/a	2.80E-01	6.63E+00	2.09E+00	2.95E+01	n/a	2.60E+00	3.26E+00	1.82E+01

Location	Maximum Concentration of Metals and Radionuclides During Project Phases						
	Zinc (mg/kg dw)	Uranium-238 (Bq/kg dw)	Uranium-234 (Bq/kg dw)	Thorium-230 (Bq/kg dw)	Radium-226 (Bq/kg dw)	Lead-210 (Bq/kg dw)	Polonium-210 (Bq/kg dw)
Quality Guideline	1.23E+02	n/a	n/a	n/a	6.00E+02	9.00E+02	8.00E+02
Kratchkowsky Lake (Reference)	9.93E+00	7.14E+00	7.14E+00	2.32E+01	6.51E+01	3.74E+02	3.80E+02
Whitefish Lake North	9.93E+00	7.14E+00	7.14E+00	2.32E+01	6.51E+01	3.74E+02	3.80E+02
Whitefish Lake Middle	1.32E+01	7.85E+01	7.85E+01	3.77E+01	7.46E+01	5.41E+02	5.42E+02

Location	Maximum Concentration of Radionuclides During Project Phases (Bq/kg dw)						
	Zinc	Uranium-238	Uranium-234	Thorium-230	Radium-226	Lead-210	Polonium-210
Whitefish Lake South	1.31E+01	7.51E+01	7.51E+01	3.75E+01	7.41E+01	5.07E+02	5.09E+02
McGowan Lake	1.21E+01	5.23E+01	5.23E+01	3.36E+01	7.15E+01	4.36E+02	4.41E+02
Russell Lake Inlet	1.15E+01	4.01E+01	4.01E+01	3.11E+01	6.98E+01	4.11E+02	4.16E+02

Table 8.4-8: Estimated Non-radiological Total Risk to Benthic Invertebrate Ecological Receptor

Location	Maximum Total Hazard Quotients During Project Phases										
	Arsenic	Cadmium	Chloride	Cobalt	Chromium	Copper	Molybdenum	Sulphate	Selenium	Uranium	Zinc
Kratchkowsky Lake (Reference)	7.10E-04	4.68E-02	7.66E-04	5.70E-03	2.30E-04	1.49E+00	3.42E-06	9.42E-04	3.11E-03	1.07E-03	2.20E-02
Whitefish Lake North	7.10E-04	4.68E-02	7.66E-04	5.70E-03	2.30E-04	6.30E-01	3.42E-06	9.42E-04	3.11E-03	1.07E-03	2.20E-02
Whitefish Lake Middle	9.10E-04	6.63E-02	1.55E-02	6.85E-03	2.91E-04	8.35E-01	5.48E-04	7.93E-02	2.45E-02	1.18E-02	2.93E-02
Whitefish Lake South	8.73E-04	6.55E-02	1.54E-02	6.83E-03	2.89E-04	8.30E-01	5.38E-04	7.88E-02	2.35E-02	1.13E-02	2.89E-02
McGowan Lake	7.93E-04	5.96E-02	1.05E-02	6.53E-03	2.71E-04	7.62E-01	3.93E-04	5.27E-02	1.67E-02	7.88E-03	2.68E-02
Russell Lake Inlet	7.61E-04	5.62E-02	8.24E-03	6.33E-03	2.61E-04	7.61E-01	2.99E-04	4.08E-02	1.30E-02	6.04E-03	2.55E-02

Decommissioning and Post-Decommissioning

Discharge to the aquatic environment of Whitefish Lake during Decommissioning is expected. Effluent rates during this phase are expected to be less than during Operation. Effluent water quality is also expected to have lower levels of COPC compared to Operation. Therefore, the analysis of potential effects on the Surface Water Quality VC during Operation (provided in Section 8.2.4.2) is considered in the bounding scenario for Decommissioning due to the influence of surface water quality on sediment quality and benthic invertebrates. There are no expected effects on sediment quality as a result of effluent discharge.

8.4.4.2.4 Changes in Water Levels and Flow

As detailed in Section 8.1, the projected withdrawal and discharge rates proposed for the Project are the largest influence on the hydrological effects of the Project. The largest predicted change in streamflow rate is -3.1% at the LA-5 and SA 2 nodes (immediately downstream of the Project) during Operation and Decommissioning, as projected against the 5th percentile low flow dataset in March. Lake levels are expected to deviate less than ±0.01 m due to all Project influences. All Project influences on the environment are expected to return to baseline conditions during Post-Decommissioning. These changes are within the range of fluctuation of environmental flows and water levels and are unlikely to affect the distribution of sediments as habitat for benthic invertebrates in the LSA.

8.4.4.2.5 Long-Term Transport of Groundwater Solutes to Whitefish Lake in Future Centuries

During the ‘future centuries’ phase as described in Section 8.4.1.3, remediation works will be completed, and the site naturalized, thereby restoring drainage patterns to report to surface waterbodies. As indicated in Section 7 of the EIS, groundwater plumes may develop from residual mass remaining post mining based on bench-scale lab tests of core flushing, and numerical modelling of reactive fate and transport.

Groundwater flow and reactive transport of dissolved constituents were modelled using three-dimensional modelling whereby the reactions were computed using PHREEQC and the transport was computed using FEFLOW (Ecometrix 2022). Groundwater flow observed, and simulated in the calibrated groundwater model, travels eastward from the mining zone within the Lower Sandstone Aquifer before moving upward through the Desilicified Zone in the Athabasca Sandstone and overlying overburden deposits toward Whitefish Lake. Modelled transport of dissolved constituents along the groundwater flow path allowed for interactions of the dissolved constituents with the geologic media through which they are flowing. Due to the relatively low groundwater velocities between the mining zone and Whitefish Lake and chemical reactions along the groundwater flow pathway, the “Future Centuries” scenario spans 100s to 1000s of years.

The results of the numerical modelling, as provided in Section 7 and Appendix 10-A in Section 10, support the conclusion that with the implementation of appropriate mitigation during the decommissioning and restoration phase of the Project, the residual effects of the Project on the intermediate Groundwater VC will not result in an adverse effect to surface water. Dissolved constituent concentrations emanating over hundreds to thousands of years in the future from the deep Ore Zone to Whitefish Lake remain below fresh water environmental quality criteria in Whitefish Lake.

For the COPC identified in the effluent, the predicted mass flux from groundwater into Whitefish Lake starting 200 years after the Project phases during the future centuries was added into the IMPACT model to predict the surface water concentrations over time at the exposed locations (see Table 8.4-9). As shown in the ERA (Appendix 10-A in Section 10), predicted surface water concentrations at all locations are expected to be below water guidelines for the protection of aquatic life, with the exception of copper which will return to baseline concentrations; however exceed the baseline copper FEQG.

Table 8.4-9: Maximum Concentration of Surface Water Constituents of Potential Concern in Surface Water During Future Centuries

Constituent	Unit	Kratchkowsky Lake (LA-7)	Whitefish Lake North (LA-6)	Whitefish Lake Middle (LA-5 North)	Whitefish Lake South (LA-5 South)	McGowan Lake (LA-1)	Icelander River	Russell Lake Inlet	Long-term Screening Concentration	Source of Screening Concentration	Notes
Alkalinity	mg/L	NC	NC	8.1	8.1	NC	NC	NC	NC	NC	(10)
Aluminum	mg/L	0.01358	0.01358	0.01388	0.01373	0.0136	0.0136	0.01359	0.1	SEQG/CCME	(1)
Ammonia (as N)	mg/L	0.01463	0.01463	0.01463	0.01463	0.01463	0.01463	0.01463	5.74	SEQG/CCME	(2)
Un-ionized Ammonia	mg/L	0.000035	0.000035	0.000035	0.000035	0.000035	0.000035	0.000035	0.019	SEQG/CCME	
Arsenic	mg/L	0.000103	0.000103	0.000107	0.000107	0.000105	0.000105	0.000104	0.005	SEQG/CCME	
Cadmium	mg/L	0.0000232	0.0000232	0.0000233	0.0000233	0.0000233	0.0000233	0.0000232	0.00004	SEQG/CCME	
Chloride	mg/L	0.32	0.32	0.41	0.41	0.39	0.39	0.38	120	SEQG/CCME	
Chromium	mg/L	0.00052	0.00052	0.00053	0.00053	0.00052	0.00052	0.00052	0.001	SEQG/CCME	(3)
Cobalt	mg/L	0.0001	0.0001	0.00011	0.00011	0.00011	0.0001	0.0001	0.00078	FEQG	(8) (9)
Copper	mg/L	**0.00062**	**0.00062**	**0.00063**	**0.00063**	**0.00062**	**0.00062**	**0.00062**	0.0002	FEQG	(4)
Iron	mg/L	0.12126	0.12126	0.12756	0.12672	0.12408	0.12405	0.12308	0.3	SEQG/CCME	
Lead	mg/L	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011	0.001	SEQG/CCME	
Lead-210	Bq/L	0.00527	0.00527	0.00605	0.00592	0.00557	0.00556	0.00545	0.2	HC	
Manganese	mg/L	0.01206	0.01206	0.01419	0.01413	0.01355	0.01353	0.01317	0.21	SEQG/CCME	(5)
Mercury	mg/L	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.000026	CCME	
Molybdenum	mg/L	0.00011	0.00011	0.00012	0.00012	0.00011	0.00011	0.00011	0.073	CCME	
Nickel	mg/L	0.00038	0.00038	0.00041	0.00041	0.0004	0.0004	0.00039	0.025	CCME	
Nitrate	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	(10)
Phosphorus	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.004 - 0.01	CCME	(6)
Polonium-210	Bq/L	0.00536	0.00536	0.00615	0.00602	0.00566	0.00564	0.00553	0.1	HC	
Radium-226	Bq/L	0.00557	0.00557	0.00639	0.00637	0.00615	0.00614	0.006	0.11	SEQG	
Selenium	mg/L	0.00003	0.00003	0.00004	0.00004	0.00004	0.00004	0.00004	0.001	CCME	
Sulphate	mg/L	0.69	0.69	0.72	0.72	0.71	0.71	0.71	128	BC MOE	
Thallium	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0008	SEQG/CCME	

Constituent	Unit	Kratchkowsky Lake (LA-7)	Whitefish Lake North (LA-6)	Whitefish Lake Middle (LA-5 North)	Whitefish Lake South (LA-5 South)	McGowan Lake (LA-1)	Icelander River	Russell Lake Inlet	Long-term Screening Concentration	Source of Screening Concentration	Notes
Thorium-230	Bq/L	0.0101	0.0101	0.01036	0.01036	0.0103	0.0103	0.01025	0.6	HC	
TSS	mg/L	3.0	2.0	2.6	2.6	2.5	2.2	4.0	background +5 mg/L	CCME	
Uranium	mg/L	0.00003	0.00003	0.00004	0.00004	0.00003	0.00003	0.00003	0.015	SEQG/CCME	
Uranium-234	Bq/L	0.0004	0.0004	0.0005	0.0005	0.0004	0.0004	0.0004	3	HC	
Uranium-238	Bq/L	0.0004	0.0004	0.0005	0.0005	0.0004	0.0004	0.0004	3	HC	
Vanadium	mg/L	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.12	FEQG	
Zinc	mg/L	0.00068	0.00068	0.00074	0.00074	0.00072	0.00072	0.00071	0.013	CCME	(7)

Notes:

All parameters listed as total concentrations unless otherwise specified

Saskatchewan Water Quality Objectives, SEQG on-line (https://envrbrportal.crmp.saskatchewan.ca/seqg-search/), SEQG for the protection of aquatic life were selected, based on total concentrations

Bold numbers indicate exceedance of long-term criteria

SEQG – Saskatchewan Environmental Quality Guidelines – Water Quality Guidelines for Freshwater Aquatic Life.

CCME – Canadian Council of Ministers of the Environment.

HC – Health Canada.

BC MOE – British Columbia Ministry of the Environment.

FEQG – Federal Environmental Quality Guidelines.

MDMER – Metal and Diamond Mining Effluent Regulations.

DOC – Dissolved organic carbon.

TSS – Total suspended solids.

A pH of 7 and a temperature of 15°C were assumed to convert total ammonia to un-ionized ammonia in accordance with CCME (2002).

(11) Long-term criterion for aluminum based on CCME/SEQG of 0.1 mg/L for dissolved aluminum when pH is greater than 6.5.

(12) Total ammonia-N calculated from the total ammonia guideline for an average annual temperature of 15°C and a pH of 7.0, Un-ionized Ammonia from Table 1 of temperature and pH, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Ammonia (https://ccme.ca/en/res/ammonia-en-canadian-water-quality-guidelines-for-the-protection-of-aquatic-life.pdf).

(13) Guideline specific to Chromium VI for conservative comparison to baseline water quality.

(14) Federal Water Quality Guideline for Copper Biotic Ligand Model (BLM) Tool and User Manual (Site-specific background hardness is 5.26 mg/L, DOC is 2.24 mg/L, pH is 6.61 [95th percentile of LA-5 and LA-6]).

(15) Long-term guideline for manganese based on Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life - Manganese, Appendix B - Canadian Water Quality Guidelines Calculator (pH = 6.61, hardness = 5.26 mg/L.

(16) Framework provides Trigger Ranges for Total Phosphorus (µg/L) - guideline for oligotrophic waterbody 4 - 10 µg/L.

(17) Long term guideline is based on CWQG = exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625). (Site-specific background hardness is 5.26 mg/L, DOC is 2.24 mg/L, pH is 6.61 (95th percentile of LA-5 and LA-6). Note – extrapolated for value outside the hardness range.

(18) Environment Canada 2017. Federal Environmental Quality Guidelines, Cobalt, May. Based on equation and lowest hardness for equation of 52 mg/L.

(19) Environment Canada 2017. Federal Environmental Quality Guidelines, Cobalt. Based on equation and hardness of 250 mg/L for equation of FWQG = exp{(0.414[ln(hardness)] – 1.887}.

(20) "NC" means not calculated/estimated in the IMPACT model during future centuries. Nitrate is not a COPC associated with ISR mining for the Project and was not included in the groundwater source term to Whitefish Lake developed through geochemical reactive transport modelling (Section 7, Appendix 7-C). Nitrate concentrations are low in the groundwater environment and in metallurgical testing informing the groundwater reactive transport model (Section 7, Appendix 7-C). As such, nitrate concentrations are expected to remain at baseline conditions in surface water bodies in the future centuries. Alkalinity was included in the geochemical reactive transport model but not in the IMPACT modelling. As such, the maximum alkalinity concentration (mg/L as $CaCO_3$) during future centuries was calculated outside of IMPACT using the same equations/approach presented in Section 10 (Appendix A of Appendix 10-A) and the mass flux of alkalinity from the geochemical reactive transport model (Reported as "C" in Table 4-4 of Appendix 7-C). The maximum concentration calculated (8.1 mg/L) is within the range or alkalinity values measured in the south part of Whitefish Lake (3-13 mg/L; Table 8.2-2) and represents an increase of approximately 5.2% over the mean baseline value of 7.7 mg/L in the south part of Whitefish Lake (Table 8.2-2). Alkalinity values in the other lakes were not calculated because they are expected to remain at baseline levels during future centuries.

8.4.5 Mitigation Measures

Measures to mitigate adverse effects on Sediment Quality and Benthic Invertebrates are consistent with those to mitigate adverse effects on Surface Water Quantity and Quality. These measures are repeated in this section for completeness.

- Maintain existing drainage patterns with the use of culverts, where applicable.
- Maintain access roads by periodically regrading and ditching to improve water flow, reduce erosion, and manage vegetation growth.
- Inspect culverts periodically. Remove accumulated material and debris upstream and downstream of the culverts to prevent erosion, flooding, habitat damage, property damage, and mobilization of sediment.
- Attenuate peak discharges and augment baseflows to the environment through the use of Project water storage features (i.e., runoff, process water, contact water, monitoring/effluent ponds).
- Develop and implement a Surface Water Management Program that provides an integrated framework to manage water quality and includes provision for water management practices for each of the primary site aspects, as well as areas of the site where there is contact water.
- Maximize the recycle and reuse of process water to reduce freshwater intake and release to Whitefish Lake.
- Design the discharge diffuser/outfall to have the smallest footprint possible while still providing effective mixing and dilution and discharge flows that do not detrimentally affect sediments.
- Develop site-specific effluent treatment to treat COPC to appropriate release limits in accordance with provincial standards and licence/permit conditions.
- Discharge effluent under a scenario that will meet provincial and federal discharge criteria, as identified through permitting. Scenarios may include:
  - discharging at a fixed rate while maintaining an appropriate minimum dilution ratio (i.e., discharge when able to meet the required dilution ratio and cease discharge during periods when unable to meet the necessary dilution ratio);
  - discharging under a variable waste load allocation (i.e., discharge an appropriate effluent volume based on flow in the receiver to maintain minimum dilution ratio); and
  - managing discharge via a hybrid of the two previous options (i.e., discharge effluent at a fixed rate to maintain the required dilution ratio, but the fixed rate is varied on a seasonal basis based on flow).
- Collect and monitor contact water to determine whether treatment is required prior to release to the environment. This will inform optimal levels of treatment.

- Maintain the water management system in place during decommissioning until such time that water quality is suitable to release to the environment.
- Monitor and manage effluent, including contingency for effluent treatment as may be required, so that water discharge objectives are achieved, as defined by applicable provincial and federal regulatory instruments.
- Design and implement an Environmental Code of Practice that defines actions levels and appropriate steps to mitigate elevated concentrations of chemical and radiological constituents in treated effluent discharge to acceptable levels.
- Implement Project-specific monitoring programs (e.g., effluent monitoring plan, environmental monitoring plan) that include monitoring treated effluent, surface water, and sediment quality and applying adaptive management if necessary.
- Work with the associated communities to develop and implement the Project-specific monitoring programs and a framework to share the results for the purpose of assessing the performance of the water management system.
- Develop and implement a decommissioning and reclamation plan to decommission and transfer the site to the province under the Institutional Control Program.

8.4.6 Residual Effects Evaluation

8.4.6.1 Residual Effects Characterization

This section describes the likely residual effects of the Project on the VCs of Sediment Quality and Benthic Invertebrates and their associated KIs. Residual effects are effects that remain after the implementation of mitigation measures and management strategies and are the expected consequences of the Project. The approach to assessing residual Project effects on the Sediment Quality and Benthic Invertebrates VCs follows the methodology outlined in Section 5.8 in Section 5. For each VC and associated KI, each residual effect is characterized in the context of the Project activities that will occur within each Project phase. A residual adverse effect on Sediment Quality is defined as a measurable change in the concentrations of a sediment quality parameter (or parameters) that exceed relevant water quality assessment benchmarks that represent concentrations that are protective of aquatic biota and water uses in watercourse and waterbodies that receive mine-affected drainage. A residual effect is also identified as a change in the sediment quantity and physical quality (grain size) from background (i.e., an increase in sedimentation). These changes also characterize a residual effect for benthic invertebrates. Additionally, a change in water level or flow from baseline and a change in available benthic invertebrate habitat are also considered residual effects on Benthic Invertebrates. Residual effects characteristics specific to Sediment Quality are defined in Table 8.4-10.

<u>Construction</u>

The primary potential change in sediment quality or benthic invertebrate habitat associated with Construction is the mobilization of suspended material into natural surface water features as a result of land clearing activities and road crossing construction. According to the site water balance (Figure 2.2-14 in Section 2), there is no planned discharge to Whitefish Lake during Construction. However, the potential influence of such discharge, if it were to occur, would be bounded by the analysis of water quality in Whitefish Lake during Operation.

Mobilization of suspended material into natural surface water features is readily mitigatable by virtue of the mine development plan and through the implementation of standard water management and sediment control practices. Water management infrastructure (e.g., collection pads, ponds, pumping stations), as well as various aspects of the water management and sediment control management systems, will be put into place coincident with the initiation of construction activities. Runoff associated with areas under development will be collected and either stored within management infrastructure (e.g., water management ponds) or potentially released into natural surface water features once it is safe to do so (i.e., suspended solid levels in the water would be at acceptable levels). No downstream effects on local sediment quality or benthic invertebrate communities are expected.

Operation

During Operation, the primary potential water quality effect from the Project is the discharge of excess water from the site water management system to Whitefish Lake (Figure 2.2-14 in Section 2). Discharge to Whitefish Lake has the potential to change the concentrations of sediment quality constituents from background and, therefore, affect benthic invertebrate habitat and communities.

For planning purposes, a continuous (year-round) discharge at an expected average effluent rate of 0.0101 m^3/s (36.5 m^3/hr) is expected throughout Operation, despite the likelihood that effluent discharge will not be continuous and will only discharge when the site water balance requires, based on water storage capabilities. The water storage capability of the Effluent Monitoring and Release Ponds has been designed to enable contingency in water storage (i.e., three ponds of 3,300 m^3 capacity).

No other routine mine-related discharges to other receiving environments are proposed during Operation. Water management infrastructure will collect and divert all site process and contact water, as well as water associated with the ISR process, through the site IWWTP. Any excess water not required during the ISR process will be directed to the IWWTP. Treated water from the WTP will be pumped to the Effluent Monitoring and Release Ponds.

Treated water in the Effluent Monitoring and Release Ponds will be monitored prior to release to Whitefish Lake. The treated effluent discharge line will be heated and have secondary containment in place.

Predicted changes in sediment quality for molybdenum and selenium are above background and most conservative screening criteria.

However, estimated total HQs for all COPC with the exception of copper, for all ecological receptors are predicted to remain below the HQ benchmark of 1. HQs for copper exceed the HQ of 1 for benthic invertebrates (all locations) and predatory fish (Whitefish Lake Middle and South) under baseline conditions (for hardness and pH). Under site operational conditions during periods of effluent discharge, the HQs for copper are below 1 for all downstream exposure locations for all aquatic biota (Appendix 10A, Section 6.3.2).

Local Indigenous communities have expressed direct concern with respect to mercury. Mercury has not been identified as a COPC for the Project as it is currently not present in the receiving environment (i.e., background condition) at detectable concentrations and will not be produced as part of the mine process; therefore, it will not be discharged to the aquatic environment. However, it is understood that potential nutrient enrichment-related effects are possible and can be linked to increases in mercury in the environment.

As described above, the Surface Water Management Program involves care and control of all site process and contact water and no discharge is proposed beyond that to Whitefish Lake. In practice, it may be necessary at times to manage runoff from disturbed areas that are either outside the water management system or are yet to be integrated into the water management system. In these cases, the areas would be isolated and specific water and sediment control management practices would be implemented to make sure any water released to natural surface water drainages is suitable for release such that the water quality in these natural surface water drainages is protected.

Changes in surface water levels (±0.01 m) and flows (maximum of -3.1% occurring at the LA-5 and SA 2 nodes during Operation) are expected to be less than the variation of natural environmental flows. As such, these changes are not expected to have a significant effect on sediment movement and/or benthic invertebrate habitats.

The overprinting of a small portion (less than 0.05%) of the LA-5 surface area by the effluent discharge pipeline and diffuser is not anticipated to constitute a major loss in benthic invertebrate habitat for the lake. Following installation of the diffuser, recolonization of the benthic invertebrate community is expected to occur. The conceptual design of the diffuser is anticipated to minimize any velocity-related effects on benthic invertebrates. Direction of discharge (nozzles) and velocities are expected to avoid any scour of sediment within the near-field discharge area.

Decommissioning / Post-Decommissioning

Following the cessation of mining operations, discharge to Whitefish Lake will cease. Water quality in Whitefish Lake is expected to return to pre-mining conditions at that time.

The site-wide water management system will continue to operate such that Denison will remain in control of site aspect affected water via the IWWTP. At that time, water (runoff) from the ISR wellfield, and contact water from the developed portion of the site (e.g., contaminated runoff pond, landfill pond, process water pond), will continue to be collected and diverted to the IWWTP. From the IWWTP, the water will be directed back to the ISR wellfield to be pumped as clean water to ground or pumped to the Effluent Monitoring and Release Ponds for monitoring prior to discharge to Whitefish Lake. Following Decommissioning, piping infrastructure will be removed and discharge to surface water will cease. Therefore, effects on sediment quality and the benthic invertebrate community are bounded by the Operation scenario. Partitioning of COPC from surface waters to sediment will cease and any changes to sediment will be monitored during Decommissioning.

Residual effects characteristics specific to the Sediment Quality and Benthic Invertebrates VCs are defined in Table 8.4-10 with evaluation of residual effects provided in Table 8.4-11, Table 8.4-12, Table 8.4-13 and Table 8.4-14.

Table 8.4-10: Sediment Quality and Benthic Invertebrates – Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Effect moves measurable parameters in a direction detrimental to sediment quality or benthic invertebrates. *Sediment Physical Quality* – A change in grain size or particle size distribution that is attributable to the mine in comparison to baseline conditions and trends. *Sediment Chemical Quality* – An increase in constituent concentrations attributable to the mine in comparison to baseline conditions and trends. *Benthic Invertebrate Habitat* – a physical loss of available benthic invertebrate habitat (area of benthic substrate) in comparison to baseline condition and/or changes in waterbody flow or water levels that reduce the availability or detrimentally alter the characteristics of benthic invertebrate habitat. **Positive** – Effect moves measurable parameters in a direction beneficial to sediment quality and/or benthic invertebrate habitat quantity or quality. An improvement in sediment quality in comparison to baseline conditions and trends.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Low** – A measurable change that is not within the variability of baseline conditions but below relevant sediment quality objectives and criteria. **Moderate** – A measurable change that is not within the variability of baseline conditions and not within applicable guidelines, legislated requirements, and/or federal and provincial management objectives, and could therefore have an adverse effect on sediment quality and/or benthic invertebrates in the LSA. **High** – A measurable change that is not within the variability of baseline conditions and not within applicable guidelines, legislated requirements, and/or federal and provincial management objectives, and is likely to have an adverse effect on sediment quality and/or benthic invertebrates in the LSA, with the effect extending beyond the LSA.

Residual Effect Characteristic	Definition	Rating
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the Sediment Quality and Benthic Invertebrates LSA. **Regional** – Effect extends beyond the Sediment Quality and Benthic Invertebrates LSA into the Sediment Quality and Benthic Invertebrates RSA. **Beyond Regional** – Effect extends beyond the Sediment Quality and Benthic Invertebrates RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions. **Partially Reversible** – A residual effect that partially diminishes to baseline conditions. **Irreversible** – A residual effect that will not diminish to baseline conditions.
Context	The extent to which the VC or KI has been affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its ability to recover from that effect (i.e., resilience).	**Low** – VC/KI has high resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or a lack of historic and ongoing anthropogenic or natural disturbance. **Moderate** – VC/KI has moderate resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or an intermediate level of historic or ongoing anthropogenic or natural disturbance with the capacity to assimilate more change. **High** – VC/KI has weak resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or a high level of historic or ongoing anthropogenic or natural disturbance.
Likelihood	Likelihood that the residual effect will occur, including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability that the residual effect will occur. **Unlikely** – A low probability that the residual effect will occur.

Table 8.4-11: Sediment Quality and Benthic Invertebrates – Summary of the Characteristics Ratings for Sediment Quantity and Physical Quality (Particle Size)

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	There is a potential through all Project phases for mobilization of solids into the natural environment, which may adversely affect the benthic sediment character and, therefore, the habitat of benthic invertebrates.

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Magnitude	Low	Using design-based mitigation through water balance and best practices or erosion and sediment control planning, the potential for an increase of suspended solids to the natural environment is predicted to be low.
Geographic Extent	Local	The effects are expected to be limited to the waterbodies (LA-5) and stream crossings associated with the Project Area and the discharge location at LA-5, which is in the LSA.
Duration	Medium-term	The effects are expected to last for the duration of the Project through to Post-Decommissioning
Frequency	Continuous	Although mobilization of suspended materials will occur at the greatest magnitude during Construction, a much smaller continuous source is considered as part of effluent discharge to LA-5.
Reversibility	Fully Reversible	Following cessation of discharge to the natural environment and reclamation of the site during Post-Decommissioning, the potential for mobilization of suspended materials to the natural environment is expected to stop and the natural processes associated with sediment mobilization and deposition are then expected to characterize the benthic environment within the LSA.
Context	Moderate	The physical characteristics of the benthic environment are resilient and typically managed by environmental flows, water depths, and ice scour.
Likelihood	Unlikely	There is a low probability of the residual effect following proper implementation of the erosion and sediment control plan and design-based water management and water treatment prior to discharge to the environment.

Table 8.4-12: Sediment Quality and Benthic Invertebrates – Summary of the Characteristics Ratings for Sediment Quality (Chemical)

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project (specifically the discharge of effluent to the natural environment) will cause a change in the concentration of constituents, which may be partitioned to sediment in the receiving water. Sediment quality in the local receiving environment will be adversely affected by effluent discharge to the environment.
Magnitude	Low	The magnitude of the residual effects associated with the Project are expected to be low as constituents that may be introduced as part of Project activities are anticipated to remain below criteria for the protection of aquatic life, or below risk HQs.
Geographic Extent	Local	The geographic extent of the residual effects is predicted to be local as effects are anticipated to be confined to the immediate waterbody adjacent to the Project (Whitefish Lake) and the estimated mixing zone is less than 5 m, facilitating an effluent discharge configuration that promotes mixing.
Duration	Long-term	Effects are expected to last between 3 to 38 years (i.e., effects expected during Construction through to the end of Post-Decommissioning).
Frequency	Continuous	For the purposes of this EIS and identifying the conservative scenario, effluent discharge has been considered as continuous during Operation and Decommissioning.

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Reversibility	Fully Reversible	Sediment quality is expected to return to pre-development levels following Post-Decommissioning as Project-related sources will cease to operate.
Context	Low	The Sediment Quality and Benthic Invertebrates VCs are resilient in the context of this assessment as COPC meet protective criteria under the bounding scenario. Therefore, under applicable mitigative measures and average flow conditions, the contextual resilience of the aquatic system to respond to change is considered to be great.
Likelihood	Likely	There is a high probability that a change in sediment quality from background conditions will occur.

Table 8.4-13: Sediment Quality and Benthic Invertebrates – Summary of the Characteristics Ratings for Benthic Invertebrates – Change in Aquatic Habitat (Area)

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	A reduction of benthic invertebrate habitat by 135 m^2 is expected due to the construction of pipeline and diffuser infrastructure at LA-5.
Magnitude	Low	The change in available benthic invertebrate habitat by the overprinting of substrates in LA-5 constitutes less than 0.05% of the surface area of the waterbody.
Geographic Extent	Local	The effects are expected to be limited to the LSA, specifically a small portion of LA-5.
Duration	Medium-term	The effects are expected to last between 3 to 38 years (i.e., effects expected during Construction through to the end of Post-Decommissioning).
Frequency	Continuous	Although the mine is unlikely to require water taking on a continuous basis, this has been assessed as a bounding scenario and, as such, must be considered as a continuous effect.
Reversibility	Fully Reversible	Following decommissioning and removal of the pipeline and diffuser, the available habitat will be restored to natural conditions due to lake currents and sediment transport dynamics.
Context	Low	The Sediment Quality and Benthic Invertebrates VCs have a high resiliency with respect to physical disturbance in the context of a small, localized area being altered or disturbed. It is not expected that the ecological integrity of the areas adjacent to the infrastructure will be affected and, as such, will provide for sources of re-distribution and recolonization following Post-Decommissioning.
Likelihood	Likely	The infrastructure associated with the pipeline and diffuser are likely to affect the localized area for which they overprint.

Table 8.4-14: Sediment Quality and Benthic Invertebrates – Summary of the Characteristics Ratings for Benthic Invertebrates – Change in Water Level or Flow

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Water quantity (flow and level) will be reduced in LA-5 as a result of the overprinting of its reporting drainage area by mine infrastructure and through site water balance. Water taking has an additional potential to reduce water levels in LA-5.
Magnitude	Low	Under all scenarios, the Project-related change in hydrology (flows or levels) compared to baseline conditions, is less than 5% of baseline conditions, and generally less than 3%.
Geographic Extent	Local	The effects are expected to be limited to the LSA, specifically the lakes within close proximity to the Project site (i.e., LA-5, LA-6, and LA-1)
Duration	Medium-term	The effects are expected to last between 3 to 38 years (i.e., effects expected during Construction through to the end of Post-Decommissioning).
Frequency	Continuous	Although the mine is unlikely to require water taking on a continuous basis, this has been assessed as a bounding scenario and, as such, must be considered as a continuous effect.

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Reversibility	Fully Reversible	Surface water hydrology is expected to return to pre-development levels following Post-Decommissioning.
Context	Moderate	Surface water flow regimes are variable, and it is this variability that provides for morphological form to be maintained and for ecological reliance (i.e., benthic invertebrate habitat, movement, and life-cycle success). Some change to environmental flows is tolerated by benthic invertebrate communities.
Likelihood	Low	Due to the localized nature and low magnitude of the effect on surface water hydrology, the likelihood of an effect is considered to be very low; therefore, the likelihood of an effect on benthic invertebrates is low.

8.4.6.2 Significance and Confidence

The significance of the residual effect is rated as **not significant** or **significant**, based on the following:

Not significant – a residual effect that is not expected to result in a change to a VC/KI that would alter its population viability or persistence beyond an acceptable level (e.g., where it is not sustainable or is unavailable to contribute to biodiversity and ecosystem function).

Significant – a residual effect that is expected to result in a change to a VC/KI that would alter its population viability or persistence beyond an acceptable level (e.g., where it is not sustainable or is unavailable to contribute to biodiversity and ecosystem function).

The significance of the residual effects on the Sediment Quality and Benthic Invertebrates VCs has been deemed **not significant.** The residual effects are not expected to cause a change in sediment quality and/or benthic invertebrate communities (or their KIs) to the extent that it will alter the ecological integrity of the VCs in the LSA beyond an acceptable level.

The prediction confidence with respect to Sediment Quality and Benthic Invertebrates is high as the mobilization of sediment can be readily mitigated, making the effects prediction relative to this effect pathway easily understood.

Confidence in the assessment of predicted effects on water levels or flow is quite high due to available hydrological data for the LSA. Uncertainty is minimal with the assumptions that the water withdrawal and discharge scenarios presented herein represent the bounding case, and hydrogeological modelling projections are not changed (Section 8.1).

Potential effects on Sediment Quality as a result of Project discharges to local receiving environments were assessed by way of numerical modeling. These predictions are generally considered conservative in nature because the assumptions on which they are based are conservative. For example:

- The assessment is based on a continuous (year-round) discharge at an expected average effluent rate of 0.0101 m^3/s (36.5 m^3/hr) throughout Construction, Operation, and

Decommissioning, despite the likelihood that effluent discharge will not be continuous and will only discharge when site water balance requires, based on water storage capabilities.

- The constituents in effluent discharge have been estimated conservatively. Presented discharge concentrations provided herein include contingency factors of one to three times.
- Baseline water quality and sediment quality are defined by the 95th percentile concentrations of individual constituents. Such an assumption is conservative as it constrains the assimilative capacity associated with the receiving environment. By definition, the assimilative capacity of a receiving environment is equal to the incremental difference between the existing baseline condition and the assessment benchmark (i.e., water quality criterion) on which the evaluation is based. Use of the 95th percentile concentration, rather than a measure of central tendency (i.e., 50th percentile, geomean), means that the incremental change in a given constituent concentration that can be assimilated by the receiving environment, whereby use of the receiving environment is protected, is relatively small in magnitude.

Due to the conservative nature of the assumptions on which the numerical assumptions are based, a high degree of confidence can be assumed.

8.4.6.3 Summary of Project-related Residual Adverse Effects on Sediment Quality and Benthic Invertebrates.

Residual adverse effects on Sediment Quality and Benthic Invertebrates are expected to occur during Construction, Operation, and Decommissioning through pathways previously identified. A summary of sediment quality and benthic invertebrate residual environmental effects that are likely to occur as a result of the Project, and their significance, is provided in Table 8.4-15.

Table 8.4-15: Project Residual Effects on Sediment Quality and Benthic Invertebrates

Residual Effect	Residual Effects Characterization									
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance Determination
Change Sediment Quantity and Physical Quality (Particle Size)	C, O, D	A	L	L	MT	CF	FR	M	U	NS
Change in Sediment Quality (Chemical)	C, O, D	A	L	L	LT	CF	FR	L	L	NS
Change in Aquatic Habitat (Area)	C, O, D	A	L	L	MT	CF	FR	L	L	NS
Change in Water Level or Flow	C, O, D	A	L	L	MT	CF	FR	M	L	NS

Notes:

Project Phase:
C: Construction
O: Operation
D: Decommissioning
Direction:
P: Positive
A: Adverse
Magnitude:
L: Low
M: Moderate
H: High
Geographic Extent:
PA: Project Area
LSA: Local
RSA: Regional
Beyond RSA: Beyond Regional

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term
Frequency:
IF: Infrequent
FF: Frequent
CF: Continuous
Reversibility:
FR: Fully Reversible
PR: Partially Reversible
IR: Irreversible

Context:
L: Low
M: Moderate
H: High
Likelihood:
L: Likely
U: Unlikely
Significance Determination
S: Significant
NS: Not Significant

8.4.7 Cumulative Effects

The spatial and temporal boundaries of the Project specific to the Sediment Quality and Benthic Invertebrate VCs are provided in Section 8.4.1.3. A description of the methods used in assessing cumulative effects is provided in Section 5.9.

8.4.7.1 Potential Cumulative Effects

Existing projects within the Wheeler River system have been considered for their potential to interact with the Sediment Quality and Benthic Invertebrates VCs for the Project. These include reasonably foreseeable projects that are described in Section 5.9.

The key potential cumulative effect pathway as it concerns the Sediment Quality and Benthic Invertebrate VCs is the surface water exposure pathway. The assessment of cumulative effects on the Sediment Quality and Benthic Invertebrate VCs considered surface water releases and partitioning to sediments from the Project and the Key Lake Operation during all phases of the Project. The key Project component contributing to potential cumulative effects is the discharge of treated effluent to the aquatic environment during Operation and Decommissioning which may interact with Cameco's current releases to water including treated water released to David Creek drainage, treated groundwater and diverted surface water to the McDonald Creek drainage (Cameco 2020).

Temporal overlap of the Key Lake Operation and the Project will also occur during 'future centuries' as described as 'post-decommissioning phase' in the Key Lake Extension Project EIS (Cameco 2020). There is potential for increased contaminant transport via groundwater to surface water during the long-term, post-decommissioning phase (i.e., 10,000 years after operations cease and the site has been reclaimed) for the Key Lake Operation. The long-term storage of tailings at a higher elevation has the potential to influence contaminants in the groundwater and incrementally add to the effect on surface water quality in the Outlet Creek Drainage.

Operation and Decommissioning

The assessment of cumulative effects on the aquatic environment considered releases from the Key Lake Operation and proposed Project during all phases of the Project. The primary Key Lake Operation component contributing to potential cumulative effects is the placement of tailings to a higher elevation in the Deilmann Tailings Management Facility (DTMF). The increased loadings from the DTMF are anticipated to result in an incremental (i.e., existing conditions plus the Project) increase of concentrations of COPCs in the aquatic environment (Cameco 2013). The spatial extent of any significant adverse effects on the aquatic environment from the Key Lake Operation were anticipated to be localized and not to extend to the Wheeler River and Russell Lake during any phase of the Project (Cameco 2013). The 2010 Status of the Environment report for the Key Lake Operation identified that no adverse effects to individual fish or fish populations are present in the Wheeler River (EcoMetrix 2010 as cited in Cameco 2020).

Potential Project residual effects on surface water quality relate to changes (increases) in constituent concentrations that are related to the controlled discharge of Project site waters into local receiving environments (Whitefish Lake). Such changes are predicted to be negligible to low in magnitude and limited to the LSA. For example, during Construction, no discharge from the Project site is planned. During Operation, treated effluent will be discharged to Whitefish Lake. The Whitefish Lake discharge will be the only routine discharge location during Operation. Water quality in Whitefish Lake and, by extension, downstream of Whitefish Lake will meet appropriate benchmarks for the protection of aquatic life in consideration of a small mixing zone in the lake. Benthic invertebrates were assessed as an ecological receptor as part of the *Wheeler River Environmental Risk Assessment* (Appendix 10-A in Section 10). The effects on Benthic Invertebrates were assessed based on pathways through Surface Water Quality and Sediment Quality (radiological and non-radiological constituents). No significant adverse effects on aquatic populations or communities (including benthic invertebrates) as a result of releases from the Project are predicted during the Project phases. All estimated total HQs for all COPC for all ecological receptors are predicted to remain below the HQ benchmark of 1 (Table 8.4-8) with the exception of copper (Section 10, Appendix 10A, Section 6.3.2). HQs for copper exceed the HQ of 1 under baseline conditions for benthic invertebrates (all locations) and predatory fish (Whitefish Lake Middle and South). Under site operational conditions during periods of treated effluent discharge, the HQs for copper are below 1 for all aquatic biota.

There were no predicted exceedances of the 9.6 mGy/d radiation dose benchmark for aquatic biota during any Project phase (Appendix 10-A). Following Decommissioning and the restoration of drainage patterns that are similar to pre-mining conditions, water quality is expected to meet appropriate benchmarks for the protection of aquatic life in Whitefish Lake and downstream. This includes Russell Lake of which the Icelander River system is associated.

In consideration of the above discussion, effects on the aquatic environment due to changes in surface water quality from the Key Lake Operation are not anticipated to spatially overlap with those from the Project and therefore a cumulative effect is not expected.

Future Centuries

The 2013 Key Lake ERA indicated that during the 10,000-year post-decommissioning period, predicted exposure levels may affect lower trophic level aquatic biota on a population or community level within some isolated lakes in the SSA, but adverse effects on the ecology of the Outlet Creek drainage, and therefore further downstream were not expected during the post-decommissioning phase (Cameco 2013). The results of the 2020 ERA for the Key Lake Operation were consistent with the findings from the 2013 ERA in that there were limited significant risks posed to aquatic receptors situated in the area surrounding the Operation, but not to areas farther downstream. The 2020 ERA concluded that environmental health in the vicinity of the Key Lake Operation will remain protected (Cameco 2020).

The results of the numerical modelling for the Project, as provided in Section 7 and Appendix 10-A in Section 10, support the conclusion that with the implementation of appropriate mitigation during the decommissioning and mining area remediation phase of the Project, the residual effects of the Project on the intermediate Groundwater VC will not result in an adverse effect to surface water or aquatic sediments. Dissolved constituent concentrations emanating over hundreds to thousands of years in the future (“Future Centuries”) from the mining area to Whitefish Lake will be localized to that waterbody and remain below fresh water environmental quality criteria. As such, impacts to downstream portions of the drainage including Russell Lake are not expected.

In consideration of the above discussion, effects on the aquatic environment due to changes in surface water quality from the Key Lake Operation are not anticipated to spatially overlap with those from the Project and therefore a cumulative effect is not expected.

8.4.7.2 Additional Mitigation Measures

Additional mitigation measures are not warranted as no potential cumulative effects were identified for the Sediment Quality and Benthic Invertebrates VCs.

8.4.7.3 Cumulative Effects Characterization and Determination of Significance

A determination of significance is not warranted as no potential cumulative effects were identified for the Sediment Quality and Benthic Invertebrates VCs.

8.4.7.4 Cumulative Effects Assessment Summary

Impacts on the aquatic environment (including sediment quality and benthic invertebrates) via the surface water quality pathway from the Key Lake Operation are expected to remain localized and not extend to the Wheeler River system or Russell Lake. Likewise, impacts on sediment quality and benthic invertebrates via the surface water pathway from the Project are expected to remain localized (Whitefish Lake) and not extend to Russell Lake. Effects on the aquatic environment due to changes in surface water quality associated with the Key Lake Operation are not anticipated to spatially overlap with those from the Project during operation/decommissioning or during "future centuries" and therefore a cumulative effect is not expected.

8.4.7.5 Environmental Monitoring and Follow-up

Specific monitoring and follow-up for Sediment Quality and Benthic Invertebrates related to cumulative effects is not warranted as no cumulative effects were identified for the Sediment Quality and Benthic Invertebrates VCs. Monitoring and follow-up specific to the Project is detailed in Section 8.4.8.

8.4.7.6 Climate Change Considerations

As discussed in Section 8.1.7.5, the frequency and magnitude of extreme precipitation events have the potential to change water levels and flows in the RSA, which may affect sediment transport, deposition and therefore benthic invertebrate habitat. Changes to average and upper and lower bounds of ambient temperatures may also affect aquatic habitat, which in turn may affect benthic invertebrate communities. Climate change over the life of the Project (i.e., 35 to 40 years) will be monitored as part of the Project's environmental monitoring programs, and influences on water quality, sediment quality, and benthic invertebrates will require adaptive management to mitigate any potential effects of the Project that may be exacerbated by climate-related changes on the aquatic environment.

8.4.8 Monitoring and Follow-up

For the purposes of this EIS, monitoring and follow-up are defined as follows:

- monitoring programs are designed to meet regulatory requirements (e.g., permit or license conditions) and/or to demonstrate compliance with environmental commitments made in the EIS; and
- follow-up programs are those that are proposed to address any uncertainties identified during the EA process (e.g., to verify predictions made during the EA; to determine the effectiveness of proposed and implemented mitigation measures) and to determine if and when to implement adaptive management measures.

Monitoring and follow-up are proposed for the Sediment Quality and Benthic Invertebrates VCs to verify the accuracy of the predicted effects and effectiveness of proposed mitigation measures. The sediment quality and benthic invertebrate monitoring program should be considered in conjunction with the surface water quantity (hydrology) (Section 8.1.8) and surface water quality (Section 8.2.8) monitoring programs as sediment quality and benthic invertebrate are specifically tied to surface water quantity and quality from the perspective of pathways of effects. Specifically, monitoring of TSS in the effluent monitoring ponds and other catchment ponds prior to discharge to the environment will be important to provide context to further evaluate Project-related effects on sediment and benthic invertebrate communities in the receiving water environment (i.e., Whitefish Lake).

The sediment quality and benthic invertebrate monitoring and follow-up program will have the following objectives:

- collecting and recording surface water quality to confirm that source and receiving water quality predictions for mobilization of solids are consistent with those presented in the EIS;
- monitoring to confirm that effluent and receiver sediment quality meet applicable regulation criteria; and
- monitoring benthic invertebrate community structure and abundance in the near-field discharge area to assess any changes that may be attributable to the Project.

The monitoring and follow-up program will include measurement of sediment quality parameters to meet regulatory criteria (i.e., provincial discharge permits, MDMER [Government of Canada 2022], and CSA N288.4-19 [CSA Group 2019]). At a minimum, this will include collection of non-radiological parameters (e.g., metals, nutrients, pH, and sulphate), radiological parameters, and physical characteristics (grain size).

Benthic invertebrate community monitoring will include the collection of samples following regulatory guidance (Government of Canada 2022) on proper collection and analysis to detect change in biota assemblages. This will include reasonable replication over a geographic area.

Metrics assessed will be associated with benthic invertebrate community diversity, evenness, density, taxa richness, and similarity indices.

Sediment and benthic invertebrate monitoring will occur in tandem and sampling locations will be co-located to facilitate comparison of benthic invertebrate community metrics with sediment quality characteristics.

Sediment and benthic invertebrate monitoring in the natural environment will occur at the point of discharge in Whitefish Lake South (near-field), at an upstream reference location (Whitefish Lake North), and at downstream locations (far-field). The far-field monitoring locations will be located in Whitefish Lake South prior to its discharge to McGowan Lake.

Constituent concentrations will be compared to the values used in the EIS and to applicable regulatory criteria or objectives.

Specific monitoring and follow-up plans for the Sediment Quality and Benthic Invertebrates VCs will be prepared to refine and finalize the approach and specific metrics following consultation with Indigenous groups, other stakeholders, and relevant federal and provincial agencies with interest in the development and implementation of this VC-specific program.

8.4.9 Sediment Quality and Benthic Invertebrates Summary

The Sediment Quality and Benthic Invertebrates VCs were selected for inclusion as Project activities have the potential to affect them via erosion-driven mobilization of suspended sediment, groundwater interactions with surface water features, and effluent discharge to the natural environment throughout all phases of development.

Baseline sediment quality surveys confirmed that the waterbodies in the LSA (i.e., McGowan Lake, Whitefish Lake North, and Whitefish Lake South) were dominated by clay substrates with silt and sand being present in lesser proportions. Sediment-metal concentrations in these waterbodies were variable. For parameters where sediment quality guidelines are available, all constituent concentrations were at or below their respective reference criteria or guidelines for the protection of aquatic life.

Benthic invertebrate communities were characteristic of depositional lake habitats (i.e., chironomids, midges, water fleas, and worms) in McGowan Lake and Whitefish Lake. Overall, diversity of the benthic invertebrate communities was highest in McGowan Lake followed by Whitefish Lake South and Whitefish Lake North.

The physical and chemical attributes of aquatic sediments directly influence benthic invertebrate community distribution, diversity, abundance, and health. Potential changes to water, from both a quantity and quality perspective, are key considerations within the EA process, as demonstrated by previous uranium mining development proposals in the Athabasca Basin, and draw a high level of concern from Interested Parties. Changes to surface water quality have the potential to influence sediment particle size and the chemistry and distribution within the aquatic environment, resulting in changes to biodiversity and biological function. Such effects are of interest with respect to the cultural values of Indigenous groups, the public, and other stakeholders.

Project activities may interact with Sediment Quality and Benthic Invertebrates during all Project phases. In general, the interactions can be characterized as being primarily associated with controlled, routine discharges from the site and mobilization of suspended material into natural surface water features as a result of land disturbance and clearing. During Operation and Decommissioning, excess water from the effluent monitoring ponds will be released to the environment. Routine discharge of this sort will be directed to Whitefish Lake only. The reduction in surface drainage reporting to Whitefish Lake due to Project development may change water levels and flows in the receiving water, thereby influencing the depositional properties of the lake and the benthic invertebrates there. The installation of the pipeline and diffuser structure will result in the overprinting of a small proportion of the Whitefish Lake benthic substrate (less than 0.05%).

To minimize the residual effects of the Project on Sediment Quality and Benthic Invertebrates, Denison will develop and implement a Surface Water Management Program that provides an integrated framework to manage water quality and includes provision for water management practices for each of the primary site aspects, as well as areas of the site where there is contact water. This will include the collection and monitoring of contact water to determine whether treatment is required prior to release to the environment, which will inform optimal levels of treatment. This will also include the monitoring and management of effluent, including contingency for effluent treatment as may be required, so that water discharge objectives are achieved as defined by applicable provincial and federal regulatory instruments. This will mitigate effects associated with the mobilization of solids and changes to sediment quality that may affect benthic invertebrates. Denison will design the discharge diffuser/outfall to have the smallest footprint possible while still providing effective mixing and dilution such that discharge flows do not detrimentally affect sediments.

The assessment predicted residual effects on Sediment Quality and Benthic Invertebrates due to change in sediment quantity and physical quality (particle size), change in sediment quality (chemical), change in aquatic habitat (area), and change in water level or flow. However, with the implementation of appropriate mitigation measures and the effects being characterized as low magnitude, localized, and fully reversible, the residual effects on Sediment Quality and Benthic Invertebrates are predicted to be **not significant**.

Monitoring and follow-up are recommended for the Sediment Quality and Benthic Invertebrates VCs to verify the accuracy of the predicted effects and effectiveness of proposed mitigation measures. The sediment quality and benthic invertebrate monitoring program should be considered in conjunction with the surface water quantity (hydrology) (Section 8.1.8) and surface water quality (Section 8.2.8) monitoring programs as sediment quality and benthic invertebrates are specifically tied to surface water quantity and quality from the perspective of pathways of effects. Specifically, monitoring of TSS in the effluent monitoring ponds and other catchment ponds prior to discharge to the environment will be important to provide context to further evaluate Project-related effects on sediment and benthic invertebrate communities in the receiving water environment (Whitefish Lake).

8.4.10 References

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8.5 Fish Health

This subsection addresses the potential effects of the Project on the Fish Health VC. The following are discussed herein as part of the EA:

- scope of the assessment;
- summary of existing conditions relevant to the Fish Health VC;
- identification and description of potential interactions between the Project and the Fish Health VC;
- identification and description of mitigation measures applicable to the Fish Health VC to eliminate, reduce, or control the potential adverse Project-related effects;
- identification and characterization of predicted Project-related residual effects on the Fish Health VC after mitigation;
- characterization of significance and assignment of the level of confidence in the predictions; and
- identification and characterization of potential cumulative effects.

Figure 8.5-1 is a graphic representation of the assessment process used in this EIS.

For reference, and as discussed in Section 8.5.1, the Fish Health VC is closely linked to, and follows directly from, the assessment of environmental pathways whereby fish could be exposed to Project-related emissions that could in turn affect their health. Health effects on fish due to exposure to chemicals in the environment are well established and such considerations form the basis of biological monitoring programs that are mandated through the MDMER (Government of Canada 2022).

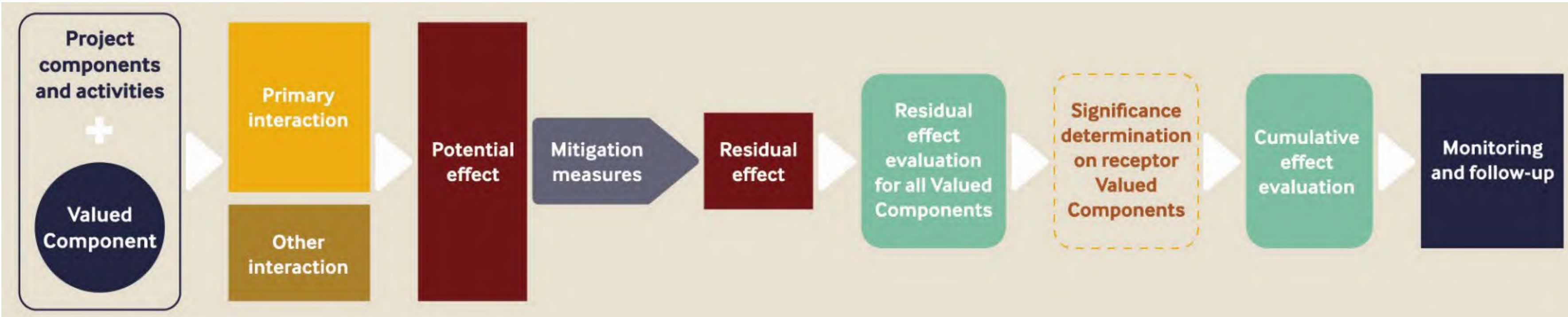

Figure 8.5-1: Environmental Assessment Process for the Wheeler River Project

8.5.1 Scope of the Assessment

The purpose of this assessment is to assess potential changes to Fish Health for all Project phases at the Project, local, and regional study areas scales. Pathways affecting Fish Health are directly associated with potential changes to intermediate VCs of Surface Water Quality and Sediment Quality. Fish rely on surface water and sediment as direct habitat within which they complete their life processes. These media sustain fish physiological processes and provide food sources (e.g., benthic invertebrates). Fish may be directly exposed to COPC in the aquatic environment, and COPC have the potential to be taken up by fish through processes such as respiration, ingestion, and absorption. As such, surface water and sediment quality, and changes thereof, can directly affect the receptor VC of fish health. Project-specific interactions with the Fish Health VC include those associated with potential changes to surface water and sediment quality, including site clearing and the potential for erosion-driven mobilization of suspended sediment into local surface waters; groundwater interactions with surface water features whereby constituents in groundwater are introduced to the surface water environment; and effluent discharge to the receiving environment whereby constituents in effluent are introduced to the receiving environment. The assessments of these pathways are considered in detail in other sections of this EIS and are summarized in this section as needed to support the assessment of Project-related effects on the Fish Health VC.

8.5.1.1 Valued Component Selection

The process and rationale for selection of VCs and establishment of KIs and associated MPs is described in Section 5. This section addresses the Fish Health VC. Changes to surface water quality and sediment quality have the potential to influence biodiversity and biological function through direct exposure and indirect food chain influences (i.e., fish health), and the cultural values of Indigenous groups, the public, and other stakeholders. In this context, Fish Health is interrelated or linked, to varying extents, to other VCs that are considered in this EIS, including:

Intermediate Valued Components:

Surface Water Quantity: Surface water flow volumes and periodicity directly influence water quality, bedload movement, and sediment deposition in a waterbody. Natural and seasonal changes in precipitation, and therefore water quantity, are directly related to water quality, sediment characteristics, and benthic invertebrate distribution. Project-related changes to surface drainage patterns, site water balance, and effluent discharge may influence water quantity, which in turn may influence the assimilative capacity of receiving waters, the movement of sediment, and sediment quality and invertebrates, which characterize the habitat and forage base of fish. Surface water Quantity may also influence the integrity of the aquatic ecosystem and, therefore, Fish Health.

Surface Water Quality: Surface Water Quality may affect the concentrations of constituents in sediments and the fish forage base, and consequently the bioaccumulation of COPC in fish tissues.

Groundwater Quantity and Quality: The quantity and quality of groundwater reporting to surface water through hydrologic connections may influence water quality in surface waterbodies and partitioning through sediments, and consequently the bioaccumulation of COPC in fish tissues.

Receptor Valued Components

Terrestrial Environment: Fish are a food resource for terrestrial fauna; therefore, Fish Health is linked to the function, biodiversity, and health of the terrestrial environment.

Fish and Fish Habitat: Fish habitat, as defined in subsection 2(1) of the *Fisheries Act* (Government of Canada 2019), includes all waters frequented by fish and any other areas upon which fish depend directly or indirectly to carry out their life processes. The types of areas that can directly or indirectly support life processes include, but are not limited to, spawning grounds, nursery habitats, rearing habitats, food supply areas, and migration areas. Alteration of Fish and Fish habitat through changes to Surface Water Quality and/or Sediment Quality may affect Fish Health.

Land and Resource Use: Indigenous Land and Resource Use and Other Land and Resource Use are influenced by Fish Health, and, specifically, concentrations of COPC in fish tissues that might influence harvest and consumption, particularly if guidelines are exceeded.

Figure 8.5-2 is a graphic representation of the main linkages among the Fish Health VC and other VCs, illustrating the flow of assessment information into and from the Fish Health VC.

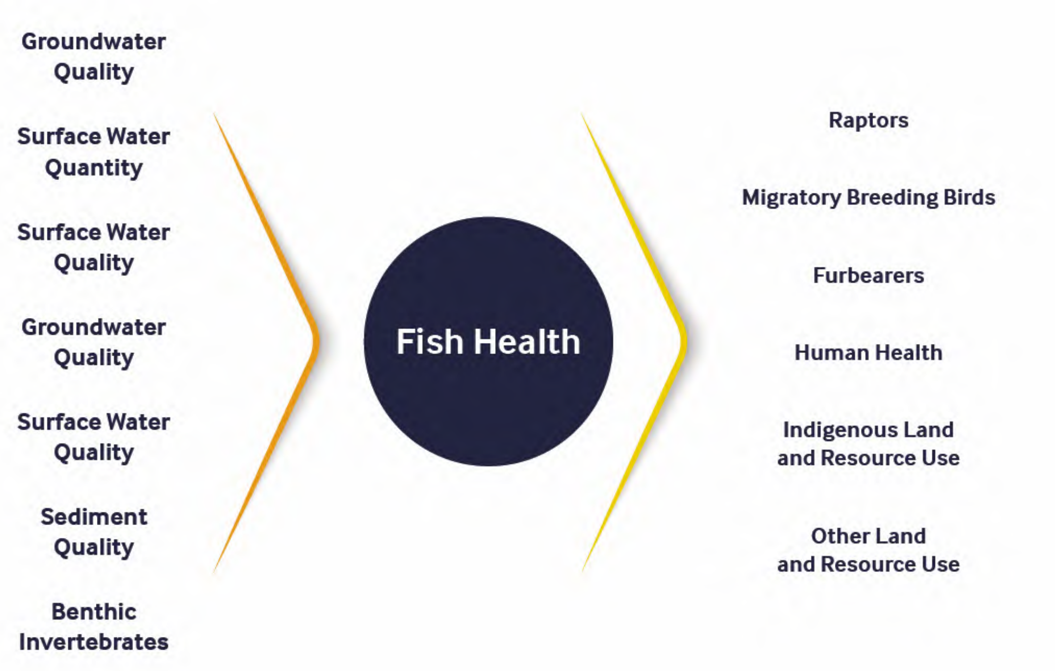

Figure 8.5-2: Integrated Assessment Approach - Key Connections between Fish Health and Other Valued Components

8.5.1.2 Key Indicators and Measurable Parameters

The KIs for the Fish Health VC include potential changes in surface water quality, sediment quality, and fish tissue COPC concentrations from baseline conditions. The rationale for each KI and the associated MPs are summarized in Table 8.5-1.

Table 8.5-1: Key Indicators and Measurable Parameters for the Fish Health Valued Component

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Change in surface water quality from baseline conditions	Introduction of constituents into receiving waterbodies as a result of the Project that are of a magnitude to adversely affect aquatic biota associated with the waterbodies.	Change in the concentration of constituents that are directly related to Project activities, measured as a mass of a chemical per unit volume in water (e.g., mg/L).
Change in sediment quality from baseline conditions	Change in sediment quality as a result of the Project that is of a magnitude to adversely affect aquatic biota associated with the waterbody.	Introduction of constituents into the sediments of waterbodies as a result of the Project that are of a magnitude to negatively affect aquatic biota associated with the waterbodies.
Change in fish tissue COPC concentrations from baseline conditions	Introduction of constituents into receiving waterbodies (surface water and sediments) as a result of the Project that are of a magnitude to adversely affect aquatic biota associated with the waterbodies.	Change in the concentration of constituents that are directly related to Project activities, measured as a mass of a chemical per unit mass in fish tissue (e.g., mg/kg).

8.5.1.3 Spatial and Temporal Boundaries

Generic considerations associated with the establishment of the spatial boundaries of the assessment are described in Section 5.3.3. As it pertains to the Fish Health VC, the following is noted.

- The **Project Area** is the direct footprint of the Project. The Project Area represents the area within which Project activities and components may occur and, as such, represents the area within which direct physical disturbance may occur as a result of the Project, either temporary or permanent. (i.e., the area of maximum physical disturbance). This area is not VC-specific, but consistent throughout the EIS for all VCs.
- The **LSA** is the area that surrounds the Project Area where both direct and indirect effects resulting from Project activities can be reasonably measured. The LSA was established to assess the potential, largely direct effects of the Project and represents the extent to which there is a reasonable potential for the Project or Project-related activities to interact with and potentially adversely affect the VC. For the Fish Health VC, the LSA was derived from watershed boundaries within proximity of the Project Area, including portions of watersheds that overlap the Project site, as well as areas directly downstream that may be influenced by the Project site or effluent discharge. The subwatersheds within the LSA are presented in Figure 8.5-3. This area was selected based on important waterbodies (notably Whitefish and McGowan lakes)

downstream of the Project where effects may occur through all Project phases. The LSA extends from those waterbodies down to their inflows to Russell Lake.

- The **RSA** is the area that surrounds and includes the LSA, and was established to assess the potential, largely indirect effects of the Project, as well as other activities, in a regional context. The RSA is large enough to capture the extent of potential effects (i.e., zone of influence) on a VC and defines the area within which cumulative effects may occur (i.e., cumulative effects assessment boundary). The RSA for the Fish Health VC is bounded by the regional watershed area in which the Project Area is located. The RSA for this assessment is based on the whole watershed within which the Project is located and extends downstream to include Russell Lake (Figure 8.5-3).

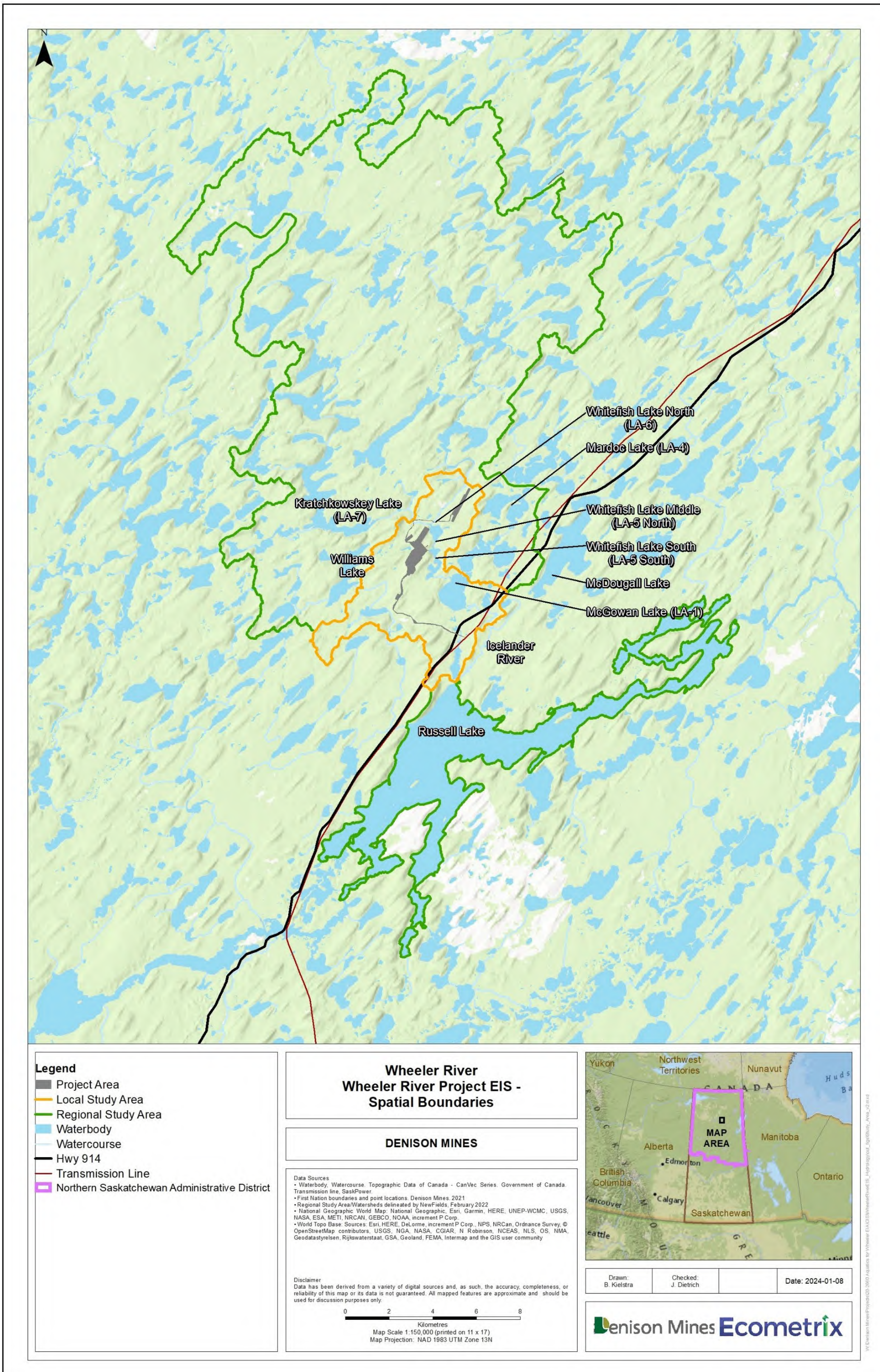

Figure 8.5-3: Spatial Boundaries for the Fish Health Valued Component

Temporal boundaries for the EIS are defined in Table 5.3-3 in Section 5.3.4. The temporal boundaries applicable to and considered in the EIS include the following Project phases:

- Construction (Year 1 to 3);
- Operation (Year 3 to 18);
- Decommissioning (Year 18 to 23); and
- Post-Decommissioning (Year 23 to 38).

Additionally, a "future centuries" scenario is considered to assess the potential effects post-restoration (i.e., beyond the Project timeline of 0-38 years) and to reflect the time period over which the highest constituent concentrations in groundwater are predicted to migrate towards and interact with surface water.

This period represents the time where the highest constituent concentrations in groundwater are predicted to interact with surface water based on groundwater modeling. In this context, the future centuries scenario is considered with respect to the interaction of groundwater migration from the Project site and its potential influence on surface water in local water bodies. The future centuries projection encompasses the long-term period during which slow migration of groundwater from the Phoenix Ore Zone area to the surface water environment is anticipated and constitutes a bounding scenario of maximum concentrations of COPC.

8.5.2 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

At its broadest level, IK can be understood as the unique and collective knowledge of Indigenous peoples that may include, but is not limited to, the environmental, cultural, economic, political, and spiritual conditions of a community or region. In this section, IK and LK are viewed as complementary and influential alongside western science to produce a full understanding of the potential effects of the Project, whether measurable or perceived. Both forms of information have been given full and fair consideration.

Denison has recorded and stored information regarding IK, LK and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 18-EN-ERFN-5.68). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment. Appendix 8-A provides a summary of unique identification numbers referenced within Section 8.5.

Indigenous Knowledge and LK quotes and citations were included in this section to provide readers with the information considered as the Project advanced throughout the EA process. Since 2016, Denison has engaged with Interested Parties (i.e., local and Indigenous communities, residents, businesses, organizations, land users, and various regulatory authorities) to support the development of positive relationships and a mutual commitment to collaboration.

The history of resource sharing between Indigenous Peoples and Europeans in the Project RSA indicates the importance of natural resources to all peoples. Such partnerships were described during engagement with English River First Nation:

> "*The biggest body of water to be impacted is Russell Lake – "Big Poor Fish Lake" in Dené. A lot of Scandinavians and Norwegians went up there in the 1930s and partnered with First Nations in that territory*" (18-EN-ERFN-5.68).

The influence of IK, LK, and engagement on the assessment of the Fish Health VC has first and foremost shaped the shared value of water and its life-sustaining properties.

> "*The lands and waters, we are definitely connected as peoples of English River. If we don't have the lands, we are not connected. If we don't have the water... Water is life to us*" (ERFN and SVS 2022).

Comments associated with water management and discharge to the environment were significant in the engagement record[6], and these were considered within the context of community interest regarding surface waters remaining supportive of natural function for biota. To this end, Project-related water management and treatment are important to maintaining surface water quality within the LSA and RSA.

Indigenous peoples and LK holders were clear in their interest in the current levels of constituents in the aquatic ecosystem and the potential for adverse changes resulting from the Project, for example:

> "*How many lakes have you tested? Is there mercury?*" (19-EN-ML21-62.34).
>
> "*Russell is one lake where I commercially fish. How will this effluent impact the water quality, fish health? Will I be able to sell fish from here? If there is going to water pollution, I just want to know*" (19-LK-ERFNTrap-134.255).
>
> "*How are you going to protect the water quality? We are concerned about mercury in fish, other animals, etc. Is there mercury or arsenic in the uranium solution?"* (21-EN-LLRIB-392.15).
>
> "What is the plan for storing and cleaning the water and where does it flow? What is the impact of ISR mining on water quality? "(21-EN-VILX-443.25).

[6] 19-EN-MN-SR3-1.2, 19-EN-ML82-1.3, 19-EN-MOE-1.4, 18-EN-VILX-3.33, 18-EN-VILX-3.35, 18-EN-VILX-3.39, and 18-EN-VILX-3.84.

Indigenous peoples shared their interest regarding the effects that changes to water quality may have on fish health. As an example the ERFN Trapper shared that:

> *"Russell is one lake where I commercially fish. How will this effluent impact the water quality, fish health? Will I be able to sell fish from here? If there is going to water pollution, I just want to know"* (19-LK-ERFNTrap-134.255).

Indigenous Knowledge and LK clearly identified the importance of water quality to local community members, plants, wildlife, and fish health. This affirms the necessity to include Fish Health as a VC in the EIS. It is understood based on engagement that additional detail is expected with respect to the potential effects of the Project on surface water quality and Fish Health, and this section of the EIS is responsive to that expectation.

8.5.3 Existing Environment

Details pertaining to existing conditions related to Surface Water Quantity (Section 8.1), Surface Water Quality, (Section 8.2), Fish and Fish Habitat (Section 8.3), Sediment Quality and Benthic Invertebrates (Section 8.4), and Groundwater (Section 7) that are relevant to the Fish Health VC, as together they describe aquatic environment conditions, are presented elsewhere in the EIS. In this subsection, fish tissue chemistry data collected as part of the baseline aquatic environment program are summarized. These data have not been presented previously in this EIS but are relevant to the consideration of the Fish Heath VC. Detailed information regarding fish tissue data collection and analyses are provided in Ecometrix (2020).

Fish tissue (i.e., flesh and bone) samples were analyzed by SRC Environmental Analytical Laboratories (Saskatoon, Saskatchewan) for the full series of constituents. Fifteen samples collected in September 2016 were destroyed at the laboratory during an ashing oven malfunction prior to radionuclide analyses. Additional fish tissue samples collected in May and June 2017 were analyzed for radionuclides and trace metals to compensate for these lost samples.

During the fish community assessment, five samples from a predator species (i.e., Northern Pike [*Esox lucius*]) and five samples from a forage species (i.e., White Sucker [*Catostomus commersonii*]) were collected at each sampling location for analysis of metals and radionuclides. In most cases, each sample was comprised of a single fish; however, to make sure that a sufficient volume of tissue was retained for analysis, some samples were comprised of two or three fish. Lengths, weights, and ages of fish comprising the samples are provided by Ecometrix (2020). Fish were gutted at the location where they were collected, and remains were returned to the waterbody. Flesh was removed from the bone either at the sampling location or at the camp the same day as capture. Flesh and bones were stored separately in individual Ziploc bags labelled with the date, sampling location, fish species, specimen number, and an indication of whether the sample contained 'flesh' or 'bone'. The samples were then frozen until delivery to the analytical laboratory. Constituent concentrations in fish tissues were determined based on the 'raw weight' and were compared to relevant guideline values. Guideline values for constituents in fish tissue are available for mercury (Health Canada 2007) and selenium (BC MOE 2014; US EPA 2021. Health Canada's total mercury guidelines of 0.5 µg/g wet weight (ww) is a human health risk-based maximum permissible concentration applied to most species of commercially sold fish. The BC MOE selenium guideline of 4 µg/g dry weight (dw) and the US EPA selenium guideline of 11.3 µg/g dw for fish muscle provide fish tissue concentrations that are protective of the health of freshwater aquatic life.

Critical locations of interest for this assessment include the following nodes, which are coincident with baseline monitoring stations and/or watersheds of interest for the assessment (Figure 8.5-4; Table 8.5-2).

- SA-1 – Fish community and habitat survey location on the stream colloquially known as the Icelander River, which is located downstream of LA-1 (McGowan Lake).
- SA-2 – Fish community and habitat survey location situated downstream of the outflow from LA-5 (Whitefish Lake) and upstream of the inflow to LA-1 (McGowan Lake).
- SA-4 – Fish community and habitat survey location situated upstream of the inflow to LA-6 (Unnamed Lake).
- SA-5 – Fish community and habitat survey location situated upstream of the inflow to LA-6 (Unnamed Lake).
- SA-6 – Fish community and habitat survey location situated downstream of the outflow from LA-6 (Whitefish Lake North) and upstream of the inflow to LA-5 (Whitefish Lake South).
- LA-1 – McGowan Lake.
- LA-5 – Whitefish Lake South.
- LA-6 – Whitefish Lake North.

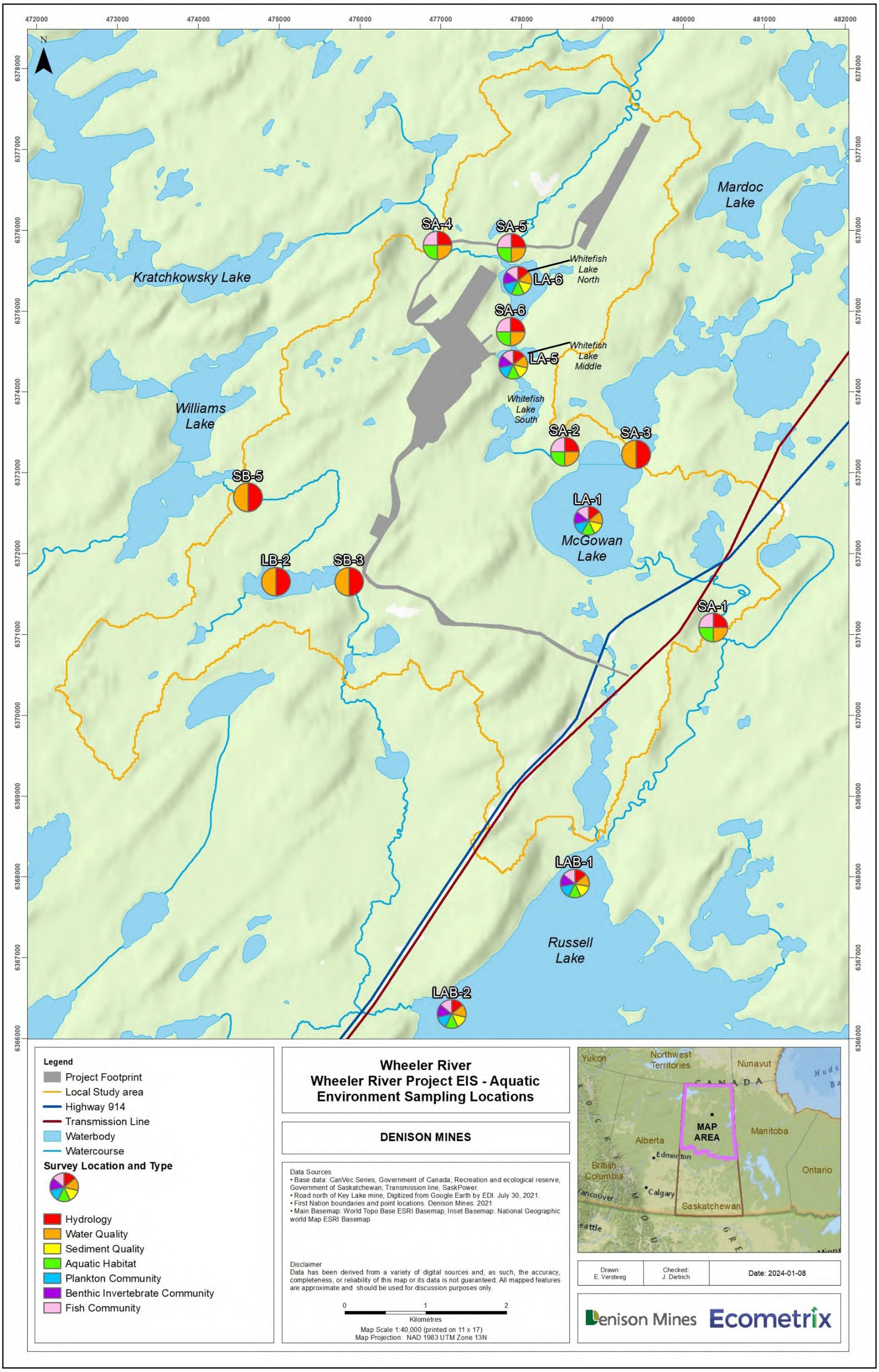

Figure 8.5-4: Water Quality, Biota, and Sediment Sampling Locations (2016 to 2018)

Fish bone and tissue samples for Northern Pike and White Sucker collected from McGowan Lake (LA-1), Whitefish Lake South (LA-5), Whitefish Lake North (LA-6), Kratchkowsky Lake (LA-7), and Russell Lake (LAB) were sent for chemical analysis. Summary results are presented in Table 8.5-2 for critical locations of interest within the LSA (i.e., McGowan Lake, Whitefish Lake North, and Whitefish Lake South), as well as for Russell Lake, which is the receiving waterbody. Detailed results, including additional constituents that were tested for and their summary stats, are provided in Ecometrix (2020).

In McGowan Lake, mean total mercury concentrations in Northern Pike (mean 0.17 ug/g ww) and White Sucker (mean 0.038 ug/g ww) tissue were below the Health Canada guideline of 0.5 ug/g ww. Mercury concentrations were higher in Northern Pike than in White Sucker, reflecting bioaccumulation through the aquatic food chain. Selenium concentrations in Northern Pike (mean 1.00 ug/g dw) and White Sucker (mean 1.29 ug/g dw) tissues were below the BC MOE and US EPA guidelines of 4 µg/g dw and 11.3 µg/g dw, respectively.

In Whitefish Lake South, total mercury concentrations in Northern Pike (mean 0.16 µg/g ww) and White Sucker (mean 0.045 µg/g ww) tissue were below the Health Canada guideline of 0.5 µg/g ww. Total mercury concentrations were higher in Northern Pike than in White Sucker, reflecting bioaccumulation through the aquatic food chain. Selenium concentrations in Northern Pike (mean 0.81 µg/g dw) and White Sucker (mean 1.03 µg/g dw) tissue were below the BC MOE and US EPA guidelines of 4 µg/g dw and 11.3 µg/g dw, respectively.

In Whitefish Lake North, total mercury concentrations in Northern Pike (mean 0.19 µg/g ww) and White Sucker (mean 0.04 µg/g ww) tissue were below the Health Canada guideline of 0.5 µg/g ww. Mercury concentrations were higher in Northern Pike than in White Sucker, reflecting bioaccumulation through the aquatic food chain. Selenium concentrations in Northern Pike (mean 0.92 µg/g dw) and White Sucker (mean 0.97 µg/g dw) tissue were below the BC MOE and US EPA guidelines of 4 µg/g dw and 11.3 µg/g dw, respectively.

In Russell Lake, total mercury concentrations in Northern Pike (mean 0.27 µg/g ww) and White Sucker (mean 0.027 µg/g ww) tissue were below the Health Canada guideline of 0.5 µg/g ww. Total mercury concentrations were higher in Northern Pike than in White Sucker, reflecting bioaccumulation through the aquatic food chain. Selenium concentrations in Northern Pike (mean 1.62 µg/g dw) and White Sucker (mean 2.15 µg/g dw) tissue were below the BC MOE and US EPA guidelines of 4 µg/g dw and 11.3 µg/g dw, respectively.

When selenium concentrations in fish are compared to the recently published ECCC FEQG (2022), fish concentrations are below the whole body and egg-ovary guidelines at all locations.

Table 8.5-2: Baseline Fish Tissue Chemistry Summary Values for Waterbodies Within the Local Study Area and Russell Lake

Parameter	Statistic	McGowan Lake (LA-1)				Whitefish Lake South (LA-5)				Whitefish Lake North (LA-6)				Russell Lake (LAB)			
		Northern Pike		White Sucker		Northern Pike		White Sucker		Northern Pike		White Sucker		Northern Pike		White Sucker	
		Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue
Aluminum (ug/g)	Min	0.5	0.5	0.5	0.5	0.5	0.5	0.7	0.5	0.8	0.5	0.5	0.5	0.8	0.5	0.5	0.5
	Max	1.3	1.0	1.4	0.8	1.3	1.3	1.7	0.9	1.5	1.1	1.0	0.9	1.3	0.5	1.4	0.5
	Mean	0.7	0.6	0.8	0.6	0.8	0.7	1.1	0.6	1.1	0.8	0.8	0.7	1.1	0.5	0.8	0.5
Antimony (ug/g)	Min	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02
	Max	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02
	Mean	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02
Arsenic (ug/g)	Min	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.02	0.01
	Max	0.03	0.01	0.03	0.05	0.03	0.01	0.06	0.04	0.03	0.02	0.07	0.06	0.05	0.02	0.03	0.05
	Mean	0.02	0.01	0.02	0.03	0.02	0.01	0.05	0.03	0.02	0.01	0.05	0.04	0.03	0.02	0.02	0.03
Barium (ug/g)	Min	2.2	0.01	3.2	0.06	6.4	0.01	3	0.01	2.9	0.01	3.6	0.02	1.9	0.01	1.3	0.02
	Max	9.8	0.1	7.3	0.25	7.2	0.06	8.5	0.17	8	0.09	5.6	0.05	3.7	0.18	2.4	0.04
	Mean	4.9	0.03	4.8	0.14	6.9	0.02	5.6	0.07	5.8	0.05	4.5	0.04	2.8	0.06	2.1	0.03
Beryllium (ug/g)	Min	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002
	Max	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002
	Mean	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002
Boron (ug/g)	Min	0.5	0.2	0.5	0.2	0.5	0.2	0.5	0.2	0.5	0.2	0.5	0.2	0.5	0.2	0.5	0.2
	Max	0.5	0.2	0.5	0.2	0.5	0.2	0.5	0.2	0.5	0.2	0.5	0.2	0.5	0.2	0.5	0.2
	Mean	0.5	0.2	0.5	0.2	0.5	0.2	0.5	0.2	0.5	0.2	0.5	0.2	0.5	0.2	0.5	0.2
Cadmium (ug/g)	Min	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002
	Max	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002
	Mean	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002
Chromium (ug/g)	Min	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1
	Max	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1

Parameter	Statistic	McGowan Lake (LA-1)				Whitefish Lake South (LA-5)				Whitefish Lake North (LA-6)				Russell Lake (LAB)			
		Northern Pike		White Sucker		Northern Pike		White Sucker		Northern Pike		White Sucker		Northern Pike		White Sucker	
		Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue
	Mean	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1
Cobalt (ug/g)	Min	0.05	0.002	0.06	0.002	0.06	0.002	0.05	0.002	0.04	0.002	0.06	0.002	0.12	0.002	0.05	0.002
	Max	0.16	0.005	0.14	0.014	0.10	0.014	0.17	0.009	0.13	0.01	0.13	0.056	0.18	0.008	0.13	0.018
	Mean	0.09	0.003	0.09	0.005	0.09	0.007	0.11	0.004	0.10	0.003	0.10	0.02	0.14	0.003	0.09	0.007
Copper (ug/g)	Min	0.16	0.14	0.27	0.17	0.08	0.09	0.26	0.16	0.26	0.15	0.42	0.2	0.06	0.08	0.38	0.16
	Max	0.82	0.55	0.46	0.62	0.16	0.14	1.6	0.42	0.63	0.23	0.93	0.42	0.44	0.46	0.66	0.32
	Mean	0.46	0.28	0.40	0.28	0.10	0.11	0.99	0.32	0.52	0.17	0.75	0.30	0.26	0.18	0.51	0.23
Iron (ug/g)	Min	2.7	1.9	4.1	2.2	1.4	0.8	6.7	2.3	3.3	1.4	4	1.7	3.3	0.8	6.8	1.3
	Max	7.7	6.4	9.8	4.6	11	2.3	18	6.2	8.6	2.4	16	3.5	150	4.7	12	2.3
	Mean	5.1	3.5	7.4	3.2	4.8	1.2	10	4.0	5.1	1.6	9.3	2.7	29	2.3	9.3	1.9
Lead (ug/g)	Min	0.010	0.002	0.010	0.002	0.010	0.002	0.010	0.002	0.010	0.002	0.010	0.002	0.010	0.002	0.010	0.002
	Max	0.040	0.003	0.030	0.009	0.010	0.004	0.090	0.006	0.030	0.004	0.040	0.003	0.030	0.002	0.100	0.002
	Mean	0.022	0.002	0.013	0.004	0.010	0.002	0.048	0.003	0.020	0.002	0.025	0.002	0.013	0.002	0.030	0.002
Manganese (ug/g)	Min	5.7	0.08	10	0.12	12	0.08	18	0.12	6	0.08	17	0.09	17	0.08	41	0.16
	Max	20	0.13	35	1.1	17	0.12	38	0.70	15	0.23	36	0.28	41	0.2	68	0.42
	Mean	15	0.10	23	0.36	14	0.11	26	0.23	11	0.13	26	0.16	26	0.13	54	0.24
Total Mercury (ug/g)	Min	0.02	0.075	0.01	0.022	0.02	0.047	0.01	0.014	0.03	0.074	0.02	0.024	0.02	0.14	0.01	0.021
	Max	0.2	0.43	0.02	0.068	0.06	0.23	0.03	0.076	0.08	0.3	0.03	0.07	0.14	0.48	0.02	0.043
	Mean	0.06	0.17	0.02	0.038	0.04	0.16	0.02	0.045	0.05	0.19	0.02	0.04	0.05	0.27	0.01	0.027
Molybdenum (ug/g)	Min	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.13	0.02
	Max	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.23	0.02
	Mean	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.18	0.02
Nickel (ug/g)	Min	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01
	Max	0.09	0.03	0.12	0.11	0.03	0.02	0.07	0.03	0.09	0.02	0.08	0.08	0.06	0.01	0.02	0.01
	Mean	0.04	0.01	0.04	0.03	0.02	0.01	0.05	0.02	0.04	0.01	0.04	0.03	0.03	0.01	0.02	0.01

Parameter	Statistic	McGowan Lake (LA-1)				Whitefish Lake South (LA-5)				Whitefish Lake North (LA-6)				Russell Lake (LAB)			
		Northern Pike		White Sucker		Northern Pike		White Sucker		Northern Pike		White Sucker		Northern Pike		White Sucker	
		Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue
Selenium (ug/g) wet weight	Min	0.12	0.19	0.13	0.21	0.09	0.15	0.14	0.17	0.11	0.19	0.15	0.18	0.2	0.25	0.32	0.33
	Max	0.2	0.25	0.26	0.3	0.17	0.19	0.23	0.28	0.16	0.23	0.22	0.24	0.27	0.53	0.59	0.56
	Mean	0.16	0.22	0.19	0.27	0.11	0.17	0.19	0.22	0.14	0.21	0.18	0.22	0.23	0.35	0.44	0.44
Selenium (ug/g) dry weight	Min	0.30	0.85	0.27	0.88	0.22	0.71	0.29	0.83	0.22	0.85	0.32	0.84	0.39	1.32	0.81	1.69
	Max	0.53	1.16	0.59	1.48	0.41	0.9	0.50	1.27	0.41	1.04	0.52	1.12	0.69	2.34	1.51	2.15
	Mean	0.41	1.00	0.45	1.29	0.28	0.81	0.41	1.03	0.31	0.92	0.40	0.97	0.52	1.62	1.16	2.66
Silver (ug/g)	Min	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002
	Max	0.01	0.002	0.02	0.018	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002
	Mean	0.01	0.002	0.01	0.005	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002	0.01	0.002
Strontium (ug/g)	Min	41	0.07	111	0.22	121	0.1	87	0.06	50	0.09	92	0.12	39	0.04	40	0.05
	Max	173	0.58	188	2.5	162	0.37	211	2.5	128	1.1	165	0.68	100	0.43	75	0.33
	Mean	112	0.23	138	0.85	150	0.21	149	0.57	106	0.39	127	0.30	72	0.15	63	0.14
Thallium (ug/g)	Min	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01
	Max	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01
	Mean	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01
Tin (ug/g)	Min	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01
	Max	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01
	Mean	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01
Titanium (ug/g)	Min	0.02	0.01	0.04	0.01	0.03	0.01	0.02	0.01	0.02	0.01	0.03	0.01	0.02	0.01	0.03	0.01
	Max	0.33	0.04	0.52	0.03	0.06	0.04	0.25	0.07	0.24	0.02	0.23	0.02	0.46	0.02	0.11	0.02
	Mean	0.14	0.02	0.19	0.02	0.05	0.02	0.07	0.02	0.08	0.02	0.07	0.01	0.15	0.01	0.062	0.012
Uranium (ug/g)	Min	0.01	0.001	0.01	0.001	0.01	0.001	0.01	0.001	0.01	0.001	0.01	0.001	0.01	0.001	0.01	0.001
	Max	0.01	0.001	0.01	0.001	0.01	0.001	0.01	0.006	0.01	0.002	0.01	0.001	0.01	0.001	0.01	0.001
	Mean	0.01	0.001	0.01	0.001	0.01	0.001	0.01	0.002	0.01	0.001	0.01	0.001	0.01	0.001	0.01	0.001
Vanadium (ug/g)	Min	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02

Parameter	Statistic	McGowan Lake (LA-1)				Whitefish Lake South (LA-5)				Whitefish Lake North (LA-6)				Russell Lake (LAB)			
		Northern Pike		White Sucker		Northern Pike		White Sucker		Northern Pike		White Sucker		Northern Pike		White Sucker	
		Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue	Bone	Tissue
	Max	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02
	Mean	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.05	0.02
Zinc (ug/g)	Min	32	3.5	16	3.6	30	3.1	15	2.8	34	3.1	16	3	31	3.7	16	3
	Max	64	9.7	21	4.9	54	4.4	33	6.5	56	4.6	22	4.3	75	9.8	26	3.9
	Mean	48	6.5	19	4.2	39	3.6	23	4.5	42	4.0	19	3.6	54	6.1	22	3.4
Lead-210 (Bq/g)	Min	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.001
	Max	0.002	0.001	0.007	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.001
	Mean	0.002	0.001	0.003	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.001
Polonium-210 (Bq/g)	Min	0.0005	0.0002	0.001	0.0006	0.0005	0.0002	0.001	0.0006	0.0005	0.0006	0.002	0.0008	0.0005	0.001	0.0005	0.0008
	Max	0.001	0.0015	0.004	0.0015	0.003	0.0021	0.003	0.0016	0.002	0.0026	0.004	0.0018	0.001	0.003	0.005	0.0021
	Mean	0.0007	0.0008	0.003	0.001	0.0012	0.0007	0.002	0.001	0.001	0.001	0.003	0.001	0.0008	0.002	0.003	0.001
Radium-226 (Bq/g)	Min	0.0007	0.00006	0.0009	0.00008	0.0008	0.00006	0.0008	0.00006	0.0009	0.00006	0.0008	0.00006	0.0007	0.00003	0.0008	0.00007
	Max	0.001	0.0002	0.001	0.0002	0.002	0.0002	0.001	0.00009	0.001	0.00009	0.001	0.0001	0.001	0.001	0.001	0.0004
	Mean	0.0009	0.0001	0.001	0.0001	0.001	0.0001	0.001	0.00008	0.001	0.00007	0.001	0.00008	0.0010	0.0002	0.0009	0.0002
Thorium-228 (Bq/g)	Min	0.001	0.0001	0.002	0.0002	0.002	0.0001	0.002	0.0001	0.002	0.0002	0.002	0.0002	0.001	0.0001	-	-
	Max	0.002	0.0004	0.002	0.0003	0.002	0.0002	0.002	0.0002	0.002	0.0002	0.002	0.0002	0.001	0.0001	-	-
	Mean	0.002	0.0003	0.002	0.0003	0.002	0.0001	0.002	0.0001	0.002	0.0002	0.002	0.0002	0.001	0.0001	-	-
Thorium-230 (Bq/g)	Min	0.001	0.0001	0.002	0.0002	0.002	0.0001	0.002	0.0001	0.002	0.0001	0.002	0.0001	0.001	0.00006	0.002	0.0001
	Max	0.003	0.0004	0.002	0.0003	0.002	0.0002	0.002	0.0002	0.003	0.0002	0.003	0.0002	0.003	0.0002	0.002	0.0002
	Mean	0.002	0.00022	0.002	0.00022	0.002	0.0001	0.002	0.0002	0.002	0.0002	0.002	0.0002	0.002	0.0001	0.002	0.0002

8.5.4 Assessment of Project-related Effects

8.5.4.1 Potential Interactions Between the Project and Valued Component / Key Indicators

The Project will require the construction, operation, and decommissioning of several components (as described in Section 2). Potential interactions between Project activities and the Fish Health VC are summarized by Project phase in Table 8.5-3 and are ranked as:

- Primary Interaction (✓): Project activity is expected to interact with the VC/KI, which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- Other Interaction (✓): Project activity is expected to interact with the VC/KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

Based on professional judgment and understanding of the nature of Project activities and their sequencing, the Project activity list was reviewed to determine the type of interactions. Potential Project-related effects are discussed in Section 8.5.4.2. Primary Project activities with the potential for adverse effects on Fish Health (i.e., flagged as 'Primary Interactions') are expected to involve surface land clearing, major earthworks, surface/grading preparations, changes to land cover, water management feature construction and function, and water taking and effluent discharge. Other Project activities (i.e., flagged as 'Other interactions') refer to those activities that may be associated with hydrogeological influences on local waterbodies and are expected to be secondary contributors to potential adverse effects. The remaining activities (e.g., power generation and supply) were deemed to have no interaction and was not carried forward in the assessment as they are not expected to result in detectable changes in the MPs associated with Fish Health. Activities during Post-Decommissioning (e.g., site inspections; monitoring and on-site engagement with Interested Parties) were deemed to have no interaction because they do not involve any land clearing, surface preparations, or major earthworks.

Table 8.5-3: Potential Project Interactions for Fish Health

Project Phase/Activity	Indicator		
	Surface Water Quality	Sediment Quality	Fish Tissue Concentrations
Construction Activities			
Development of access roads and air strip	✓	✓	✓
Site preparation and earthworks; clearing, levelling, and grading of the Project Area	✓	✓	✓
Power generation – generators			

Project Phase/Activity	Indicator		
	Surface Water Quality	Sediment Quality	Fish Tissue Concentrations
Installation of main substation and distribution of power around site			
Wellfield and freeze hole drilling; ground freezing	✓	✓	✓
Batch plant operation (concrete); crusher at borrow area			
Development of surface infrastructure (camp, operations centre, plants, ponds, pads, and support facilities)	✓	✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	✓	✓	✓
Water management (including treatment and site runoff)	✓	✓	✓
Groundwater supply	✓	✓	✓
Surface water withdrawal	✓	✓	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)			
On-site and off-site operation of vehicles and transport of materials	✓	✓	✓
Air transportation for workers			
Regulatory site inspections			
Engagement – site visit from Interested Parties			
Operation Activities			
Operation of the ISR wellfield	✓	✓	✓
Wellfield and freeze wall drilling	✓	✓	✓
Operation and expansion of freeze wall	✓	✓	✓
Batch plant operation (grout and cement); crusher in borrow area			
Expansion of pond and pads	✓	✓	✓
Operation of the processing plant and production of uranium concentrate	✓	✓	✓
Water withdrawal from groundwater or surface waterbody	✓	✓	✓
Management of surface water (including seepage and site runoff)	✓	✓	✓
Water treatment, both domestic and industrial	✓	✓	✓
Water release to surface waterbody	✓	✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	✓	✓	✓
Hazardous waste management (temporary storage, handling, and off-site transportation)			
Storage and disposal of drill waste rock, process precipitates, and industrial wastewater treatment plant precipitates	✓	✓	✓

Project Phase/Activity	Indicator		
	Surface Water Quality	Sediment Quality	Fish Tissue Concentrations
On-site and off-site operation of vehicles and transport of materials	✓	✓	✓
Power supply – primarily power from the grid, also generators and back-up generators			
Package and transport of nuclear substances			
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)			
Air transportation for workers			
Progressive decommissioning and reclamation	✓	✓	✓
Regulatory site inspections			
Engagement – site visit from Interested Parties			
Decommissioning Activities			
Site water management, treatment, and release	✓	✓	✓
Mining horizon remediation and thawing of freeze wall	✓	✓	✓
Process water treatment and release	✓	✓	✓
Closure of ISR and freeze wells and related infrastructure	✓	✓	✓
Decontamination of surface facilities and injection, recovery, and monitoring wells	✓	✓	✓
Asset removal (including site power transmission lines and electrical infrastructure)			
Demolition and disposal of non-salvageable surface infrastructure and materials	✓	✓	✓
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	✓	✓	✓
Generators			
Waste management (composting and landfill operation)	✓	✓	✓
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)	✓	✓	✓
On-site and off-site operation of vehicles and transport of materials			
Reclamation of disturbed areas	✓	✓	✓
Regulatory site inspections			
Engagement – site visit from Interested Parties			
Post-Decommissioning Activities			
Environmental monitoring	✓	✓	✓
Regulatory site inspections			
Engagement – site visit from Interested Parties			

8.5.4.2 Potential Project-related Effects

Potential Project-related effects on Fish Health are directly related to changes in surface water quality and are assessed on this basis. Project activities may interact with surface water quality and, therefore, fish health during all Project phases. In general, the interactions can be characterized as being primarily associated with controlled, routine discharges from the Project site. During site preparation and construction, the primary effect pathway relates to the mobilization of suspended material into natural surface water features as a result of land disturbance and clearing. During Operation and Decommissioning, excess water from the effluent monitoring ponds will be released to the environment. Routine discharge of this sort will be directed to Whitefish Lake only. Direct discharge of treated effluent to the natural environment has the potential to change surface water constituent concentrations. Constituents of potential concern in the aquatic environment have the potential to be taken up by fish through fish life functions (i.e., respiration, ingestion, and absorption). Decommissioning will involve the restoration of natural site drainage to the Whitefish Lake receiver and, similar to Construction, Decommissioning activities have the potential to increase the mobilization of suspended solids into natural surface waters. The following sections discuss each predicted effect.

8.5.4.2.1 Mobilization of Suspended Materials

Construction

The primary effect pathway during Construction relates to the mobilization of suspended material into natural surface water features as a result of land disturbance and clearing. According to the site water balance (Figure 2.2-14 in Section 2), there is no planned discharge to Whitefish Lake during Construction. The mobilization of suspended material into natural surface water features is readily mitigatable by virtue of the mine development plan and through the implementation of standard water management and sediment control practices. Water management infrastructure (e.g., collection ditches, ponds, pumping stations) and various aspects of the water management and sediment control management systems will be put into place coincident with the initiation of construction activities. Waters (e.g., runoff) associated with areas under development will be collected and stored within management infrastructure (e.g., clean waste rock pond, Figure 2.2-14 in Section 2). In the event that releases to the natural environment are necessary, they will only occur once it is safe to do so (i.e., suspended solid levels in the water would be at acceptable levels). No downstream effects on surface waters, natural sediments, or fish health are expected.

Operation

During Operation, mobilization of suspended materials will be managed through the development and operation of water management infrastructure and implementation of the Surface Water Management Program. Releases of contact water to the natural environment will be directed through applicable collection ponds, IWWTP, and Effluent Monitoring and Release Ponds. Discharge will only occur once it is safe to do so (i.e., suspended solids levels in the water would be at acceptable levels). Denison may employ active means (e.g., filtering), if required, to achieve low TSS levels in discharge, in addition to passive means, such as settling and clarification in the IWWTP to manage TSS in the effluent stream to low levels. No downstream effects on surface waters, natural sediments, or fish health are expected.

Decommissioning and Post-Decommissioning

During Decommissioning and Post-Decommissioning, the site-wide management system will continue to operate such that Denison will maintain control of the site aspect affected water through the IWWTP. Surface drainage during Decommissioning activities will continue to be directed to the system of collection ponds, IWWTP, and Effluent Monitoring and Release Ponds to facilitate the control of suspended solids and achieve low TSS levels in the discharge, thereby minimizing any potential for adverse changes to water quality, sediment quality, sedimentation, fish health.

8.5.4.2.2 Controlled Discharge to Receiving Environments

Construction

Discharge to the environment is not expected during Construction. Site contact water will be collected and held in the Clean Waste Rock Pond (Figure 2.2-14 in Section 2). Therefore, potential effects of discharge on the Fish Health VC are not expected.

Operation

Denison does not intend to include constant freshwater withdrawal or effluent discharge throughout Operation; however, for the purpose of assessing the scenario of greatest potential effects, the Project was assessed as having a continuous freshwater withdrawal rate of 40.5 m^3/hr and a continuous effluent discharge rate of 36.5 m^3/hr (Figure 2.2-15 in Section 2).

Fish Health was assessed as an ecological receptor as part of the *Wheeler River Environmental Risk Assessment* (Appendix 10-A in Section 10). The potential effects on Fish Health were assessed based on pathways through surface water quality and sediment quality for both radiological and non-radiological constituents.

Surface water and sediment quality modeling were completed using IMPACT™ version 5.6.0. The IMPACT™ programming code is consistent with the COPC transport equations outlined in CSA N288.1-20 (CSA Group 2020). The modeling is discussed in detail in the *IMPACT™ Model Report for the Wheeler River Project* (Appendix A of Appendix 10-A of Section 10). Waterbodies from Whitefish Lake to the Russell Lake inlet were modelled in IMPACT™ to assess the effects of the Project on the downstream environment, including the following distinct water polygons: Whitefish Lake Middle, Whitefish Lake South, McGowan Lake, and Russell Lake. Kratchkowsky Lake and Whitefish Lake North were modelled as reference locations. The geometric mean of measured water concentrations from baseline studies performed between 2011 and 2019 (Ecometrix 2019) were selected as the baseline concentrations for constituents that had measured data over the detection limit. Sediment baseline concentrations were predicted from surface water concentrations using the partitioning coefficients that are based on regional published values that have been calibrated at similar sites in northern Saskatchewan and were checked against data collected for the Project. The assessment of potential Project emissions (effluent) on water quality was based on estimated effluent concentrations of COPC as presented in Table 8.2-9 (Section 8.2.4.2.3).

Surface Water Quality

The estimation of potential changes in surface water quality as a result of effluent discharge to the environment are discussed in Sections 8.2.4.2.2, 8.2.4.2.3, and 8.2.4.2.4. These subsections discuss the methods, assumptions, and results of predictive models used to assess the potential effects on the receiving environment in the LSA.

The near-field analysis (Section 8.2.4.2.3) identified that under all flow regime scenarios (i.e., 7Q10, monthly low, and monthly average), constituents are expected to be well mixed within LA-5 and below the most restrictive criteria for the protection of aquatic life (Table 8.2-10; Appendix 8-E). Under induced water quality criteria chromium, copper, molybdenum, and selenium do not meet criteria for the protection of aquatic life, but these are conservative estimates and not yet based on BATEA. Additionally, the extent of the mixing zone in Whitefish Lake is estimated to be less than 5 m under all flow scenarios assessed (Table 8.2-11).

A regional surface water quality model was used to predict effects on surface water quality within Whitefish Lake outside the initial mixing zone (Section 8.2.4.2.4). When the treated effluent is released to Whitefish Lake (LA-5), surface water concentrations were predicted using IMPACT according to the equations outlined in the IMPACT model (Section 2.2.2 in Appendix A of Appendix 10-A in Section 10). The predicted maximum concentrations of COPC in water are summarized in Table 8.2-13. No predicted exceedances of water quality guidelines were identified for any of the COPC during Construction, Operation, or Decommissioning, with the exception of copper where baseline concentrations exceed the FEQG (due to the copper analytical detection limit being equal to the FEQG) and the guideline does not consider conditions expected during operations.

Sediment Quality

Sediment quality predictive modeling was completed using IMPACT version 5.6.0. IMPACT is consistent with the COPC transport equations outlined in CSA N288.1-20 (CSA Group 2020). The modeling is discussed in detail in the *IMPACT Model Report for the Wheeler River Project* (Appendix A of Appendix 10-A in Section 10). The geographic area assessed was consistent with the area identified for surface water quality. The results of this modelling are discussed in Section 8.4.4.2.3. Sediment baseline concentrations were predicted from surface water concentrations using the partitioning coefficients, which consist of regional published values that have been calibrated on similar sites in northern Saskatchewan and have been checked against data collected for the Project. Predicted concentrations of most COPC did not exceed sediment quality guidelines; however, molybdenum and selenium exceeded reference level values, but not no-effect (NE2) level as developed by Burnett-Seidel and Liber (2013) for application at Saskatchewan uranium operations (Appendix 10-A).

The Ecological Risk Assessment (Appendix 10-A) estimated dose and risk to representative aquatic receptors, including fish, during all Project phases, including the pathway through water quality and sediment quality. The potential for ecological effects was assessed by comparing exposure levels to toxicological benchmarks, and the potential effects were characterized quantitatively in terms of total HQs. A total HQ greater than one indicates adverse effects may be possible for a given ecological receptor and further investigation is warranted.

Risk to Fish Health

No significant adverse effects on aquatic populations or communities (including fish) as a result of releases from the Project were predicted during the Project phases. Estimated total HQs for all COPC for all ecological receptors were predicted to remain below the HQ benchmark of 1 (Table 8.5-4) with the exception of copper. Under baseline conditions (for hardness and pH), HQs for copper exceed the HQ of 1 for benthic invertebrates (all locations) and predatory fish (Whitefish Lake Middle and South). Under site operational conditions during periods of treated effluent discharge, the HQs for copper are below 1 (Section 10, Appendix 10A, Section 6.3.2).

An HQ is not typically calculated for radiological risk; however, a comparison of the total radiological dose (baseline plus Project) against the ecological dose benchmarks is presented as part of the Ecological Risk Assessment (Appendix 10-A).

There were no predicted exceedances of the 9.6 mGy/d radiation dose benchmark for aquatic biota in the Project area, LSA, or RSA during any phase of the Project. This includes Whitefish Lake, McGowan Lake, and Russell Lake as exposure locations, as well as Kratchkowsky Lake as a reference location. All predicted doses were predicted to be well below the radiation dose benchmarks (Appendix 10-A).

Table 8.5-4: Estimated Non-radiological Total Risk to Fish Ecological Receptors

Fish	Location	Maximum Total Hazard Quotients During Project Phases										
		Arsenic	Cadmium	Chloride	Cobalt	Chromium	Copper	Molybdenum	Sulphate	Selenium	Uranium	Zinc
Northern Pike	Reference (Kratchkowsky Lake)	1.89E-04	6.62E-02	3.26E-04	6.38E-05	5.05E-03	2.07E-01	1.34E-06	1.37E-03	6.10E-02	5.67E-05	2.19E-02
	Whitefish Lake North	1.75E-04	6.51E-02	3.26E-04	6.36E-05	4.99E-03	2.07E-01	1.34E-06	1.37E-03	5.97E-02	5.55E-05	2.15E-02
	Whitefish Lake Middle	2.32E-04	1.10E-01	6.60E-03	8.09E-05	7.10E-03	2.74E-01	3.04E-04	1.16E-01	7.87E-01	1.04E-03	3.32E-02
	Whitefish Lake South	2.36E-04	1.07E-01	6.57E-03	8.05E-05	6.95E-03	2.72E-01	2.99E-04	1.15E-01	7.49E-01	9.93E-04	3.23E-02
	McGowan Lake	2.00E-04	9.09E-02	4.51E-03	7.48E-05	6.22E-03	2.50E-01	1.97E-04	7.76E-02	4.69E-01	6.12E-04	2.81E-02
	Russell Lake Inlet	1.94E-04	8.36E-02	3.50E-03	7.20E-05	5.88E-03	2.39E-01	1.48E-04	5.91E-02	3.54E-01	4.56E-04	2.62E-02
White Sucker	Reference (Kratchkowsky Lake)	9.03E-04	8.10E-02	4.65E-04	2.47E-04	9.90E-04	3.10E-01	3.46E-06	2.29E-04	7.66E-02	2.04E-05	1.97E-02
	Whitefish Lake North	8.47E-04	8.00E-02	4.65E-04	2.47E-04	9.80E-04	3.09E-01	3.45E-06	2.29E-04	7.53E-02	2.01E-05	1.95E-02
	Whitefish Lake Middle	1.12E-03	1.30E-01	9.41E-03	3.10E-04	1.36E-03	4.03E-01	7.25E-04	1.93E-02	8.97E-01	3.40E-04	2.90E-02
	Whitefish Lake South	1.12E-03	1.27E-01	9.37E-03	3.08E-04	1.33E-03	4.01E-01	7.14E-04	1.92E-02	8.55E-01	3.24E-04	2.83E-02
	McGowan Lake	9.66E-04	1.09E-01	6.42E-03	2.88E-04	1.21E-03	3.71E-01	4.79E-04	1.29E-02	5.47E-01	2.04E-04	2.50E-02
	Russell Lake Inlet	9.33E-04	1.01E-01	5.00E-03	2.78E-04	1.14E-03	3.55E-01	3.61E-04	9.90E-03	4.15E-01	1.53E-04	2.35E-02

Fish Tissues

The recommended US EPA criterion for selenium in fish tissue (i.e., 11.3 mg/kg dw muscle; US EPA 2021) was used for large-bodied fish included in this assessment (i.e., Northern Pike and White Sucker). To compare against predicted selenium fish tissue concentrations that are in ww, the criterion needed to be adjusted from a dw to a ww basis based on the moisture content of the fish tissue collected. The dw to ww ratio of 0.25 to 1.0 from CSA N288.1-20 (CSA Group 2020) was used to convert the selenium criterion to a fresh weight (fw) basis (Appendix 10-A in Section 10).

Fish Tissue Criterion (mg/kg fw) = Fish Tissue Criterion (mg/kg dw) * 0.25 (kg dw/kg fw)

Therefore, the recommended criterion for selenium in fish tissue on a fw basis is 2.83 mg/kg ww muscle. The concentration of selenium in fish tissue is predicted to increase during Operation to an upper bound selenium concentration of 1.49 mg/kg (ww) for Northern Pike and 2.28 mg/kg (ww) for White Sucker; both of these vales are below the US EPA criterion for selenium. Following cessation of effluent discharge to the aquatic environment, selenium concentrations in fish tissues are predicted to return to background condition (Figure 8.5-5).

For other COPC assessments of risk to fish health (including molybdenum), a toxicity reference value was used. Toxicity reference values for aquatic biota, such as fish, are based on water concentrations. An HQ was used to provide a quantitative estimate of overall risk to fish health. For fish, the HQs were estimated as the ratio between the water concentration and the fish toxicity reference value. The predicted HQs for fish were less than one for all COPC during all phases of the Project (Table 8.5-4 and Appendix 10-A in Section 10) with the exception of copper (Section 10, Appendix 10A, Section 6.3.2). HQs for copper exceed the HQ of 1 under baseline conditions for predatory fish in Whitefish Lake Middle and South. Under site operational conditions during periods of treated effluent discharge, the HQs for copper are below 1(Section 10, Appendix 10A, Section 6.3.2). Risk to fish health is not expected.

Local Indigenous communities have expressed direct concern with respect to mercury. Mercury has not been identified as a COPC for the Project as it is currently not present in the receiving environment (i.e., background condition) at detectable concentrations and will not be produced as part of the mine process and therefore, not discharged to the aquatic environment. However, it is understood that potential nutrient enrichment-related effects are possible and can be linked to increases in mercury in the environment. Denison notes that there is potential for increased methylmercury production in the receiving environment under a certain combination of factors to which the Project may contribute, such as increased nutrient levels in the environment; and will undertake monitoring or total mercury and methylmercury in the aquatic environment over the life of the Project. Further details of such monitoring are provided in Section 8.5.8.

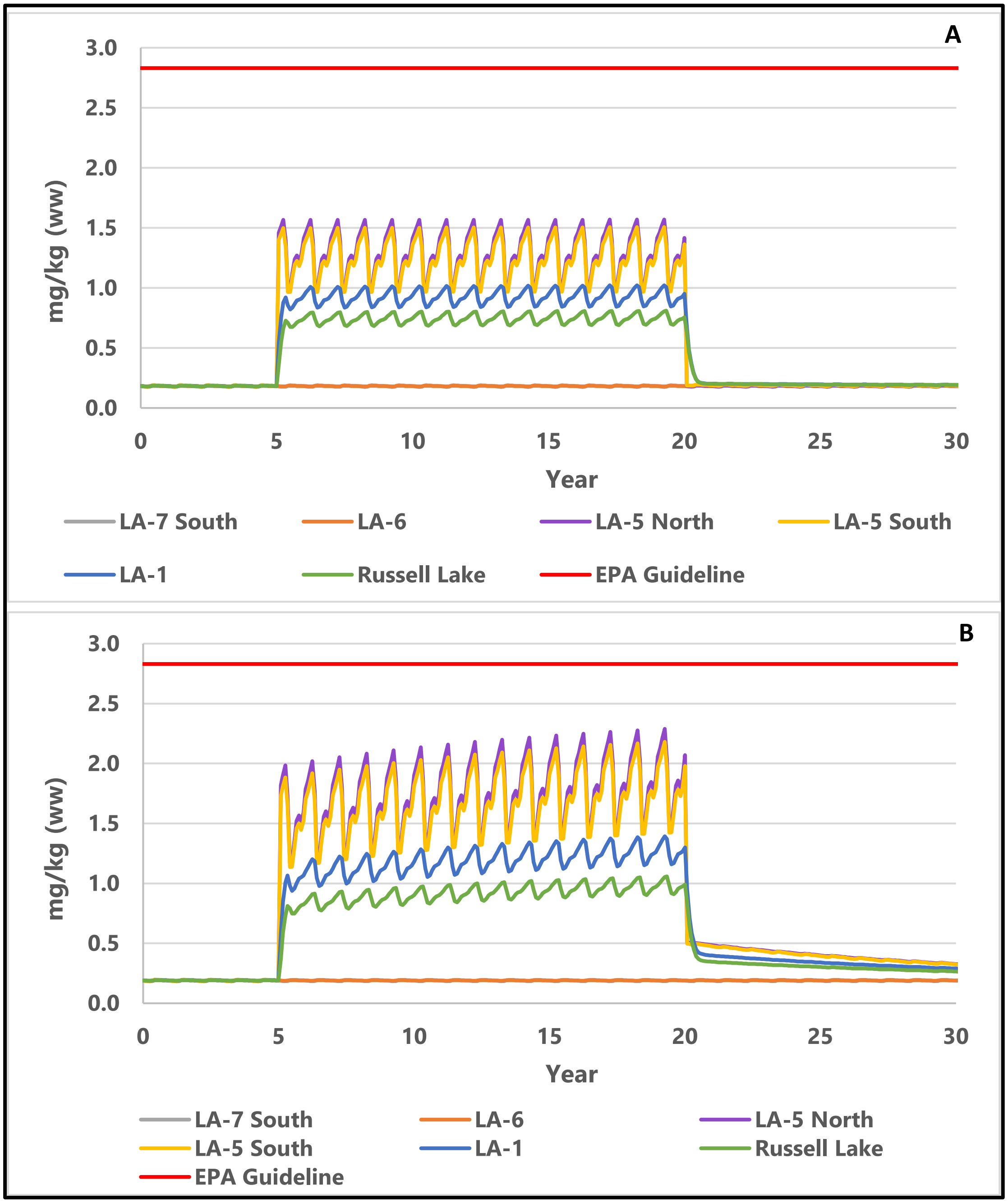

Figure 8.5-5: Predicted Selenium Concentrations in Fish Tissues Against Criterion for Key Indictor Species (A) Northern Pike (B) White Sucker

Decommissioning and Post-Decommissioning

Discharge to the aquatic environment of Whitefish Lake during some portion of Decommissioning is expected. Effluent rates during Decommissioning are expected to be less than during Operation. Effluent water quality is also expected to have lower levels of COPC compared to Operation. Therefore, the analysis of the potential effects on the Fish Health VC via surface water quality and sediment quality pathways during Operation provided in Section 8.5.4.2.2 is considered the bounding scenario for Decommissioning as well. No effects on sediment quality are expected as a result of effluent discharge.

8.5.4.2.3 Long-Term Transport of Groundwater Solutes to Whitefish Lake in Future Centuries

During the 'future centuries' phase as described in Section 8.5.1.3, remediation works will be completed, and the site naturalized, thereby restoring drainage patterns to report to surface waterbodies. As indicated in Section 7 of the EIS, groundwater plumes may develop from residual mass remaining post mining based on bench-scale lab tests of core flushing, and numerical modelling of reactive fate and transport.

Groundwater flow and reactive transport of dissolved constituents were modelled using three-dimensional modelling whereby the reactions were computed using PHREEQC and the transport was computed using FEFLOW (Ecometrix 2022). Groundwater flow observed, and simulated in the calibrated groundwater model, travels eastward from the mining zone within the Lower Sandstone Aquifer before moving upward through the Desilicified Zone in the Athabasca Sandstone and overlying overburden deposits toward Whitefish Lake. Modelled transport of dissolved constituents along the groundwater flow path allowed for interactions of the dissolved constituents with the geologic media through which they are flowing. Due to the relatively low groundwater velocities between the mining zone and Whitefish Lake and chemical reactions along the groundwater flow pathway, the "Future Centuries" scenario spans 100s to 1000s of years.

The results of the numerical modelling, as provided in Section 7 and Appendix 10-A in Section 10, support the conclusion that with the implementation of appropriate mitigation during the decommissioning and restoration phase of the Project, the residual effects of the Project on the intermediate Groundwater VC will not result in an adverse effect to surface water. Dissolved constituent concentrations emanating over hundreds to thousands of years in the future from the deep Ore Zone to Whitefish Lake remain below fresh water environmental quality criteria in Whitefish Lake.

For the COPC identified in the effluent, the predicted mass flux from groundwater into Whitefish Lake starting 200 years after the Project phases during the future centuries was added into the IMPACT model to predict the surficial sediment concentrations over time at the exposed locations (see Table 8.5-5). As shown in the ERA (Appendix 10-A in Section 10), predicted surface water concentrations at all locations are expected to be below water guidelines for the protection of aquatic life, except for copper where incremental increase in concentration is predicted such that the predicted copper concentration (0.0006 mg/L) would be greater than the FEQG of 0.0002 mg/L under baseline conditions, indicating a slight increased level of risk to the most sensitive aquatic biota.

Table 8.5-5: Predicted Maximum Concentrations of Sediment Constituents of Potential Concern during Future Centuries

Constituent	Unit	Kratchkowsky Lake (LA-7)	Whitefish Lake North (LA-6)	Whitefish Lake Middle (LA-5 North)	Whitefish Lake South (LA-5 South)	McGowan Lake (LA-1)	Russell Lake Inlet	Sediment Quality Guidelines					
								Burnett-Seidel and Liber		Thompson et al.		CCME	
								REF	NE2	LEL	SEL	ISQG	PEL
Chloride	mg/kg(dw)	2.81	2.81	3.62	3.61	3.43	3.29	--	--	--	--	--	--
Sulphate	mg/kg(dw)	6.00	6.00	6.29	6.29	6.22	6.17	--	--	--	--	--	--
Arsenic	mg/kg(dw)	**8.35**	**8.35**	**8.66**	**8.62**	**8.48**	**8.43**	21	522	9.8	346.4	5.9	17
Cadmium	mg/kg(dw)	0.34	0.34	0.34	0.34	0.34	0.34	--	--	--	--	0.6	3.5
Chromium	mg/kg(dw)	5.86	5.86	5.94	5.93	5.91	5.90	31.5	26.2	47.6	115.4	37.3	90
Cobalt	mg/kg(dw)	0.25	0.25	0.27	0.26	0.26	0.26	--	--	--	--	--	--
Copper	mg/kg(dw)	1.85	1.85	1.87	1.87	1.87	1.86	9.1	11.3	22.2	268.8	35.7	197
Lead	mg/kg(dw)	10.21	10.21	10.34	10.31	10.26	10.24	16.3	19.7	36.7	412.4	35	91.3
Molybdenum	mg/kg(dw)	0.34	0.34	0.37	0.37	0.36	0.35	23	245	13.8	1,239	--	--
Nickel	mg/kg(dw)	3.32	3.32	3.53	3.52	3.47	3.43	21	326	23.4	484	--	--
Selenium	mg/kg(dw)	0.62	0.62	0.83	0.82	0.76	0.72	3.6	30	1.9	16.1	--	--
Uranium	mg/kg(dw)	0.58	0.58	0.71	0.70	0.66	0.64	97	2,296	104.4	5,874	--	--
Zinc	mg/kg(dw)	9.93	9.93	10.79	10.76	10.52	10.37	--	--	--	--	123	315
Total Ammonia (N)	mg/kg(dw)	0.13	0.13	0.13	0.13	0.13	0.13	--	--	--	--	--	--
Thorium-230	Bq/kg(dw)	23.19	23.19	23.80	23.79	23.64	23.54	--	--	--	--	--	--
Radium-226	Bq/kg(dw)	65.14	65.14	74.67	74.39	71.82	70.13	--	--	600	14,400	--	--
Lead-210	Bq/kg(dw)	373.84	373.84	428.83	419.39	394.66	386.43	--	--	900	20,800	--	--
Polonium-210	Bq/kg(dw)	380.31	380.31	436.25	426.65	401.49	393.07	--	--	800	12,100	--	--
Total mercury	mg/kg(dw)	No background information or effluent concentration to model											

Constituent	Unit	Kratchkowsky Lake (LA-7)	Whitefish Lake North (LA-6)	Whitefish Lake Middle (LA-5 North)	Whitefish Lake South (LA-5 South)	McGowan Lake (LA-1)	Russell Lake Inlet	Sediment Quality Guidelines					
								Burnett-Seidel and Liber		Thompson et al.		CCME	
								REF	NE2	LEL	SEL	ISQG	PEL
Aluminum	mg/kg(dw)	Monitoring required in effluent under MDMER Schedule 5 - no criteria stipulated under this regulation											
Iron	mg/kg(dw)	Monitoring required in effluent under MDMER Schedule 5 - no criteria stipulated under this regulation											
Thallium	mg/kg(dw)	Monitoring required in effluent under MDMER Schedule 5 - no criteria stipulated under this regulation											
Manganese	mg/kg(dw)	Monitoring required in effluent under MDMER Schedule 5 - no criteria stipulated under this regulation											
Phosphorus	mg/kg(dw)	Monitoring required in effluent under MDMER Schedule 5 - no criteria stipulated under this regulation											

Note:

Bolded values indicate exceedance of the CCME ISQG

Estimated total HQs for all COPC for fish tissues during the ‘future centuries’ phase were predicted to be lower than those predicted for the period of mine life (i.e., construction through to post-decommissioning) and therefore below the HQ benchmark of 1 (Appendix 10-A in Section 10).

The concentration of selenium in fish tissue during the ‘future centuries’ phase is predicted to remain below 0.26 mg/kg ww muscle for both Northern Pike and White Sucker, which is well below the recommended criterion for selenium in fish tissue on a fresh weight basis of 2.83 mg/kg ww muscle (Appendix 10-A). Therefore, risk to fish health during this phase is not expected.

8.5.5 Mitigation Measures

Measures to mitigate adverse effects on Fish Health are consistent with those to mitigate adverse effects on Surface Water Quality and Sediment Quality. These mitigation measures are repeated in this section for completeness. To mitigate adverse effects on the Fish Health VC, Denison will implement the following mitigation measures.

- Inspect culverts periodically. Remove accumulated material and debris upstream and downstream of the culverts to prevent erosion, flooding, habitat damage, property damage, and mobilization of sediment.
- Develop and implement a Surface Water Management Program that provides an integrated framework to manage water quality, including provision for water management practices for each of the primary site aspects, as well as areas of the Project site where contact is expected.
- Maximize the recycle and reuse of process water to reduce freshwater intake and release to Whitefish Lake.
- Design the discharge diffuser/outfall to provide the smallest footprint possible while still achieving effective mixing and dilution, and to provide discharge flows that do not adversely effect sediments.
- Develop site-specific effluent treatment to treat COPC to appropriate release limits in accordance with provincial standards and licence/permit conditions.
- Discharge effluent under a scenario that will meet provincial and federal discharge criteria identified through permitting. Scenarios may include:
  - discharging at a fixed rate while maintaining an appropriate minimum dilution ratio (i.e., discharge when able to meet the required dilution ratio and cease discharge during periods when unable to meet the necessary dilution ratio);
  - discharging under a variable waste load allocation (i.e., discharge at an appropriate effluent volume based on flow in the receiver to maintain a minimum dilution ratio); and
  - managing discharge via a hybrid of the two previous scenarios (i.e., discharge effluent at a fixed rate to maintain the required dilution ratio, but the fixed rate can be varied on a seasonal basis based on flow).

- Collect and monitor contact water to determine whether treatment is required prior to release to the environment to inform optimal levels of treatment.
- Maintain the water management system during Decommissioning until such time that water quality is suitable to release to the environment.
- Monitor and manage effluent, including contingency for effluent treatment as may be required, so that water discharge objectives are achieved as defined by applicable provincial and federal regulatory instruments.
- Design and implement an environmental code of practice that defines action levels and appropriate steps to be taken to mitigate elevated concentrations of chemical and radiological constituents in treated effluent discharge to acceptable levels.
- Implement Project-specific monitoring programs (e.g., effluent monitoring plan, environmental monitoring plan) that include monitoring treated effluent, surface water, sediment quality, and fish tissue contaminant concentrations and applying adaptive management, if necessary.
- Work with the associated communities to develop and implement the Project-specific monitoring programs and a framework to share the results for the purpose of assessing the performance of the water management system.
- Develop and implement a decommissioning and reclamation plan to decommission and transfer the site to the province under the Institutional Control Program.

8.5.6 Residual Effects Evaluation

8.5.6.1 Residual Effects Characterization

General definitions of the residual effects characteristics are provided in Section 5.8. Residual effects characteristics specific to Fish Health are defined in Table 8.5-6 with evaluation of residual effects provided in Table 8.5-7, Table 8.5-8, and Table 8.5-9.

Table 8.5-6: Fish Health – Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Effect moves measurable parameters in a direction detrimental to fish health. *Water Quality* – An increase in constituent concentrations attributable to the Project in comparison to baseline conditions and trends. *Sediment Chemical Quality* – An increase in constituent concentrations attributable to the Project in comparison to baseline conditions and trends. *Fish Tissue Concentrations* – An increase in constituent concentrations attributable to the Project in comparison to baseline conditions and trends. **Positive** – Effect moves measurable parameters in a direction beneficial to fish health. An improvement in fish health in comparison to baseline conditions and trends.

Residual Effect Characteristic	Definition	Rating
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Low** – A measurable change that is not within the variability of baseline conditions but is below relevant sediment quality objectives and criteria. **Moderate** – A measurable change that is not within the variability of baseline conditions or within applicable guidelines, legislated requirements, and/or federal and provincial management objectives; therefore, the change could have an adverse effect on Fish Health in the LSA. **High** – A measurable change that is not within the variability of baseline conditions or within applicable guidelines, legislated requirement, and/or federal and provincial management objectives; therefore, the change is likely to have an adverse effect on Fish Health in the LSA, with the effect extending beyond the LSA.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the Fish Health LSA. **Regional** – Effect extends beyond the Fish Health LSA into the Fish Health RSA. **Beyond Regional** – Effect extends beyond the Fish Health RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions. **Partially Reversible** – A residual effect that partially diminishes to baseline conditions. **Irreversible** – A residual effect that will not diminish to baseline conditions.
Context	The extent to which the VC or KI has been affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its ability to recover from that effect (i.e., resilience).	**Low** – VC/KI has high resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or a lack of historic and ongoing anthropogenic or natural disturbance. **Moderate** – VC/KI has moderate resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or an intermediate level of historic or ongoing anthropogenic or natural disturbance with the capacity to assimilate more change. **High** – VC/KI has weak resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or a high level of historic or ongoing anthropogenic or natural disturbance.
Likelihood	Likelihood that the residual effect will occur, including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability that the residual effect will occur. **Unlikely** – A low probability that the residual effect will occur.

Table 8.5-7: Fish Health – Summary of the Characteristics Ratings in Relation to Water Quality

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project, and specifically the discharge of effluent to the natural environment, will cause a change in the concentration of constituents, as measured as a mass of a chemical per unit volume in water (e.g., mg/L). Surface water quality in the local receiving environment will be adversely affected by effluent discharge to the aquatic environment, thereby providing a pathway to adversely affect fish health.
Magnitude	Moderate	The magnitude of the residual effects associated with the Project is predicted to be low overall as the vast majority of constituents that may be introduced as part of Project activities are expected to remain below criteria for the protection of aquatic life and human health. However, with the exceedance of the Cu FEQG and in response to Round 4 IR-114, the overall rating was conservatively changed to moderate, even though the copper values in the EIS have been overpredicted in the models for a number of reasons including the fact that the baseline water quality analytical detection limit for copper was equal to the Cu FEQG.
Geographic Extent	Local	The geographic extent of the residual effects is predicted to be confined to the immediate waterbody adjacent to the Project (i.e., Whitefish Lake). The estimated mixing zone is less than 5 m, implementing an effluent discharge configuration that promotes mixing.
Duration	Long-term	Effects are expected to last between 3 to 38 years (i.e., effects expected during Construction through to the end of Post-Decommissioning).
Frequency	Continuous	For the purposes of this EIS, a conservative scenario was identified, with effluent discharge being considered as continuous during Operation and Decommissioning.
Reversibility	Fully Reversible	Surface water quality is expected to return to pre-development levels following Post-Decommissioning as Project-related sources will cease to operate.
Context	Low	Fish health is expected to be resilient to changes in surface water quality in the context of this assessment as COPC meet protective criteria even at the extreme low water scenario. Therefore, under applicable mitigative measures and average flow conditions, the contextual resilience of the aquatic system to respond to change is considered to be great.
Likelihood	Likely	A high probability exists that a change in water quality from background conditions will occur.

Table 8.5-8: Fish Health – Summary of the Characteristics Ratings in Relation to Sediment Quality

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project, and specifically the discharge of effluent to the natural environment, will cause a change in the concentration of constituents, which may be partitioned to sediment in the receiving water. Sediment quality in the local receiving environment will be adversely affected by effluent discharge to the environment, which may in turn affect fish health.
Magnitude	Low	The magnitude of the residual effects associated with the Project is predicted to be low as constituents that may be introduced as part of Project activities are expected to remain below criteria for the protection of aquatic life or below risk HQs.

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Geographic Extent	Local	The geographic extent of the residual effects is predicted to be confined to the immediate waterbody adjacent to the Project (i.e., Whitefish Lake). The estimated mixing zone is less than 5 m, implementing an effluent discharge configuration that promotes mixing.
Duration	Long-term	Effects are expected to last between 3 to 38 years (i.e., effects expected during Construction through to the end of Post-Decommissioning).
Frequency	Continuous	For the purposes of this EIS, a conservative scenario was identified, with effluent discharge being considered as continuous during Operation and Decommissioning.
Reversibility	Fully Reversible	Sediment quality is expected to return to pre-development levels following Post-Decommissioning as Project-related sources will cease to operate.
Context	Low	Fish health is expected to be resilient to changes in sediment quality in the context of this assessment as COPC meet protective criteria even at the extreme low water scenario. Therefore, under applicable mitigative measures and average flow conditions, the contextual resilience of the aquatic system to respond to change is considered to be great.
Likelihood	Likely	A high probability exists that a change in sediment quality from background conditions will occur.

Table 8.5-9: Fish Health – Summary of the Characteristics Ratings in Relation to Fish Tissue Concentrations

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project, and specifically the discharge of effluent to the natural environment, has the potential to change the concentration of constituents in fish tissues though ingestion, respiration, and absorption pathways.
Magnitude	Low	The magnitude of the residual effects associated with the Project is predicted to be low as constituents that may be introduced as part of Project activities are expected to remain below criteria for the protection of aquatic life or below risk HQs.
Geographic Extent	Local	The geographic extent of the residual effects is predicted to be confined to the immediate waterbody adjacent to the Project (i.e., Whitefish Lake). The estimated mixing zone is less than 5 m, implementing an effluent discharge configuration that promotes mixing.
Duration	Long-term	Effects are expected to last between 3 to 38 years (i.e., effects expected during Construction through to the end of Post-Decommissioning).
Frequency	Continuous	For the purposes of this EIS, a conservative scenario was identified, with effluent discharge being considered as continuous during Operation and Decommissioning.
Reversibility	Fully Reversible	Water quality and sediment quality are expected to return to pre-development levels following Post-Decommissioning as Project-related sources will cease to operate. As a result, exposure to COPC by fish will cease, reversing the potential for uptake of these constituents to fish tissues.
Context	Low	Fish health is expected to be resilient to changes in fish tissue concentrations in the context of this assessment as COPC meet protective criteria even at the extreme low water scenario.

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Likelihood	Likely	A high probability exists that a change in COPC concentrations in fish tissue from background condition will occur.

8.5.6.2 Significance and Confidence in the Assessment

The characterization of residual effects is based on the review of existing conditions, the assessment of Project-related effects and proposed mitigation measures and management strategies, other relevant scientific information, IK, and the professional judgment of the EA team.

The significance of the residual effect is rated as **not significant** or **significant**, based on the following:

Not significant – a residual effect that is not expected to result in a change to a VC/KI that would alter its population viability or persistence beyond an acceptable level (e.g., where it is not sustainable or is unavailable to contribute to biodiversity and ecosystem function).

Significant – a residual effect that is expected to result in a change to a VC/KI that would alter its population viability or persistence beyond an acceptable level (e.g., where it is not sustainable or is unavailable to contribute to biodiversity and ecosystem function).

The threshold for significance for the Fish Health VC relates to predicted changes in the concentrations of water quality parameters, sediment quality parameters, and/or fish tissue concentrations of COPC, whereby the changes could result in exceedances of relevant water quality, sediment quality, or fish tissue assessment benchmarks. These benchmarks represent concentrations that are protective of aquatic biota in waterbodies that receive mine-affected drainage.

With the proposed mitigation and environmental protection measures outlined in Section 8.5.5, the residual effects of the Project on Fish Health are predicted to be **not significant**. This determination is supported by the fact that the predicted changes in water quality, sediment quality, and fish tissue concentrations are not expected to result in exceedances of assessment benchmarks in the LSA.

Potential effects on Fish Health as a result of Project discharges to local receiving environments were assessed by way of numerical modeling. These predictions are generally considered conservative in nature because the assumptions on which they are based are conservative. For example:

- The assessment was based on a continuous (year round) discharge at an expected average effluent discharge rate of 0.0101 m^3/s (or 36.5 m^3/hr) throughout Construction, Operation, and Decommissioning despite the likelihood that effluent discharge will not be continuous and

Denison will only discharge when site water balance requires, based on water storage capabilities.

- Constituents in effluent discharge were estimated conservatively. Presented discharge concentrations provided herein include contingency factors of one to three times to facilitate conservancy.
- Baseline water quality and sediment quality were defined by the 95th percentile concentrations of individual constituents. Such an assumption is conservative as it constrains the assimilative capacity associated with the receiving environment. By definition, the assimilative capacity of a receiving environment is equal to the incremental difference between the existing baseline condition and the assessment benchmark (i.e., water quality criterion) on which the evaluation is based. Use of the 95th percentile concentration, rather than a measure of central tendency (i.e., 50th percentile, geomean), means that the incremental change for a given constituent concentration that can be assimilated by the receiving environment is relatively small in magnitude.
- Water quality predictions did not consider physical or chemical processes that may attenuate concentrations in the receiving environment. An example of such a process would be partitioning of constituents from the water column to Whitefish Lake sediments. No attempt was made to adjust water quality predictions to account for this portioning, despite using this relationship to consider the potential effects of discharge on sediment quality.

Due to the conservative nature of the assumptions on which the numerical assumptions were based, a high degree of confidence was assumed.

8.5.6.3 Summary of Project-related Residual Adverse Effects on Fish Health

Residual adverse effects on Fish Health are expected to occur during Construction, Operation, and Decommissioning through pathways previously identified. A summary of fish health residual environmental effects that are likely to occur as a result of the Project, and their significance, is provided in Table 8.5-10.

Table 8.5-10: Project Residual Effects on Fish Health

Residual Effect	Residual Effects Characterization									
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance Determination
Change in Water Quality	C, O, D	A	M	LSA	LT	CF	FR	L	L	NS
Change in Sediment Quality	C, O, D	A	L	LSA	LT	CF	FR	L	L	NS

Residual Effect	Residual Effects Characterization									
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance Determination
Change in Fish Tissue Concentrations	C, O, D	A	L	LSA	LT	CF	FR	L	L	NS

Notes:

Project Phase:	Construction (C), Operation (O), Decommissioning (D)
Direction:	Adverse (A), Positive (P)
Magnitude:	Low (L), Moderate (M), High (H)
Geographic Extent:	Project Area (PA), Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA)
Duration:	Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency:	Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility:	Reversible (FR), Partially Reversible (PR), Irreversible (IR)
Context:	Low (L), Moderate (M), High (H)
Likelihood:	Unlikely (U), Likely (L)
Significance:	Not Significant (NS), Significant (S)

8.5.7 Cumulative Effects

The spatial and temporal boundaries of the Project specific to the Fish Health VC are provided in Section 8.5.1.3. A description of the methods used in assessing cumulative effects is provided in Section 5.9.

8.5.7.1 Potential Cumulative Effects

Existing projects within the Wheeler River Watershed have been considered for potential to interact with the Surface Water Quality VC for the Project. These include reasonably foreseeable projects that are described in Section 5.9.

The Cameco Key Lake Operation has the potential to interact with the Fish Health VC for the Project (Figure 5.9.1) via the surface water pathway. The site has been in operation since 1983. In 2018, sustained low uranium prices resulted in a decision to curtail production for the foreseeable future and place the operation into safe care and maintenance. On February 9, 2022, Cameco announced plans for the operation's gradual return to production. Cameco's Key Lake Operation will overlap spatially and temporally with the Project.

The Project is situated approximately 35 km northeast of the Key Lake Operation and both are located in watersheds that ultimately report to Russell Lake. Releases to the aquatic environment from the Key Lake Operation are received by the David Creek, McDonald Creek, and Outlet Creek drainages. These three drainages join the Wheeler River, which then flows to Russell Lake (Cameco

2020). Therefore, a potential spatial overlap was identified for the Project and the Key Lake Operation and further assessed or cumulative effects.

The key potential cumulative effect pathway as it concerns the Fish Health VC is the surface water exposure pathway. The assessment of cumulative effects on the Fish Health VC considered surface water releases and partitioning to sediments from the Project and the Key Lake Operation during all phases of the Project. The key Project component contributing to potential cumulative effects is the discharge of treated effluent to the aquatic environment during Operation and Decommissioning which may interact with Cameco's current releases to water including treated water released to David Creek drainage, treated groundwater and diverted surface water to the McDonald Creek drainage (Cameco 2020).

Temporal overlap of the Key Lake Operation and the Project will also occur during 'future centuries' as described as 'post-decommissioning phase' in the Key Lake Extension Project EIS (Cameco 2020). There is potential for increased contaminant transport via groundwater to surface water during the long-term, post-decommissioning phase (i.e., 10,000 years after operations cease and the site has been reclaimed) for the Key Lake Operation. The long-term storage of tailings at a higher elevation has the potential to influence contaminants in the groundwater and incrementally add to the effect on surface water quality in the Outlet Creek Drainage.

Operation and Decommissioning

The assessment of cumulative effects on the aquatic environment considered releases from the Key Lake Operation and proposed Project during all phases of the Project. The primary Key Lake Operation component contributing to potential cumulative effects is the placement of tailings to a higher elevation in the Deilmann Tailings Management Facility (DTMF). The increased loadings from the DTMF are anticipated to result in an incremental (i.e., existing conditions plus the Project) increase of concentrations of COPCs in the aquatic environment (Cameco 2013). The spatial extent of any significant adverse effects on the aquatic environment from the Key Lake Operation were anticipated to be localized and not to extend to the Wheeler River and Russell Lake during any phase of the Project (Cameco 2013). The 2010 Status of the Environment report for the Key Lake Operation identified that no adverse effects to individual fish or fish populations are present in the Wheeler River (EcoMetrix 2010 as cited in Cameco 2020).

Potential Project residual effects on the Fish Health VC are primarily related to controlled discharge of site water into local receiving environments during all Project phases. Such changes are predicted to be negligible to low in magnitude and limited to the LSA. For example, during Construction, no discharge from the Project site is planned. During Operation, treated effluent will be discharged to Whitefish Lake. The Whitefish Lake discharge will be the only routine discharge location during Operation. Water quality in Whitefish Lake and, by extension, downstream of Whitefish Lake will meet appropriate benchmarks for the protection of aquatic life in consideration of a small mixing zone in the lake, which will remain within tolerable HQs for fish health. Changes to fish tissue concentrations in the LSA are also predicted to remain within or near existing levels and are not predicted to be associated with effects on Fish Health. Selenium levels in fish tissues in Russell Lake during operation will remain well below the EPA recommended criterion (less than 1.25 mg/kg ww and 2.83 mg/kg ww muscle, respectively). Following cessation of effluent discharge to the aquatic environment, selenium concentrations in fish tissues are predicted to return to background condition (Figure 8.5-5). Following Decommissioning and the restoration of drainage patterns that are similar to pre-mining conditions, water quality and sediment quality are expected to meet appropriate benchmarks for the protection of aquatic life in Whitefish Lake and downstream. This includes Russell Lake, of which the Icelander River system is associated.

In consideration of the above discussion, effects on the Fish Health VC due to changes in surface water quality from the Key Lake Operation are not anticipated to spatially overlap with those from the Project and therefore a cumulative effect is not expected.

Future Centuries

The 2013 Key Lake ERA indicated that during the 10,000-year post-decommissioning period, predicted exposure levels may affect lower trophic level aquatic biota on a population or community level within some isolated lakes in the SSA, but adverse effects on the ecology of the Outlet Creek drainage, and therefore further downstream were not expected during the post-decommissioning phase (Cameco 2013). The results of the 2020 ERA for the Key Lake Operation were consistent with the findings from the 2013 ERA in that there were limited significant risks posed to aquatic receptors situated in the area surrounding the Operation, but not to areas farther downstream. The 2020 ERA concluded that environmental health in the vicinity of the Key Lake Operation will remain protected (Cameco 2020).

The results of the numerical modelling for the Project, as provided in Section 7 and Appendix 10-A in Section 10, support the conclusion that with the implementation of appropriate mitigation during the decommissioning and mining area remediation phase of the Project, the residual effects of the Project on the intermediate Groundwater VC will not result in an adverse effect to surface water. Dissolved constituent concentrations emanating over hundreds to thousands of years in the future (“Future Centuries”) from the mining area to Whitefish Lake will be localized to that waterbody and remain below fresh water environmental quality criteria. As such, impacts to fish health in downstream portions of the drainage including Russell Lake are not expected.

In consideration of the above discussion, effects on fish health due to changes in surface water quality from the Key Lake Operation are not anticipated to spatially overlap with those from the Project and therefore a cumulative effect is not expected.

8.5.7.2 Additional Mitigation Measures

Additional mitigation measures are not warranted as no potential cumulative effects were identified for the Fish Health VC.

8.5.7.3 Cumulative Effects Characterization and Determination of Significance

A determination of significance is not warranted as no potential cumulative effects were identified for the Fish Health VC.

8.5.7.4 Cumulative Effects Assessment Summary

Effects on the aquatic environment and specifically the Fish Health VC due to changes in surface water quality or sediment quality from the Key Lake Operation are expected to remain localized and not extend to the Wheeler River system or Russell Lake. Likewise, impacts on surface water quality from the Project are expected to remain localized (Whitefish Lake) and not extend to Russell Lake. Effects on the aquatic environment due to changes in surface water quality associated with the Key Lake Operation are not anticipated to spatially overlap with those from the Project during operation/decommissioning or during "future centuries" and therefore a cumulative effect is not expected.

8.5.7.5 Environmental Monitoring and Follow-Up

Specific monitoring and follow-up for Fish Health related to cumulative effects are not needed as no cumulative effects were identified for this VC. Monitoring and follow-up specific to the Project for the Fish Health VC are detailed below in Section 8.5.8.

8.5.7.6 Climate Change Considerations

As discussed in Section 8.1.7.5, the frequency and magnitude of extreme precipitation events have the potential to change water levels and flows in the Project RSA, which may affect water quality, sediment transport, fish habitat and, subsequently, fish health. Changes to average and upper and lower bounds of ambient temperatures may also affect Fish and Fish Habitat, which in turn may affect Fish Health. Climate change over the life of the Project (i.e., 35 to 40 years) will be monitored as part of the Project's environmental monitoring programs, and influences on Water Quality, Sediment Quality, and Fish Health will require adaptive management to mitigate any potential effects of the Project that may be exacerbated by climate-related changes on the aquatic environment.

8.5.8 Monitoring and Follow-Up

For the purposes of this EIS, monitoring and follow-up are defined as follows:

- monitoring programs are designed to meet regulatory requirements (e.g., permit or license conditions) and/or to demonstrate compliance with environmental commitments made in the EIS; and
- follow-up programs are designed to address any uncertainties identified during the EA process (e.g., to verify predictions made during the EA; determine the effectiveness of proposed and implemented mitigation measures) and to determine if and when to implement adaptive management measures.

Monitoring and follow-up are proposed for the Fish Health VC to verify the accuracy of the predicted effects and the effectiveness of the proposed mitigation measures. The fish health monitoring program should be considered in conjunction with the surface water quality monitoring (Section 8.2.8), fish and fish habitat monitoring (Section 8.3.8), and sediment and benthic invertebrate monitoring (Section 8.4.8) programs as it is specifically tied to these monitoring programs from the perspective of pathways of effects. Specifically, monitoring of water quality in the effluent monitoring ponds and other catchment ponds prior to discharge to the environment will be important to provide context to further evaluate Project-related effects on Fish Health in the receiving water environment (i.e., Whitefish Lake).

The fish health monitoring and follow-up program will have the following objectives:

- collecting and recording surface water quality to confirm that source and receiving water; quality predictions for mobilization of solids are consistent with those presented in the EIS;
- monitoring to confirm that effluent and receiving water quality meet applicable regulation criteria; and,
- monitoring changes in fish tissue concentrations of COPC that may be attributable to the Project.

The monitoring and follow-up program will include measurements of fish health for comparison to baseline data and regulatory criteria (i.e., Canadian Tissue Residue Guidelines for the Protection of Wildlife Consumers of Aquatic Biota [e.g., CCME 2000], MDMER [Government of Canada 2022], CSA N288.4-19 (CSA Group 2019), and applicable United States Environmental Protection Agency criteria (e.g., US EPA 2021). At a minimum, this will include collection of representative fish species from multiple trophic levels and size classes to investigate the bioaccumulation potential of non-radiological (e.g., molybdenum, selenium, total mercury, methylmercury and other metals) and radiological parameters. Fish will also be assessed for their general health condition through assessment of condition and growth metrics consistent with those described in current or updated MDMER EEM technical guidance (e.g., Environment Canada 2012).

Local Indigenous communities have expressed direct concern with respect to mercury. Mercury has not been identified as a COPC for the Project as it is currently not present in the receiving environment (i.e., background condition) at detectable concentrations and will not be produced as part of the mine process and therefore, not discharged to the aquatic environment. However, it is understood that potential nutrient enrichment-related effects are possible and can be linked to increases in mercury in the environment. Denison notes that there is potential for increased methylmercury production in the receiving environment under a certain combination of factors to which the Project may contribute, such as increased nutrient levels in the environment. Denison commits to monitoring mercury and methylmercury in the aquatic environment over the life of the Project to determine the potential changes in mercury concentrations in fish tissue over time. As the Project advances and operational monitoring is underway, Denison will assess health risks from fish consumption by comparing fish tissue data collected during operation from the monitoring program against applicable human health risk-based maximum permissible concentrations.

Fish Health monitoring will occur in tandem with Surface Water Quality, Sediment Quality, Benthic Invertebrate and Fish and Fish Habitat sampling. Sampling locations will be co-located to facilitate comparison to water quality and sediment quality characteristics.

Sediment and benthic invertebrate monitoring in the natural environment will occur at an upstream reference location (i.e., LA-6 – Whitefish Lake North), at a downstream near-field location close to the point of discharge (i.e., LA-5 – Whitefish Lake South), and at downstream far-field locations (i.e., in LA-5 – Whitefish Lake South prior to its discharge to LA-1 – McGowan Lake).

The assessment will also include comparison of fish tissue COPC concentrations between a pre-mining period (i.e., before) and the Construction, Operation, and Decommissioning period (i.e., after). It is recognized that additional collection of pre-mining fish tissue concentrations in Whitefish Lake and a reference area are needed.

Specific monitoring and follow-up plans for the Fish Health VC will be prepared to refine and finalize the approach and specific metrics following consultation with Indigenous groups, other stakeholders, and relevant federal and provincial agencies with interest in the development and implementation of this VC-specific program.

8.5.9 Fish Health Summary

The Fish Health VC was selected for inclusion as effluent discharge to the natural environment has the potential to affect fish health. Furthermore, inclusion of the Fish Health VC is vital due to its importance to Indigenous peoples from a cultural and subsistence perspective. Contaminants of concern in fish may include heavy metals, including mercury. Concentrations of mercury and selenium in fish tissues collected during baseline studies were below guidelines that are protective of human health and freshwater aquatic life.

The main Project activity that may affect Fish Health is the release of treated effluent to Whitefish Lake. Changes in surface water quality and sediment quality have the potential to affect Fish Health in the receiving environment.

To minimize Project-related residual effects on Fish Health, Denison will develop and implement a Surface Water Management Program that provides an integrated framework to manage water quality, including provision for water management practices for each of the primary site aspects and areas of the site where contact water is expected. This will include the collection and monitoring of contact water to determine whether treatment is required prior to release to the environment, which will inform optimal levels of treatment. This will also include the monitoring and management of effluent, including contingency for effluent treatment as may be required, so that water discharge objectives are achieved as defined by applicable provincial and federal regulatory instruments. Measures in the Surface Water Management Program are expected to mitigate effects associated with changes to water and sediment quality that may affect Fish Health.

The assessment predicted residual effects on Fish Health due to treated effluent discharge. It should be noted that predicted effects do not include mercury-related effects. Identified residual effects are associated with changes in surface water quality and sediment quality; however, the changes are expected to remain well below levels that may affect Fish Health. Considering this, and following the implementation of appropriate mitigation measures, the residual effects of the Project on Fish Health are predicted to be **not significant**.

A fish health monitoring program is recommended for confirming the effectiveness of the proposed mitigation measures and the predications made in the EIS. The monitoring program will consist of the collection of multiple fish species to assess changes in fish tissue COPC, including mercury and selenium.

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Appendix 8-A Engagement Database Summary – Aquatic Environment

See file "S8_App 8-A Aquatic Environment Engagement_Wheeler River.pdf"

Appendix 8-B Hydrology Baseline Report

See file “S8_App 8-B Hydrology Baseline Report_Wheeler River.pdf”

Appendix 8-C Hydrological Effects Assessment Report

See file “S8_App 8-C Hydrological Effects Assessment Report_Wheeler River.pdf”

Appendix 8-D Aquatic Environmental Baseline Study

See file "S8_App 8-D Aquatic Environment Baseline Study_Wheeler River.pdf"

Appendix 8-E Constituent Concentrations and Mixing Zone Assessment Report

See file “S8_App 8-E Constituent Concentrations & Mixing Zone Report_Wheeler River.pdf”

Appendix 8-F Wetlands Effects Assessment Report

See file "S8_App 8-F_Wetland Assessment.pdf"

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Wheeler River Project

Final Environmental Impact Statement

November 2024

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Wheeler River Project

Final Environmental Impact Statement

Section 9 – Terrestrial Environment

November 2024

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Roadmap

This roadmap of the Wheeler River Project Environmental Impact Statement (EIS) has been provided to summarize the main document sections and appendices of the EIS.

Wheeler River Project
Environmental Impact Statement

Executive Summary

PART I: INTRODUCTION AND CONTEXT	PART II: BIOPHYSICAL ENVIRONMENTAL ASSESSMENTS	PART III: HUMAN ENVIRONMENT ASSESSMENTS	PART IV: INTEGRATED TOPICS AND SUMMARY
Section 1: Project Introduction and Overview	Section 6: Atmospheric and Acoustic Environment	Section 10: Human Health	Section 14: Accidents and Malfunctions
Section 2: Project Description	Section 7: Geology and Groundwater	Section 11: Land and Resource Use	Section 15: Effects of the Environment on the Project
Section 3: Indigenous and Local Knowledge	Section 8: Aquatic Environment	Section 12: Quality of Life	Section 16: Assessment Summary and Conclusions
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Abbreviations, Acronyms, and Units

Abbreviation / Acronym	Definition
BAM	Boreal Avian Modelling
BBS	Breeding Bird Survey
BMP	Best management practice
CBC	Christmas Bird Count
CEA	Cumulative effects assessment
COPC	Constituents of potential concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWD	Chronic wasting disease
CSA	Canadian Standards Association
Denison	Denison Mines Corp.
EA	Environmental Assessment
EIS	Environmental Impact Statement
EMS	Environmental Management System
ERA	Environmental risk assessment
ERFN	English River First Nation
HDPE	High-density polyethylene
IK	Indigenous Knowledge
ISR	In situ recovery
KI	Key Indicator
LK	Local Knowledge
LSA	Local Study Area
MP	Measurable Parameter
Project	Wheeler River Project
PSP	Permanent sample plots
ROW	Rights-of-way
RSA	Regional Study Area
SARA	*Species at Risk Act*
SARGSS	Saskatchewan Activity Restriction Guidelines for Sensitive Species
SGI	Saskatchewan Government Insurance
SK CDC	Saskatchewan Conservation Data Centre
SK MOE	Saskatchewan Ministry of Environment
VC	Valued Component
WMZ	Wildlife Management Zone

Units	Definition
Bq/g	becquerels per gram
cm	centimetre
ha	hectare
km	kilometre
m	metre
µg/g	microgram per gram

Glossary

Term	Definition
Abundance	The number of individuals in a given species.
Anthropogenic disturbance	Changes in ecosystems caused by human land use and development activities.
Baseline conditions	The existing conditions on the landscape (e.g., environmental, social, economic) prior to the initiation of a project. The surveyed baseline conditions are used as a reference point against which future surveys are compared after a project is initiated. Knowing the baseline conditions helps to assess project-related effects and guides reclamation efforts.
Biodiversity	The variety and variability of life on Earth. Biodiversity is a measure of variation at the genetic (genetic variability), species (species diversity), and ecosystem (ecosystem diversity) levels.
Biomass	The mass of living biological organisms in a given area or ecosystem at a given time.
Bog	A peatland that receives water primarily through precipitation. Bogs are typically isolated from surface runoff and groundwater inflow and are nutrient poor with low plant diversity.
Breeding phenology	Environmental characteristics, including geography, elevation, weather, and other seasonally changing conditions that may affect bird breeding behavior and nesting success.
Breeding range	The geographic area in which individual pairs or populations of a species are known to breed.
Browse	The plant material eaten by species feeding on leaves, soft shoots, or fruits of mostly woody plants.
Bryophyte	A non-vascular plant, which means it has no roots or vascular tissue for transporting water or nutrients, but instead absorbs water and nutrients from the air through its surface (e.g., leaves). Bryophytes includes mosses, liverworts, and hornworts.
Constituent of potential concern (COPC)	A constituent (e.g., metal, trace element, radionuclide) that may be released to the environment as a result of a project, which could lead to an adverse effect on one or more environmental components (e.g., aquatic, terrestrial).
Critical habitat	The habitat that is necessary for the survival or recovery of listed species under the federal *Species at Risk Act* (or other jurisdictions).
Ecological function	The natural processes that environments provide or perform at the species, ecosystem, and landscape levels.
Ecosystem	Consists of all the organisms (e.g., plants, animals) and the physical environment (e.g., wetland, forest, stream) within which they interact. The biotic (living) and abiotic (non-living) components of an ecosystem are linked together through nutrient cycles and energy flows.
Equivalent land capability	Reclamation standard referring to the ability of the land to support various land uses after conservation and reclamation that are similar to the pre-development conditions, but not necessarily identical to it.
Erosion	The action of surface processes that remove soil, rock, or dissolved material from one location and transport it to another location where it is deposited.
Fen	A peatland that receives water from a combination of precipitation, surface runoff, and groundwater inflow. Fens are more nutrient rich than bogs because of surface and groundwater inflows.
Forb	A herbaceous plant without grass-like features.

Term	Definition
Gestation	The period of time between conception and birth.
Graminoid	A herbaceous plant with grass-like features (e.g., grasses and sedges).
Habitat	The natural home or environment of an animal, plant, or other organism. Includes the array of biotic (living) and abiotic (non-living) factors that are present in an area and support the survival and reproduction of a particular species.
Habitat effectiveness	The ability of the habitat to support wildlife species.
Habitat integrity	The capacity of an ecosystem to support native biological and physical properties that have adapted to that system through natural processes.
Habitat regeneration	The processes by which ecosystems replenish what is being eaten, disturbed, or harvested.
Herb (or herbaceous)	Any seed-bearing plant that does not have a woody stem and dies down to the ground after flowering.
Home range	The area that encompasses all the resources an animal requires to survive (e.g., food and shelter) and reproduce.
Incubation period	The period between laying of an egg until that egg hatches.
Inter- and intra-specific competition	Interspecific competition occurs between individuals of different species and intraspecific competition occurs between individuals of the same species
Invasive plant	A non-native plant that has been introduced to a new environment outside of its natural range. Lacking natural predators, invasive plants may out-compete native plants for space, moisture, and nutrients, with the capacity to spread quickly and extensively. Some invasive plants are designated as prohibited, noxious, or nuisance weeds in Saskatchewan.
Landscape	A mosaic of heterogeneous landforms, vegetation types, and land uses. Assemblages of different ecosystems (the physical environments and the organisms that inhabit them, including humans) create landscapes on Earth.
Lichen (terrestrial or arboreal)	A complex, plant-like organism made up of an alga or a cyanobacterium and a fungus growing in symbiotic association. Lichens are slow-growing and typically form low, crusty, leaf-like, or branching growths on solid surfaces (e.g., rocks, walls, trees). Lichen species that cover the ground (including rocks) are terrestrial species and those that grow on trees are arboreal species.
Listed plant species	Plant species that have been identified at the federal and/or provincial level as species of conservation concern.
Microclimate	A local set of atmospheric conditions that differ from those in the surrounding areas.
Migratory	Describing regular seasonal movements between breeding and wintering grounds, different from daily movements.
Moisture regime	The amount of water that is available at a site to support plant growth.
Nutrient regime	The amount of nutrients that are available at a site to support plant growth.
Population	All members of a particular species that live in a certain area.
Population density	The concentration of individuals within a species in a specific geographic area.
Progressive reclamation	Planned approach to reclamation that is carried out concurrently during all Project Phases. Intended to progressively reduce the Project Area by reclaiming areas no longer necessary for Operations.

Term	Definition
Reclamation	The process of returning disturbed land to its former land use and condition, or another/alternative land use. Contingent on the re-instatement of terrain, soil, and vegetation.
Recruitment	In wildlife populations, the process by which new individuals are added to an existing population, either by birth or by immigration.
Relative abundance	The percent composition of a species relative to other species in the area as a measure of how common or rare that species is in that location or community.
Reproductive success	The successful production of independent offspring per breeding attempt or lifetime.
Revegetation	The process of re-establishing vegetative ground cover via seeding and/or planting. Natural revegetation relies on native soil seedbank and/or colonization by volunteer plant species.
Riparian habitat	The transitional habitat between upland and aquatic (e.g., wetland, lake, river, stream) ecosystems.
Sediment	Originates from soil erosion or the decomposition of plants and animals. Wind, water, and ice carry sediment particles to rivers, lakes, and streams.
Self-sustaining	A population is self-sustaining when it has more births than deaths and is large enough to withstand natural disasters and human pressures (e.g., industrial development, hunting). A self-sustaining landscape is a stable ecosystem.
Semi-aquatic	A mammal that spends part of its time on land and part in water but not living entirely in water.
Seral stages or habitats	The stages of ecological succession of a plant community, from bare ground to the climax stage (i.e., the last stage of an ecosystem).
Setback buffer or distance	A designated avoidance or protective area around a sensitive habitat (e.g., calving or breeding ground) or habitat feature (e.g., a bird nest) which is determined based on the species, the level of the disturbance and the surrounding habitat.
Shrub	A woody plant that is smaller than a tree and has several main stems arising at or near the ground.
Soil	Comprises the naturally occurring, unconsolidated mineral and/or organic materials at the earth's surface capable of supporting plant growth. Topsoil (the most bioactive portion of soil) refers to the topmost soil horizon(s) composed of surface organic materials and/or the mineral A horizon (depending on biogeoclimatic conditions). Subsoil (B Horizon) refers to soil horizons directly underlying topsoil and overlying parent material (C Horizon).
Soil stripping/salvage	Action of temporarily removing and stockpiling soil over an indeterminate timeframe (from short- to long-term). The purpose of soil stripping and salvage is to viably separate topsoil from subsoil and/or parent material and conserve soil quality and quantity as a growing substrate for reclamation purposes.
Species	A group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding.
Succession	The process by which the composition of species and habitat types in an area changes over time and replace one another.
Suitable habitat	The habitat type featuring ecological characteristics necessary for breeding, feeding, resting, or sheltering of a wildlife species.
Sustainable harvest levels	Level of harvest that is at or below the threshold that allows the resource to regenerate itself indefinitely.

Term	Definition
Swamp	A mineral wetland that receives water from a combination of precipitation, surface runoff, and groundwater inflow. Swamps have fluctuating water tables, are seasonally flooded, and have fertile soils that support a diversity of trees, shrubs, and other plants.
Terrain	Predominant surface features of an area of land expressed in terms of topography (relief), elevation, slope and aspect that define its morphology and stability. Terrain is shaped by surficial geology (parent material) and combined actions of geological and erosional processes. Terrain then influences surface water flow and distribution.
Territory	An actively defended area within an individual's home range.
Upland	Generally considered to be land that is at a higher elevation than alluvial plains, wetlands, or stream terraces, which are considered to be lowlands.
Vascular plants	A large group of land plants that have lignified tissues for conducting water and nutrients throughout the plant. Vascular plants include clubmosses, horsetails, ferns, gymnosperms (including conifers), and angiosperms (flowering plants).
Vegetation	Plants considered collectively, especially those found in a particular area or habitat.
Wetland	Land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity which are adapted to a wet environment.

9 Terrestrial Environment

Section 9 of the Environmental Impact Statement (EIS) for the Wheeler River Project (the Project) is focused on the Terrestrial Environment. The integrated biophysical and human environment assessment approach is illustrated in Figure 9-1. As a guide for EIS reviewers, Figure 9-2 provides a preview of the Valued Components (VC) associated with the assessments completed in this section of the EIS.

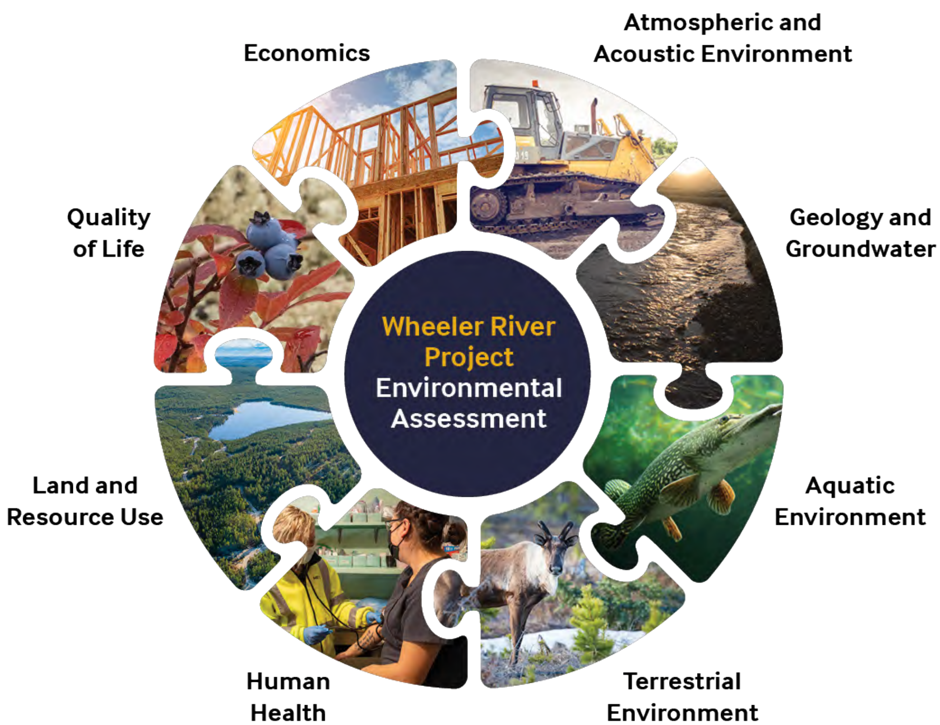
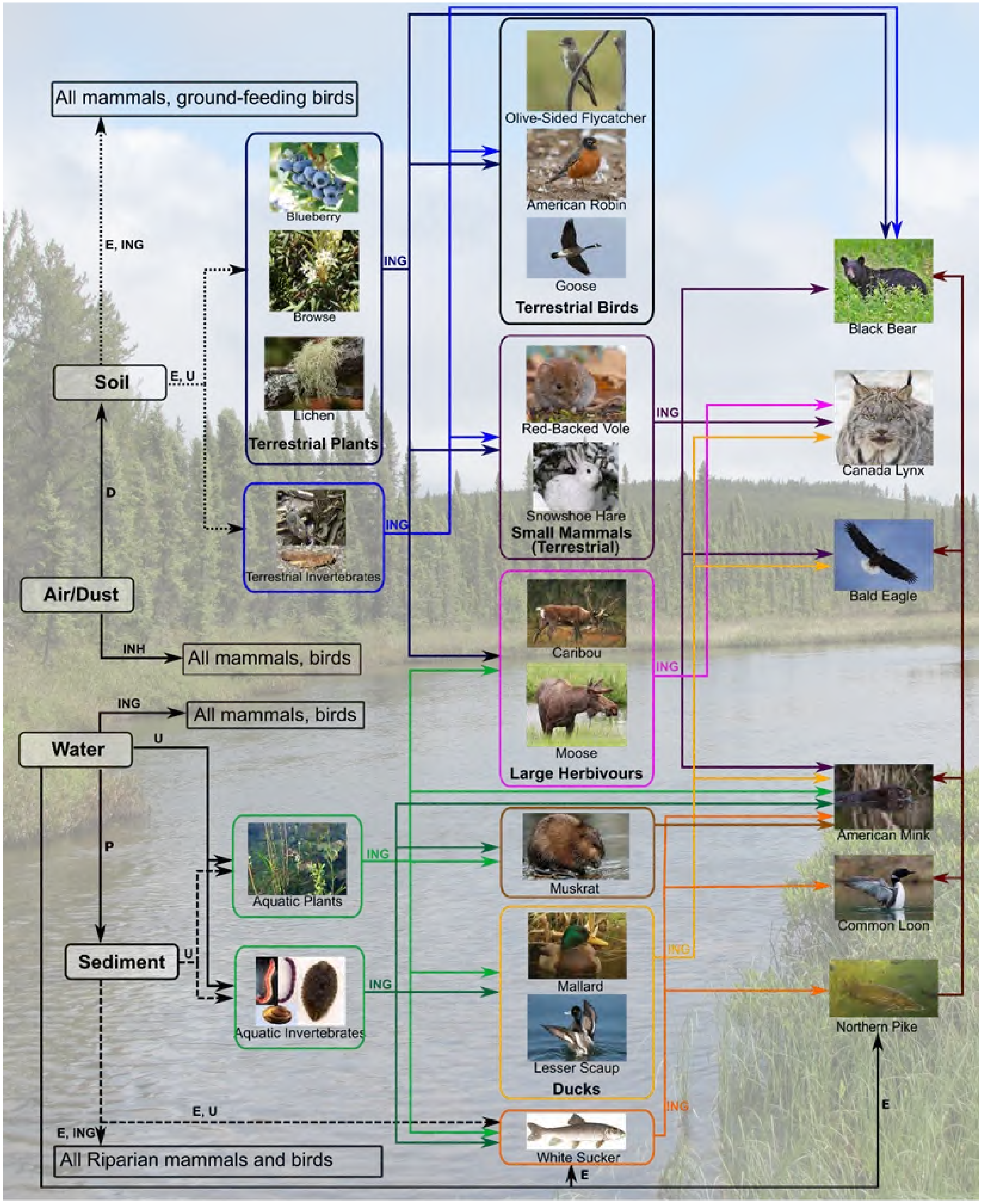


Figure 9-1: Biophysical and Human Environment Assessments for the Wheeler River Project Environmental Assessment

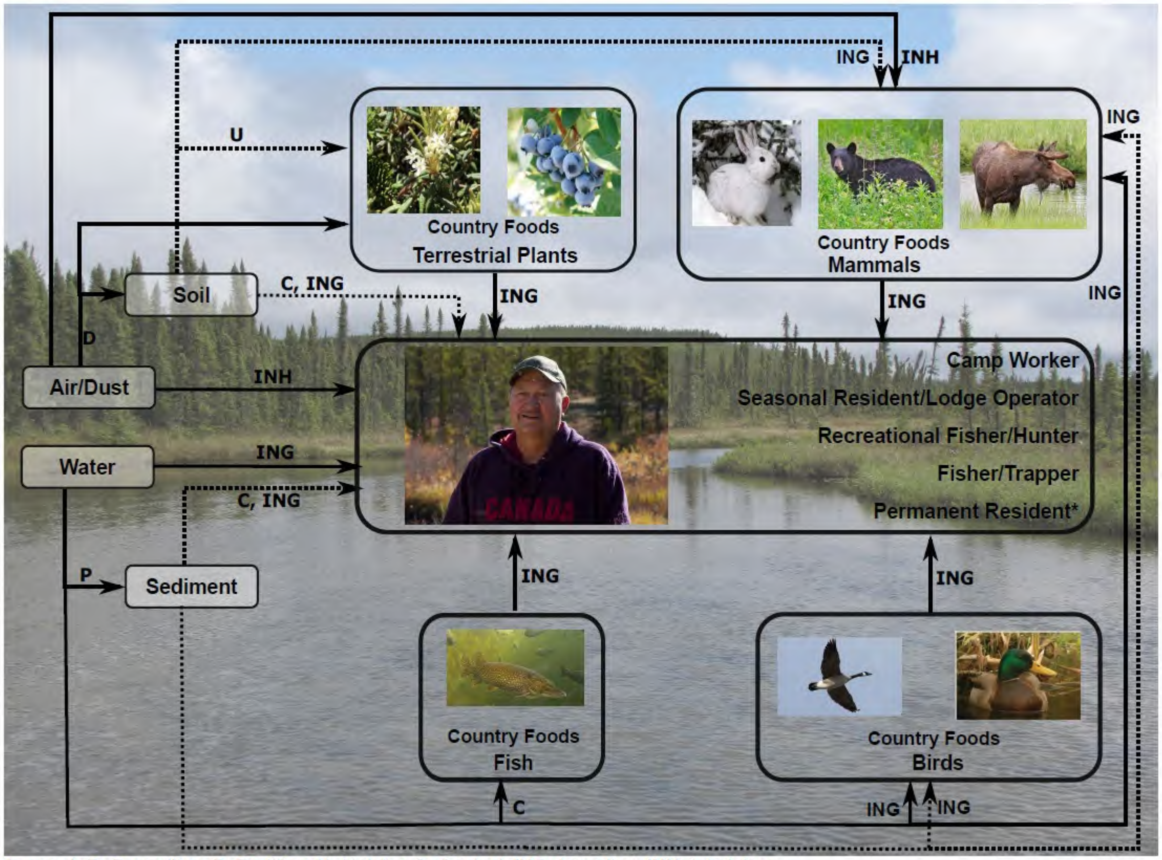
Figure 9-2: Terrestrial Environment - Valued Components

An environmental risk assessment (ERA), including both an ecological risk assessment and a human health risk assessment are included in the EIS in Appendix 10-A in Section 10. The ERA was prepared to be compliant with Canadian Standards Association Group (CSA) N288.6-12 *Environmental Risk Assessments for Class I Nuclear Facilities and Uranium Mines and Mills* (CSA 2012). The ERA uses the expected sources of atmospheric and liquid releases to predict the transport of radiological and non-radiological constituents of potential concern (COPCs) through the environment, exposure and dose to the public, and exposure and effects on representative ecological receptors. For reference, the conceptual site models for the ecological risk assessment and human health risk assessment are shown in Figure 9-3 and Figure 9-4, respectively. As shown in these figures, there are various aspects of the terrestrial environment considered in the ERA including soil, plants, birds, and mammals. Predictions of changes in concentrations of COPCs in various terrestrial components and evaluation of risk associated with COPC uptake are presented in Appendix 10-A and have not been repeated in Section 9.



D: Deposition; P: Partition; E: External Dose; U: Uptake; ING: Ingestion; INH: Inhalation;

Figure 9-3: Ecological Risk Assessment Conceptual Site Model for the Project



Legend: D: Deposition; **P:** Partition; **U:** Uptake; **C:** Contact; **ING:** Ingestion; **INH:** Inhalation;
⟶ Exposure pathway from primary media; ⇢ Exposure pathway from secondary media.
* Human Receptors are assumed to be present during all project stages, except the Permanent Resident who is assumed to be present during future centuries.

Note: Denison would like to gratefully acknowledge the contributions of Bobby John (shown in the centre of this image) to this EIS and extend a thank you to his family for granting permission to use his image herein.

Figure 9-4: Human Health Conceptual Site Model for the Project

9.1 Terrain, Soil, and Organic Matter/Peat

This subsection addresses potential effects from the Project on Terrain, Soil, and Organic Matter/Peat, respectively, as VCs. This section comprises the following steps as part of the assessment:

- scope of the assessment;
- summary of existing conditions relevant to VCs;
- identification and description of potential interactions between the Project and VCs;
- identification and description of mitigation measures applicable to VCs to eliminate, reduce, or control the potential adverse Project-related effects);
- identification and characterization of predicted Project residual effects for VCs after mitigation;

- characterization of significance and assignment of the level of confidence in the predictions; and
- identification and characterization of potential cumulative effects.

Figure 9.1-1 is a graphic representation of the assessment process used in this EIS.

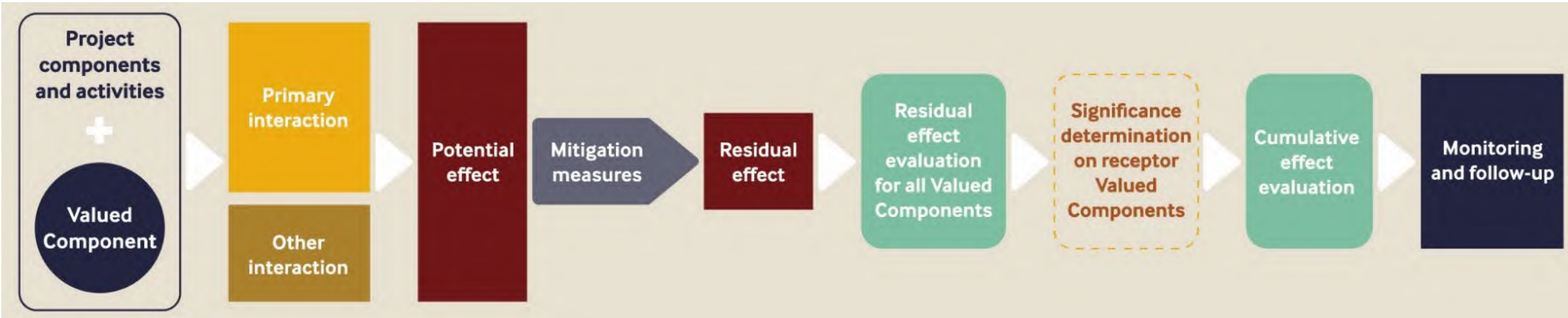


Figure 9.1-1: Environmental Assessment Process for the Wheeler River Project

9.1.1 Scope of the Assessment

9.1.1.1 Valued Component Selection

The process and rationale for selection of VCs, establishment of Key Indicators (KIs) and associated Measurable Parameters (MPs) is described in Section 5 Approach and Methodology of the Assessment. This section addresses three VCs: Terrain, Soil, and Organic Matter/Peat. Terrain, Soil, and Organic Matter/Peat were selected because Project activities have the potential to affect land use, economic activity, biodiversity, and biological function (i.e., ecosystem function and wildlife habitat) in proximity to the Project—as well as potentially affecting cultural values of Indigenous groups, the public and other Interested Parties. These VCs have historically been incorporated in previous assessments for other similar and/or nearby Projects, namely: Key Lake Uranium Mine (Cameco 1994, Key Lake Mining Corp. 1979), McArthur River Uranium Mine (Areva 2009), and Millennium Mine Project (Cameco 2009).

Terrain, Soil, and Organic Matter/Peat are interrelated, to varying extent depending on the landscape, and are linked to other VCs, including:

Atmospheric and Acoustic

- Air Quality: dust deposition and air emissions have the potential to disperse trace metals and radionuclides into the ambient air, which can subsequently be deposited onto Vegetation and Ecosystems, Listed Plant Species, and Wetlands and be taken up into plant tissues.

Geology and Groundwater

- Groundwater: Terrain, Soil and Organic Matter/Peat interact with and contribute to Groundwater via hydrologic connectivity to influence groundwater flow and water cycling within landscape form and function.

Aquatic Environment

- Surface Water Quantity and Quality: Terrain, Soil and Organic Matter/Peat interact with and contribute to Surface Water Quantity and Quality via hydrologic connectivity to influence surface drainage patterns within landscape form and function; management of surface water is a key component of reclamation design.

Terrestrial Environment

- Vegetation and Ecosystems: vegetation interacts with terrain and soil to shape ecosystem form and function and biodiversity; terrain, soil and vegetation are, together, key components of reclamation design and reinstatement of equivalent land capability.
- Ungulate, Furbearers, Woodland Caribou, Raptors, Migratory Birds, Bird Species at Risk: terrain and soil contribute to landscape form and function that support wildlife species and habitat.

Figure 9.1-2 to Figure 9.1-4 are graphic representations of the main linkages among the Terrain, Soil, and Organic Matter/Peat VCs and other VCs, illustrating the flow of assessment information into and from the Terrain, Soil, and Organic Matter/Peat VCs.

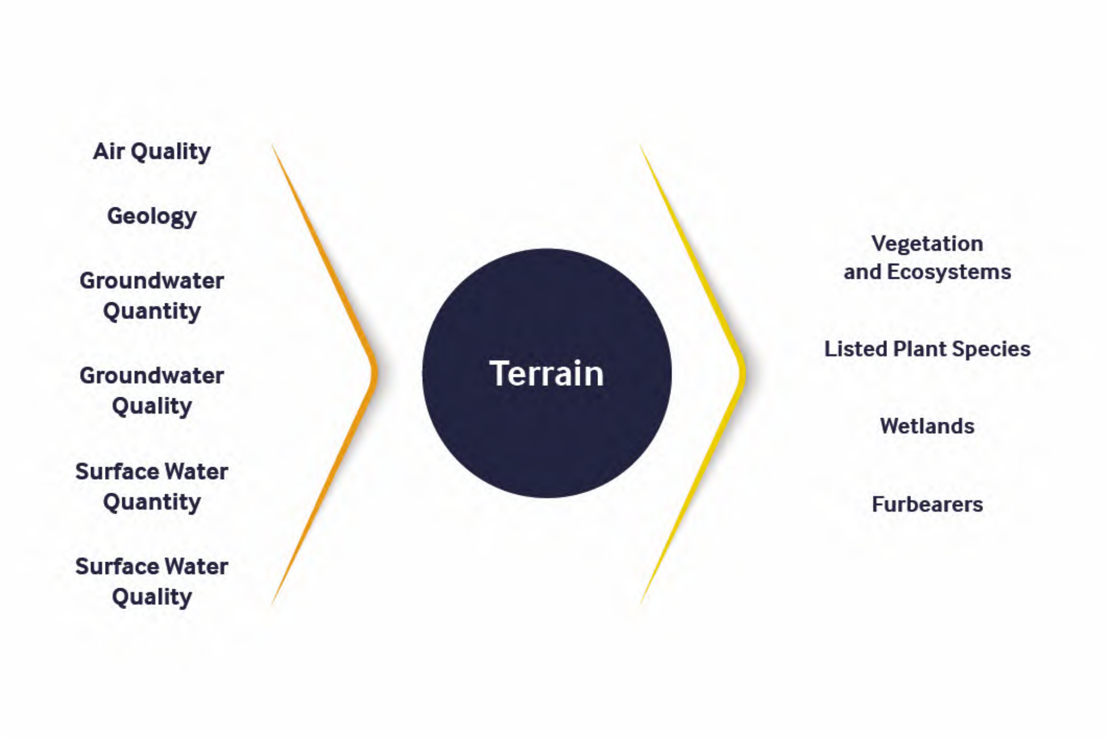


Figure 9.1-2: Integrated Assessment Approach - Key Connections between Terrain and Other Valued Components

Figure 9.1-3: Integrated Assessment Approach - Key Connections between Soil and Other Valued Components

Figure 9.1-4: Integrated Assessment Approach - Key Connections between Organic Matter/Peat and Other Valued Components

9.1.1.2 Key Indicators and Measurable Parameters

The KIs and associated MPs for Terrain, Soil, and Organic Matter/Peat are summarized, respectively, in Table 9.1-1, Table 9.1-2, and Table 9.1-3.

Table 9.1-1: Key Indicators and Measurable Parameters for Terrain

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Terrain Morphology	• Project activities may alter terrain morphology resulting in changes in landscape function. • Changes may affect (1) land use and economic activity and (2) biological functions in proximity to the Project.	Change in slope grade, aspect Change in topographical contours and drainage patterns
Terrain Stability	• Project activities may surficial geology resulting in changes to terrain stability and/or accelerated erosion. • Changes may affect (1) land use and economic activity and (2) biological functions in proximity to the Project.	Change in the stability of landform attributes Increase in erosion potential; acceleration of erosional processes.

Table 9.1-2: Key Indicators and Measurable Parameters for Soil

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Soil Quantity	• Project activities may increase the potential for erosion and sediment transport resulting in changes in soil quantity. • Changes may affect (1) land use and economic activity and (2) biological functions in proximity to the Project.	Change (i.e., net loss) of soil volume.
Soil Quality	• Project activities may alter soil quality and resulting in changes growing capacity. • Changes may affect (1) land use and economic activity and (2) biological functions in proximity to the Project.	Degradation in soil physical properties (particle size/texture, structure, and aggregation) Increase in concentration of constituents of potential concern (COPC) in soil [1]

1 A quantitative assessment modelling dispersion and uptake of COPCs in the environment was completed for the Project as part of the ERA, which is in Appendix 10-A of Section 10. This approach is aligned with the Canadian Standards Association (CSA) N288.6 guidance (CSA 2012). The ERA will be updated throughout the life of the Project and will provide a key tool for environmental performance reporting. In the ERA, changes in COPCs were estimated for soil based on air dispersion modelling. Direct and indirect (through changes to plant tissue) contact/ingestion of soil was subsequently evaluated for various terrestrial receptors, including humans. The selection of this MP for the Soil Quality VC is not intended to repeat the information from the ERA, but provide a separate evaluation.

Table 9.1-3: Key Indicators and Measurable Parameters for Organic Matter/Peat

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Organic Matter/Peat Quantity	• Project activities may alter quantity of organic Matter/Peat and hydrologic conditions underpinning peat-forming processes • Changes may affect (1) land use and economic activity and (2) biological functions in proximity to the Project.	Change (i.e., net loss) in percentage of area extent of organic matter.

9.1.1.3 Spatial Boundaries

Study area (i.e., spatial) boundaries for Terrain, Soil, and Organic Matter/Peat (as shown in Figure 9.1-5) are defined and delineated as:

- **Project Area:** the area (169.64 ha) within which the Project and all components/activities are located (i.e., the Project footprint; the area of maximum physical disturbance). This area is not VC-specific, but consistent throughout the EA.
- **Terrain, Soil, and Organic Matter/Peat Local Study Area (LSA):** encompasses the Project Area plus: (a) a 500 m surrounding buffer of the Plant Site and Ancillary Facilities/Features (e.g., airstrip, borrow pits, effluent ponds) and (b) a 250 m surrounding buffer for access roads and other linear features; representing the area (1,161.8 ha) where both direct and indirect effects resulting from Project activities can be reasonably measured. The LSA is established to assess the potential, largely direct effects of the Project and represents the extent to which there is a reasonable potential for the Project or Project-related activities to interact with and potentially adversely effect the VC.
- **Terrestrial Regional Study Area (RSA):** encompasses the Project Area and LSA plus a minimum 8 km surrounding buffer around the LSA; this area was established to assess the potential, largely indirect effects of the Project in a regional context. The RSA is large enough to capture the extent of potential effects (i.e., zone of influence) on a VC and defines the area (40,173.6 ha) within which cumulative effects may occur (i.e., cumulative effects assessment [CEA] boundary).

9.1.1.4 Temporal Boundaries

Temporal boundaries for the EA are defined in Table 5.3-3 in Section 5. The temporal boundaries for the EA represent the timeframes that the Project is expected to interact with and potentially affect the VCs, and as appropriate, reflect seasonal and annual variations or biophysical constraints related to a VC. The temporal boundaries are aligned with the Project development schedule. The temporal boundaries applicable to and considered in this section include the following Project phases:

- Construction (Year 1 to 3);
- Operation (Year 3 to 18);
- Decommissioning (Year 18 to 23); and
- Post-Decommissioning (Year 23 to 38).

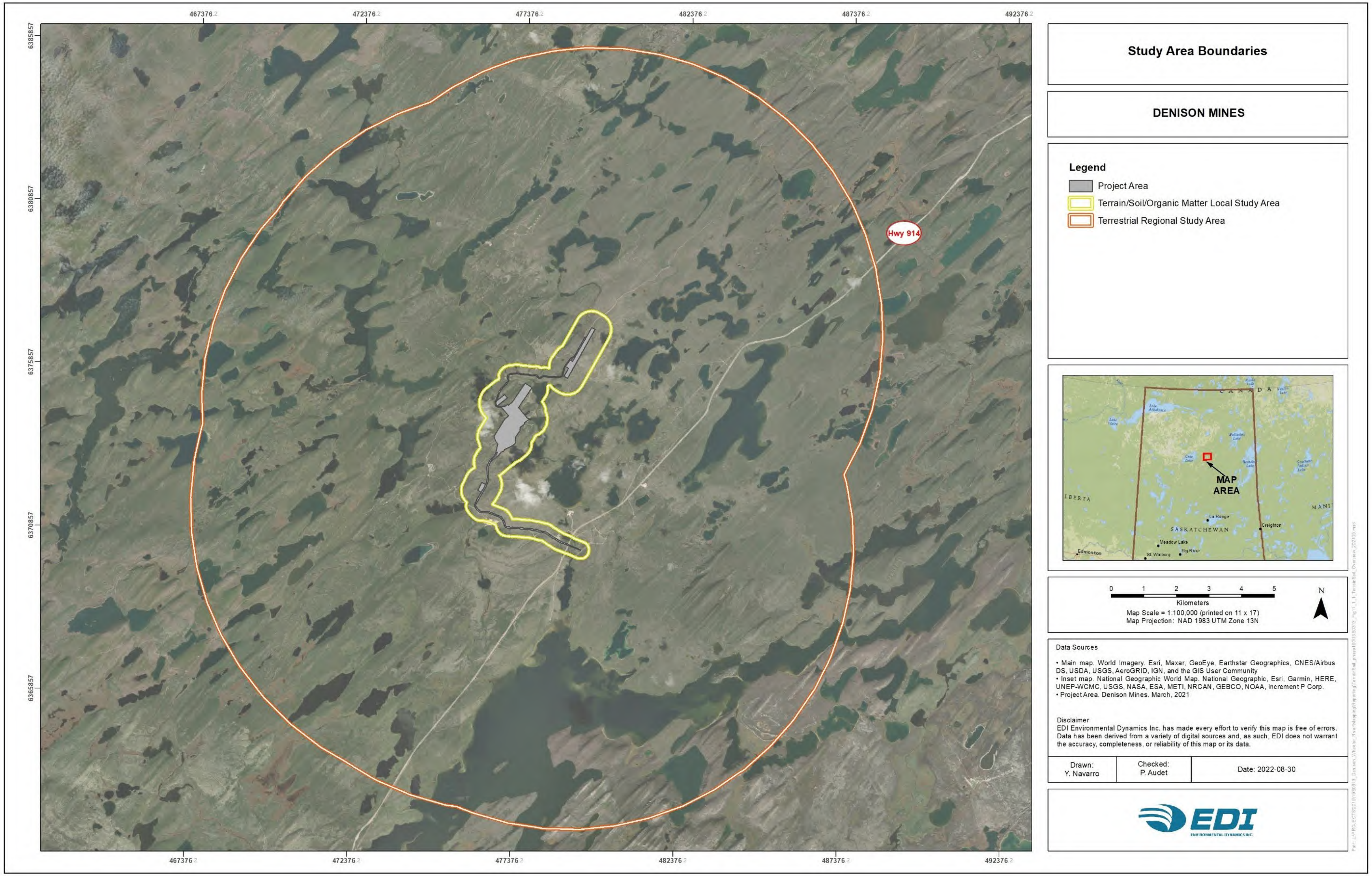


Figure 9.1-5: Terrain, Soil, and Organic Matter/Peat – Study Area Boundaries

9.1.2 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

At its broadest level, Indigenous Knowledge (IK) can be understood as the unique and collective knowledge of Indigenous peoples that may include, but is not limited to the environmental, cultural, economic, political, and spiritual conditions of a community or region. In this section, IK and Local Knowledge (LK) are viewed as complementary and influential alongside western science to produce a full understanding of the potential effects of the Project, whether measurable or perceived. Both forms of information have been given full and fair consideration.

Since 2016, Denison Mines Corp. (Denison) has been engaging with Interested Parties (i.e., local and Indigenous communities, residents, businesses, organizations, land users, and the various regulatory authorities) to support the development of positive relationships and a mutual commitment to collaboration. Denison has recorded and stored information regarding IK, LK, and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 20-LK-LEASESUR-267.20). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment.

Indigenous Knowledge and LK quotes and citations have been included herein to provide readers with the information considered as the Project advanced throughout the effect assessment process. Appendix 9-A provides a summary of unique identification numbers referenced within Section 9.1.

Upon review of the Project-specific Engagement Database, no recorded quotes existed with direct relevance to Terrain, Soil, and Organic Matter/Peat, as it relates to their status and/or existing condition. Entries with direct or indirect relevance to issues of concern, including end-land use, land management, and aesthetics, were considered in the evaluation of Terrain, Soil, and Organic Matter/Peat[1]. Several entries[2] refer specifically to terrain stability and the potential for subsidence. Meanwhile, the *Kineepik Value Ecosystem Components KML Pre-Statement for Denison EIS* report (KML and NVP 2022) emphasizes that the EIS should engage in conversation on the progressive reclamation of this and other legacy Projects. Kineepik Metis Local and the Northern Village of Pinehouse.

9.1.3 Existing Environment

This Existing Environment section establishes the current baseline conditions and environmental setting for Terrain, Soil, and Organic Matter/Peat (e.g., predominant features and characteristics,

[1] Refer to 20-LK-LEASESUR-267.20 to 267-25, 267-40, 267.44 to 267.98, and 267.109 to 267.126; 21-EN-ERFN-473.8.
[2] 18-EN-VB-4.50, 22-EN-ERFN-618.16, 22-EN-ERFN-618.23 to 618.25.

past and current disturbances or other natural and human caused trends affecting baseline conditions). This section also evaluates the quality and reliability of baseline data and identifies any knowledge gaps and/or uncertainty associated with baseline conditions.

Project-specific investigations pertaining to the Terrestrial Environment were conducted by Omnia Ecological Consulting (Omnia; Calgary, AB) from 2017 to 2019. Methodological details, survey parameters and assumptions, and comprehensive data summaries are presented in the Project-specific baseline report (Omnia 2020, provided as Appendix 9-B). A supplementary baseline annex report (based on desktop review of available studies, historic surveys, and databases relevant to the Project Area) was completed by EDI Environmental Dynamics Inc. (EDI; Saskatoon, SK, and Calgary, AB) in 2021 to provide additional context (EDI 2021, provided as Appendix 9-C) as it pertains to Terrain, Soil, Vegetation, Wetlands and Wildlife. The following subsections summarize baseline conditions and available mapping products based on the Omnia (2020) and EDI (2021) Project-specific reports (i.e., Appendix 9-B and Appendix 9-C). This information is summarized (hereafter) in the form of 1:20,000 interpreted mapping products that were compiled using the following inputs:

- 1:1,000,000 terrain mapping (Saskatchewan GeoHub 2021; Simpson 1997);
- 1:20,000 to 1:250,000 soil mapping (Soil Landscapes of Canada Working Group 2010);
- 1 m topographical contours and elevation mapping (Denison 2020);
- 1:5,000 anthropogenic features mapping; and,
- field sampling/ground truthing sites (Omnia 2020).

9.1.3.1 Terrain

The Project is located near the Wheeler River in north-central Saskatchewan within the Athabasca Basin region in the Canadian Shield (i.e., Laurentian Plateau); the Project also lies within the Athabasca Plain of the Boreal Shield Ecozone (Acton et al. 1998, Wiken 1986). Geomorphologic processes involved in forming the terrain of the RSA include deglaciation (glacial retreat) and a combination of erosional (wind) and fluvial processes (Saskatchewan GeoHub 2021, Simpson 1997, Norris et al. 2017). Parent materials are associated with glacio-fluvial and morainal deposits (quartzite) originating from Proterozoic sandstone; surface textures are predominantly sand textured (sand, loam sand/sandy loam and silty sand). As shown on Figure 9.1-6, the Terrain is characterized by eskers (long winding ridges) and drumlins (elongated oval-shaped hills) with small variations in elevation (ranging 480 to 590 m above sea level) resulting in a gently sloping terrain ranging from Slope Class A (0–3%, little or no slope) to Slope Class C (10–15% gradient, moderate slopes) depending on slope position (Acton et al. 1998, Denison 2020, Saskatchewan GeoHub 2021).

Several named and unnamed waterbodies of various sizes occur within the RSA and in proximity to the Project. Surface drainage is dependent on proximity to waterbodies, area specific slope and topographical contours. The reader is referred to Section 8 Aquatic Environment for characterization of waterbodies, surface water quantity and quality and associated surface drainage patterns and processes, as well as Section 9.2 for characterization of wetlands.

Most of the Terrain in the RSA is gently rolling and supports undeveloped forested land. No agricultural cultivation occurs in the RSA and little to no capacity for agricultural exists (Agriculture and Agri-Food Canada 1998). The region has also undergone previous disturbance associated with various discrete land use activities (Figure 9.1-7) including road development, and seismic and geologic/mineral exploration. Based on available ecosite classifications data (McLaughlin et al. 2010; Acton et al. 1998) and using Vegetation/Ecosystem Mapping products (refer to Section 9.2), the Terrain has been broadly designated (herein) as either upland[3], lowland[4], lakes, waterbodies or anthropogenically disturbed land[5] (Figure 9.1-8). Most of the Project Area (99.7%) coincides with upland (144.4 ha, representing 85.1%) or anthropogenically disturbed land (24.8 ha, representing 14.6%). Only small discrete portions of the Project Area coincide with lowland (0.44 ha, representing <0.3%) and waterbodies (0.01 ha, representing <0.1%), and no lakes (0.00 ha, 0%). A similar proportional distribution occurs at the scale of the LSA where the combined upland and anthropogenically disturbed land represent a 91.5% (1,063.5 ha) of the area versus lowland, lakes and waterbodies that represent 8.5% (98.3 ha). At the scale of the RSA, upland represents 72.8% (29,231 ha) of the area, while lowland, lakes and waterbodies represent 27.2% (10,940 ha).

[3] Predominantly referring to BS3 and BS3/BS7 Forest Ecosites (cf. McLaughlin et al. 2010); the reader is referred to Section 9.2 for characterization of forest ecosites.
[4] Referring to wetlands (bogs, fens, shores).
[5] Clearings, cut lines and other anthropogenically disturbed areas assumed to be upland.

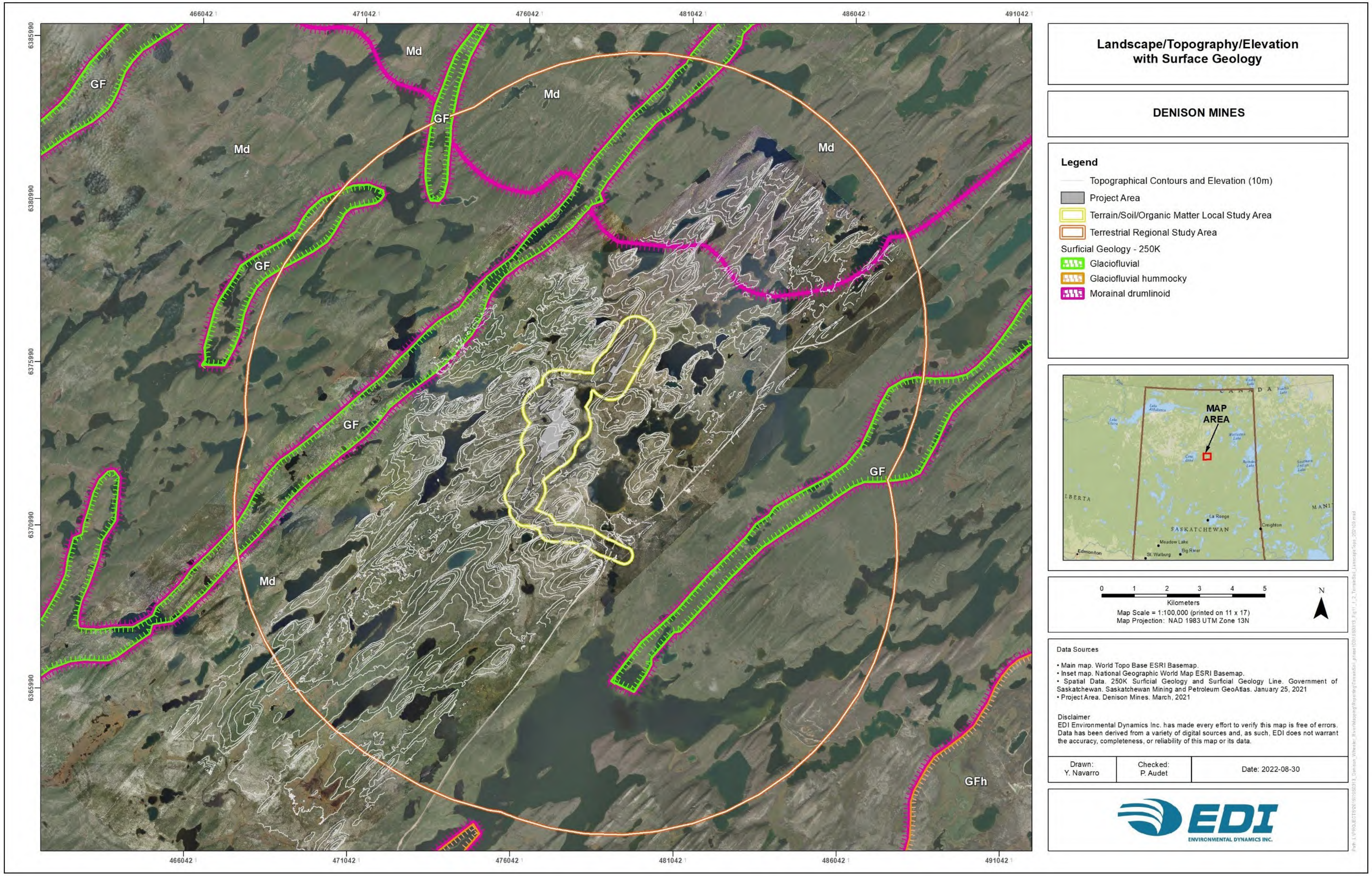


Figure 9.1-6: Terrain – Predominant Landform Attributes and Geomorphological Processes

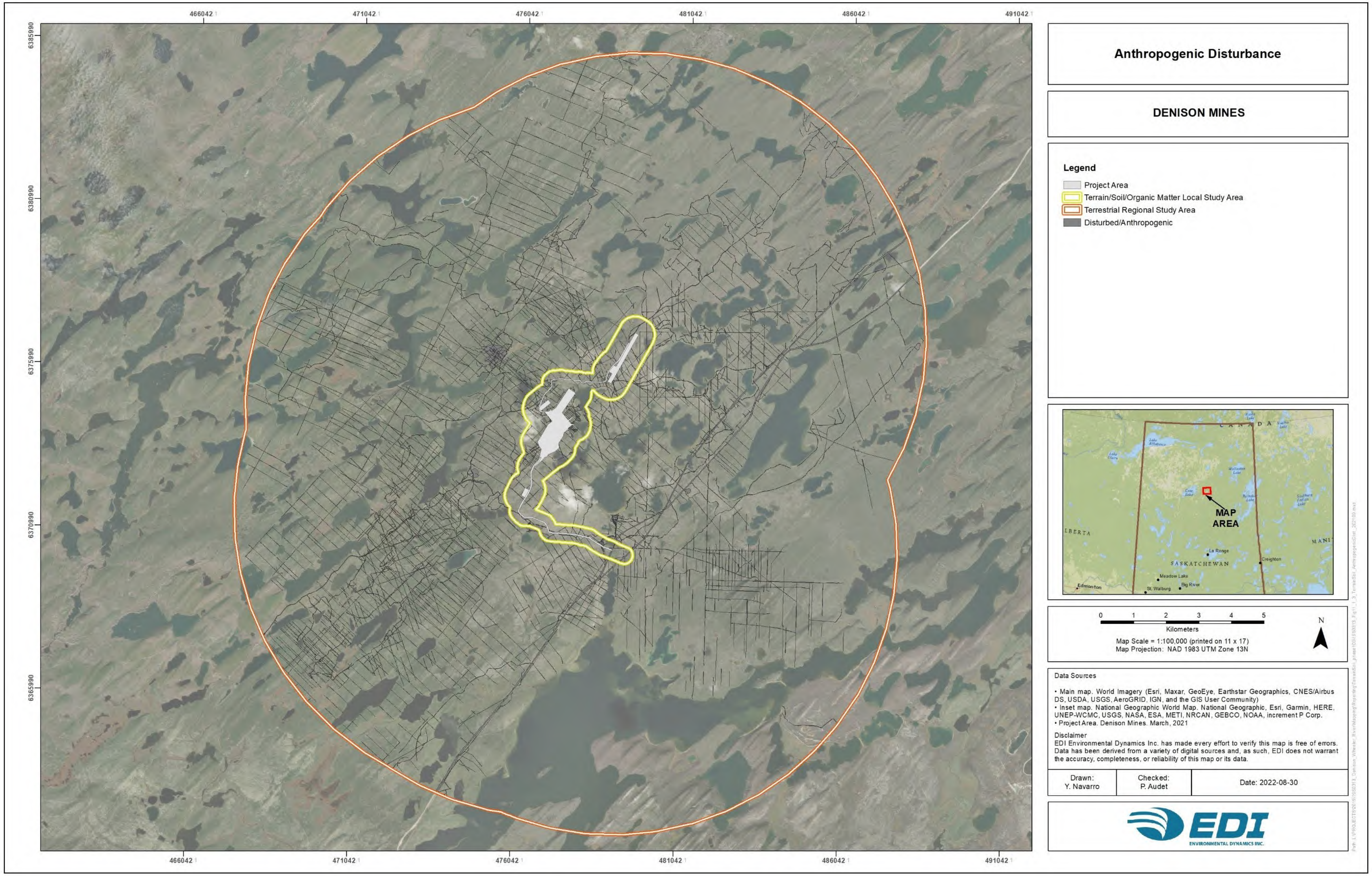


Figure 9.1-7: Terrain – Anthropogenic Disturbance

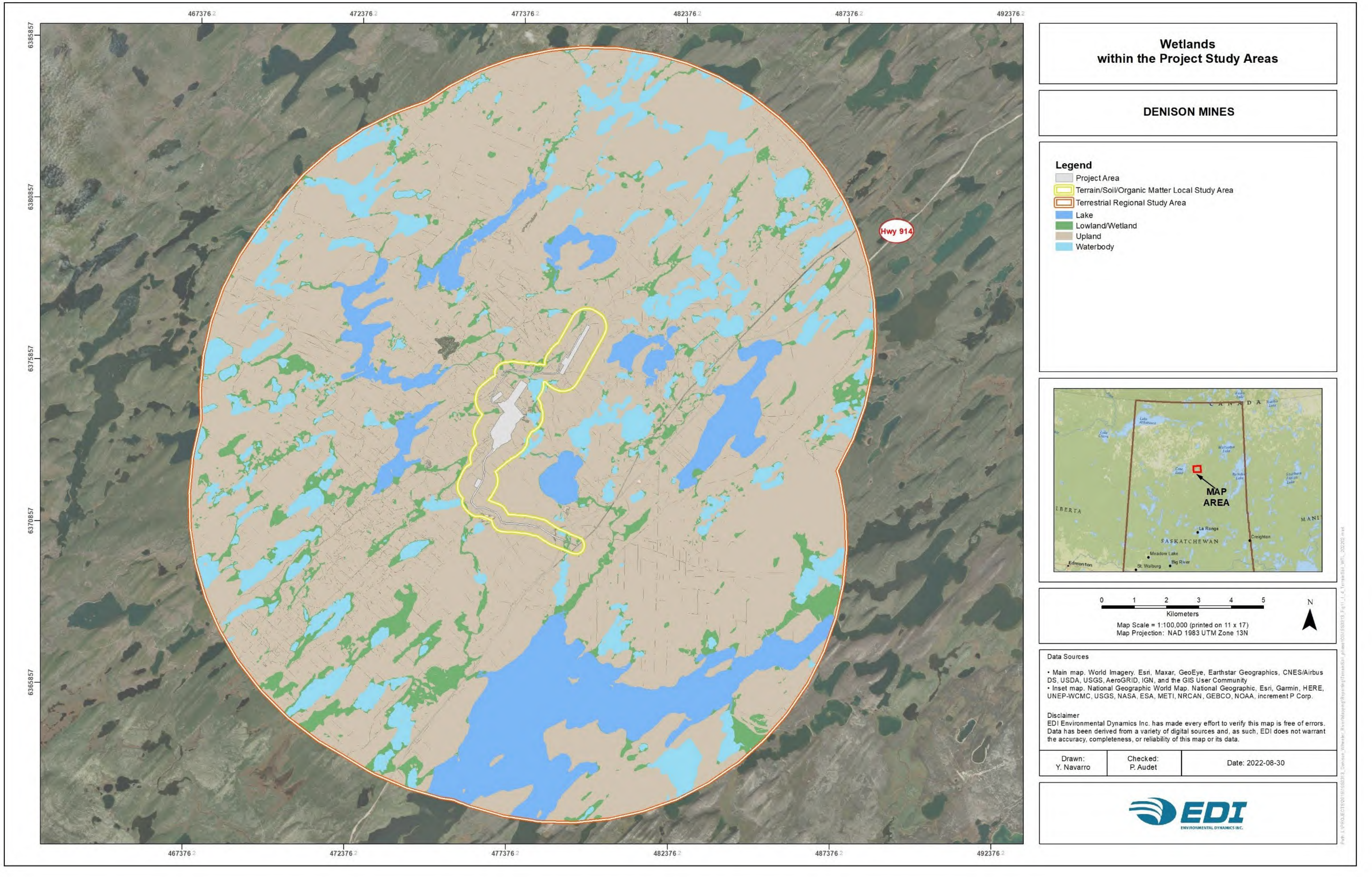


Figure 9.1-8: Terrain – Upland, Lowland and Waterbodies

9.1.3.2 Soil

Soil Type/Classification

Brunisols predominate the Athabasca Plain Ecozone and are considered the primary soil order within the RSA (Soil Landscapes of Canada Working Group 2010; McLaughlan et al. 2010). Regosols also occur along with Organic Fibrisols and discrete/sporadic Organic Cryosols. Based on available ecosite characteristics (McLaughlin et al. 2010; Acton et al. 1998) and using Vegetation/Ecosystem Mapping products (refer to Section 9.2), the landscape has been broadly characterized as upland, lowland, waterbodies, and anthropogenically disturbed land—as depicted in Section 9.1.3.1. Mineral soils are associated with upland sites and (in all likelihood) anthropogenically disturbed land that, together, correspond with >99% of the Project Area and 91.5% of the LSA (Figure 9.1-8). The predominate mineral soils within the RSA have been classified as Sandy Dystric Brunisols (Smith et al. 2011). Brunisolic soils are typically acidic, hold low fertility and organic matter content, and lack a well-developed mineral-organic surface horizon; as such, their effective rooting depths can be relatively shallow (<30 cm) in some locations. Topsoil profiles—representing the soil's uppermost and most bioactive portion—are composed of a thin surface organic layer (LFH, Litter-Ferment-Humus) followed by a thin, sand-textured Ae (eluviated) or Aeh (eluviated humic) horizon. Subsoils are then composed of a characteristically sand-textured Bm (modified) horizon of variable depth, a potentially thin/faint Bf (with clay and/or mineral inclusions) horizon (if/where present), and then a sand-textured BC or C horizons and/or R horizon (bedrock). Where they occur within the RSA (typically in areas prone to unstable terrain), Regosols are characterized by a lack of or only weakly developed soil horizons (as described above).

Soil salvage potential, soil suitability for reclamation, and soil erosion potential can be informed based on review of soil profile characteristics and composition, including horizon depths, texture, effective rooting depths, coarse fragment content and organic matter content (SQCWG 1987). Soil salvage potential and soil suitability for reclamation are expected to be fair to poor (potentially unsuitable depending on the level of previous anthropogenic disturbance and the presence/depth of a restrictive horizon) due to the predominance of soils characterized by a thin surface organic layer, thin sand-textured A-horizon and low fertility. Fair to poor soil suitability for reclamation refers to moderate to severe limitations of the growing substrate to support revegetation; these limitations will require commensurate levels of planning and management to achieve the desired reclamation endpoint. Unsuitability reflects very severe limitations. Sand textured soil holds a medium to high soil erosion potential in relation to water and wind erosion, as well as low to moderate susceptibility to compaction. The soil erosion potential and susceptibility to compaction will likely vary depending on slope class and slope position and other site-specific characteristics (e.g., cover vegetation and exposure) that will require appropriate levels of mitigation and management.

Soil Chemistry and Constituents of Potential Concern

Soil sampling (100 g per sample collected from 0-5 cm surface soil) was completed at permanent sample plots (PSP; n=10; sample ID RSV01-RSV10[6]) distributed throughout the LSA and RSA (Omnia 2020; Appendix 9-B). Samples were analysed by the Saskatchewan Research Council for chemical analysis, including metals and trace elements (via Inductively Coupled Plasma–Mass Spectrometry; ICP-MS) and radionuclides (via beta counting or alpha spectroscopy); the reader is referred to the baseline study for sample collection locations, procedures, and methodological standards. These data are intended to support atmospheric modeling predictions for the dispersion of constituents of potential concern (COPC); the reader is referred to Section 6 Atmospheric and Acoustic Environment for additional details related to modelling of dust and associated COPC. Soil samples were analysed to determine baseline conditions for essential and non-essential metals, nutrients and radionuclide constituents, including:

- Aluminum
- Antimony
- Arsenic
- Barium
- Beryllium
- Boron
- Cadmium
- Chromium
- Cobalt
- Copper
- Iron
- Lead
- Lead-210
- Manganese
- Molybdenum
- Nickel
- Polonium-210
- Radium-226
- Selenium
- Silver
- Strontium
- Thallium
- Thorium-230
- Tin
- Titanium
- Uranium
- Vanadium

Table 9.1-4 summarizes essential and non-essential elements and radionuclide constituents in soil. If/where applicable, these values were compared to the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health within Residential/Parkland Land-Use Areas[7] (CCME 2011). All values were consistently low and/or below soil quality threshold values for environmental and human health (i.e., where Canadian Council of Ministers of the Environment thresholds are available for comparison).

[6] Referring to permanent vegetation sample plots for assessment of COPC in vegetation described in Section 9.2.3.1.2.

[7] The Project is primarily situated within undeveloped forest land. Residential/Parkland guidelines were chosen as they represent the highest threshold of soil quality for human and environmental health.

Table 9.1-4: Soil – Essential and non-essential elements and radionuclides (from Omnia 2020)

Parameter	Unit	RSV1	RSV2	RSV3	RSV4	RSV5	RSV6	RSV7	RSV8	RSV9	RSV10	Mean	Standard Deviation	CCME Exceedance[1]
Metals and Trace Elements														
Aluminum	µg/g	4300	4900	4300	4600	3300	4800	4050	1980	1990	1580	3580	1212	*N/D*
Antimony	µg/g	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	–	No
Arsenic	µg/g	0.8	0.8	0.8	1	0.5	0.8	0.6	0.4	0.4	0.4	0.7	0.21	No
Barium	µg/g	48	58	30	62	67	39	66	36	84	30	52	17.3	No
Beryllium	µg/g	0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.07	–	No
Boron	µg/g	3	2	3	4	3	5	2	1	2	<1	2.55	–	*N/D*
Cadmium	µg/g	0.3	0.2	0.2	0.3	0.4	0.6	0.3	0.6	0.4	0.6	0.4	0.15	No
Chromium	µg/g	6.4	5.2	5.9	7	3.7	5	4.7	1.1	1.5	0.8	4.1	2.15	No
Cobalt	µg/g	0.5	0.3	0.3	0.4	0.2	0.2	0.3	<0.2	0.2	<0.2	0.26	–	*N/D*
Copper	µg/g	1.7	2.5	0.8	1.7	1.5	0.7	2.4	0.8	4.6	0.8	1.8	1.14	No
Iron	µg/g	4940	2680	3610	4390	1870	2240	2880	640	850	520	2462	1466	*N/D*
Lead	µg/g	4.4	3.2	2.6	2.7	2.7	2.7	3.4	1.6	6.4	1.8	3.2	1.32	No
Manganese	µg/g	64	38	39	48	48	36	42	24	120	31	49	26	*N/D*
Molybdenum	µg/g	0.2	0.1	0.1	0.1	0.2	0.1	0.1	<0.1	0.1	<0.1	0.1	0.04	No
Nickel	µg/g	1.1	1.4	1	1.4	1.2	0.9	1.4	0.5	1.2	0.5	1.1	0.32	No
Selenium	µg/g	<0.1	0.2	<0.1	0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	0.08	–	No
Silver	µg/g	0.3	0.2	0.1	0.2	0.3	0.6	0.1	0.5	0.2	0.4	0.3	0.16	No
Sodium	µg/g	440	240	290	300	390	640	290	400	160	290	344	125	*N/D*
Strontium	µg/g	16	19	16	21	18	20	19	18	18	18	18	1.49	*N/D*
Thallium	µg/g	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	–	No
Tin	µg/g	0.5	0.4	0.5	0.5	0.2	0.4	0.4	<0.1	0.1	<0.1	0.31	–	No
Titanium	µg/g	550	370	450	490	230	400	340	90	90	74	308	168	*N/D*

Parameter	Unit	RSV1	RSV2	RSV3	RSV4	RSV5	RSV6	RSV7	RSV8	RSV9	RSV10	Mean	Standard Deviation	CCME Exceedance[1]
Uranium	µg/g	0.6	0.4	0.6	0.6	0.4	0.6	0.4	0.2	0.2	0.2	0.4	0.17	No
Vanadium	µg/g	11	7.6	9.2	11	4.3	6.7	7.4	1.4	2.2	1.2	6.2	3.55	No
Zinc	µg/g	5.8	8.3	2.5	3.8	8.6	4.4	5.9	2.3	19	4	6.5	4.65	No
Primary/Essential Nutrients														
Phosphorus	µg/g	130	250	150	150	80	160	140	30	300	40	143	80	*N/D*
Potassium	µg/g	1100	770	930	760	1400	1500	980	990	880	820	1013	241	*N/D*
Radionuclides														
Lead-210	Bq/g	0.16	0.05	0.11	<0.04	0.11	<0.04	0.09	<0.04	0.19	<0.04	0.079	–	*N/D*
Polonium-210	Bq/g	0.14	0.07	0.04	0.05	0.07	0.04	0.07	0.03	0.21	0.06	0.078	0.053	*N/D*
Radium-226	Bq/g	0.02	0.02	0.02	0.02	<0.01	0.02	0.02	<0.01	<0.01	<0.01	0.02	0	*N/D*
Thorium-230	Bq/g	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	–	*N/D*

1 CCME – Canadian Council of Ministers of the Environment. Threshold values from the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health within Residential/Parkland Land-Use Areas (CCME 2011).

N/D = No Data.

9.1.3.3 Organic Matter/Peat

Organic Fibrisols have been delineated within the RSA as well as discrete/sporadic Organic Cryosols (Soil Landscapes of Canada Working Group 2010; McLaughlan et al. 2010). Based on available ecosite characteristics (McLaughlin et al. 2010; Acton et al. 1998) and using Vegetation/Ecosystem Mapping products (refer to Section 9.2), the landscape can be broadly characterized as upland and lowland sites (Figure 9.1-8). Organic soils are commonly associated with lowland sites occurring within or in proximity of wetlands (i.e., bogs, fens, and shores) and waterbodies that, together, account for <1% of the Project Area and 8.5% of the LSA; the reader is referred to Section 9.2 (cf. Section 9.2.3.3) for further details related to Wetlands. Organic soil profiles are characterized by a thin LFH (Litter-Ferment-Humus) followed by Of (fibric), Om (mesic), and/or Oh (humic) horizons of variable depths (depending on the wetland classification). Subsoils are characterized by a sand-textured Cg (gleyed) horizon and/or R horizon. In addition to these properties, Organic Cryosols are further characterized by the presence of permafrost.

Although Organic soils are limited within the Project Area, surface organic materials are salvageable and can be used as an organic amendment during reclamation. Presently, salvage potential for organic soils (e.g., locations, depths and volumes) is not known, but expected to be minor.

9.1.4 Assessment of Project-related Effects

9.1.4.1 Potential Interactions Between the Project and Valued Components / Key Indicators

The Project will require the construction, operation, and decommissioning of several components (as described in Section 2 Project Description). Potential interactions between Project activities and the Terrain, Soil, and Organic Matter/Peat VCs (and their associated KIs) are summarized by Project Phase in Table 9.1-5 and ranked as:

- **Primary Interaction** (✓): Project activity is expected to interact with the VC / KI which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- **Other Interaction** (✓): Project activity is expected to interact with the VC / KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- **No Interaction:** Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

Based on professional judgment and understanding of the nature of Project activities and their sequencing, these types of activities were used to filter the Project activity list and determine expected interactions; potential Project-related effects are then discussed in Section 9.1.4.2. Primary Project activities with the potential for adverse effects on Terrain, Soil, and Organic Matter/Peat (i.e., flagged as ‘primary interactions’) are expected to involve surface land clearing, major earthworks, surface/grading preparations and/or associated mobilization of equipment, assets and personnel that will occur during the Project life cycle. Other Project activities (i.e., flagged as 'expected interaction') refer to drilling, waste management and water management expected to be secondary contributors to potential adverse effects. The remaining activities—for example, power generation and supply, asset decommissioning and removal—were deemed to have no interaction and were not carried forward in the assessment as they are not expected to result in detectable changes in the MPs associated with Terrain, Soil, and/or Organic Matter/Peat. Activities during Post-Decommissioning (comprising site inspections, monitoring and on-site engagement with interested parties) were deemed to have no interaction because they do not involve any land clearing, surface preparations or major earthworks.

Table 9.1-5: Potential Project Interactions for Terrain, Soil, and Organic Matter/Peat

Project Phase/Activity	Terrain		Soil		Organic Matter/Peat
	Morphology	Stability	Quantity	Quality	Quantity
Construction Phase					
Development of access roads and air strip	✓	✓	✓	✓	✓
Site preparation and earthworks; clearing, leveling and grading of the Project Area	✓	✓	✓	✓	✓
Power generation - generators				✓	
Installation of main substation and distribution of power around site					
Wellfield and freeze hole drilling; ground freezing				✓	
Batch plant operation (concrete); crusher at borrow area				✓	
Development of surface infrastructure (camp, operations centre, plants, ponds, pads and support facilities)	✓	✓	✓	✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)				✓	
Water management (including treatment and site runoff)			✓	✓	✓
Groundwater supply					
Surface water withdrawal			✓	✓	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)				✓	
On-site and off-site operation of vehicles and transport of materials				✓	
Air transportation for workers				✓	
Regulatory site inspections					

Project Phase/Activity	Terrain		Soil		Organic Matter/Peat
	Morphology	Stability	Quantity	Quality	Quantity
Engagement – site visit from Interested Parties					
Operation Phase					
Operation of the ISR wellfield				✓	
Wellfield and freeze wall drilling	✓	✓	✓	✓	✓
Operation and expansion of freeze wall				✓	
Batch plant operation (grout and cement); crusher in borrow area				✓	
Expansion of pond and pads	✓	✓	✓	✓	✓
Operation of the processing plant and production of uranium concentrate				✓	
Water withdrawal from groundwater or surface water body					✓
Management of surface water (including seepage and site runoff)			✓	✓	✓
Water treatment, both domestic and industrial					
Water release to surface water body				✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)					
Hazardous waste management (temporary storage, handling, and off-site transportation)				✓	
Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates				✓	
On-site and off-site operation of vehicles and transport of materials				✓	
Power supply – primarily power from the grid, also generators and back-up generators				✓	
Package and transport of nuclear substances				✓	
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)				✓	
Air transportation for workers				✓	
Progressive decommissioning and reclamation	✓	✓	✓	✓	✓
Regulatory site inspections					

Project Phase/Activity	Terrain		Soil		Organic Matter/Peat
	Morphology	Stability	Quantity	Quality	Quantity
Engagement – site visit from Interested Parties					
Decommissioning Phase					
Site water management, treatment, and release				✓	✓
Mining horizon remediation and thawing of freeze wall					
Process water treatment and release				✓	✓
Closure of ISR and freeze wells and related infrastructure				✓	
Decontamination of surface facilities and injection, recovery and monitoring wells				✓	
Asset removal (including site power transmission lines and electrical infrastructure)				✓	
Demolition and disposal of non-salvageable surface infrastructure and materials				✓	
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)				✓	
Generators				✓	
Waste management (composting and landfill operation)				✓	
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)				✓	
On-site and off-site operation of vehicles and transport of materials				✓	
Reclamation of disturbed areas	✓	✓	✓	✓	✓
Regulatory site inspections					
Engagement – site visit from Interested Parties					
Post-Decommissioning Phase					
Environmental monitoring					
Regulatory site inspections					
Engagement - Site visit from Interested Parties					

9.1.4.2 Potential Project-related Effects

Based on the timing and nature of the interactions identified in Table 9.1-5, the subheadings summarize potential adverse effects on the Terrain, Soil and Organic Matter/Peat VCs that may occur during the lifetime of the Project. Mitigation measures are then described in Section 9.1.5.

In support of this EIS, an environmental risk assessment (ERA) was prepared with the objective to predict and assess the risk to representative human and ecological receptors resulting from exposure to radiological and non-radiological COPC expected to be released throughout all Project phases (Appendix 10-A in Section 10 Human Health). The ERA used the expected sources of atmospheric and liquid releases to predict the transport of these constituents through the environment and resulting exposure and effects on ecological receptors (including soil quality). These potential Project-related effects are addressed in Section 9.1.4.2.2 with reference to the ERA.

9.1.4.2.1 Terrain

Construction Phase

Development of the Project—comprising construction of the plant site, borrow pits and effluent ponds, roads, and ancillary features (e.g., airstrip/airport, camps/offices, facility pads)—has the potential to result in Project-related effects on terrain morphology and terrain stability. Potential effects are associated with grading preparations (i.e., clearing and grubbing of vegetation, stripping of soil and organic materials) and major earthworks (i.e., subgrade cut/fill and construction of sub-base) that can result in changes in topography (slope, aspect, and exposure), alter surface drainage patterns, increase surface erosion potential, and ultimately destabilize landscape features. Given the characteristics of surface materials (i.e., predominately fine-textured sandy soil), clearing/grubbing vegetation and stripping soil are expected to increase the area of exposed and/or unconsolidated surficial materials leading to increased potential for sediment mobilization (for details, refer to Sections 9.1.4.2.2 and 9.1.4.2.3).

Depending on landscape characteristics (i.e., parent material, slope grade, aspect, and position), subgrade cut/fill and other terrain recontouring activities can cause discrete slope failures and/or slumping[8] (Montgomery 1994; Wemple et al. 2000); infilling/backfilling of excavated features can result in settling and subsidence[9].

Changes in topographical contours (e.g., due to the construction of facilities and roads) can alter the magnitude, timing, and flashiness of surface drainage patterns resulting in alteration/retraining of overland surface water flow and acceleration of erosional processes (Duncan et al. 2014; Hancock and Willgoose 2004; Nyssen and Vermeersch 2010). Changes in overland surface water flow can also affect the permanence of surface water (e.g., pooling) and/or the potential for

[8] A mass wasting event that happens when loose materials move a short distance down a slope.
[9] Gradual caving or sinking of an area of land.

inundation (refer to Section 7 Geology and Groundwater). Over time, there is potential for these combined effects to alter landscape form and function both *in situ* and downgradient.

Operation Phase

Should they occur, construction type activities such as grading preparations and major earthworks during the Operation Phase (e.g., expansion of pads, effluent ponds and/or other facilities) are anticipated to have the same Project-related effects toward terrain morphology and terrain stability described above. As mentioned, changes in topographical contours can alter surface drainage patterns resulting in alteration/retraining of overland surface water flow and acceleration of erosional processes. During Operations, water release to groundwater and/or surface water bodies can change surface water flow and exacerbate erosional processes.

Decommissioning Phase

Decommissioning of the Project is intended to create a safe, stable, and self-sustaining landscape. Reclamation design planning is at a conceptual or pre-feasibility stage. Presently, most Project features are planned to be reclaimed by re-instating (to the extent practical) predominant topographical contours and drainage features, and preparing the site (e.g., via grading, and scarifying and/or other surface preparations) in a manner that promotes natural revegetation. The primary access road is expected to remain in place for the purpose of maintenance and aftercare during the Post-Decommissioning phase. Certain Project features (e.g., the clean waste rock pile) may be integrated into the end-landscape (i.e., applying the same site preparation approaches listed above) to create a safe, stable, and self-sustaining landscape.

Any/all reclamation activities involving major earthworks (i.e., cut/fill, infilling/backfilling, and re-grading/recontouring) and other landscape preparations may result in similar Project-related effects previously described, but to a lesser extent. Project-related effects may include discrete/isolated slope failures, minimal surface subsidence (specific to the area above the mining area), and changes in surface drainage patterns. Areas with exposed/unconsolidated surficial materials may cause increased potential for sediment mobilization until re-establishment of vegetation cover.

9.1.4.2.2 Soil[10]

Construction

Development of the Project has the potential to result in Project-related effects on the quality and quantity of mineral soil. Potential effects are primarily associated with grading preparations (i.e., clearing and grubbing of vegetation, stripping of soil, and organic materials) that can result in

[10] 21-EN-ERFN-473.8, Advisory Committee Meeting, 2021-06-15.

changes in soil quantity (i.e., loss of soil) and quality (i.e., degradation of physical and chemical properties).

Where applicable and to the extent practical, mineral soil within the Project Area will be stripped and salvaged prior to construction. Salvaged soil materials will be used for progressive reclamation (where applicable) and/or stockpiled material may be stored until the Decommissioning Phase for final reclamation. Soil salvage potential and soil suitability for reclamation are expected to range from fair to poor and may include soil that has limitations for reclamation. Disturbance and prolonged stockpiling of soil can further alter its physical and chemical properties, and thereby reduce its biological/ecological integrity[11]. For example, over-stripping soil, intermixing soil horizons (i.e., soil and parent material), and/or excessively handling soil can alter its structure (e.g., changes in porosity, micro- and macro-aggregation) and fertility profile (e.g., soil carbon, nitrogen/phosphorus, micro-nutrient composition) (Feng et al. 2019; Larney and Angers 2012; Liu et al. 2017; Sheoran et al. 2010; Shrestha and Lal 2011; Ussiri and Lal 2005). Changes in soil properties can then affect water holding capacity, root infiltration and vegetation re-establishment, thereby leading to changes in soil function to the detriment of revegetation and end-land use capability during reclamation and decommissioning (Cooke and Johnson 2002; Doley and Audet 2013, 2017). Meanwhile, overland vehicle and equipment travel within the Project Area can increase the potential for incidental disturbance of intact soils. Depending on soil properties, site clearing activities during wet or extremely dry conditions would be expected to exacerbate these effects.

Site clearing, construction, and associated equipment travel/mobilization are expected to result in the production and dissemination of open-source (i.e., fugitive) dust originating from roads, and vehicle and equipment travel on areas of exposed soil and/or surface materials. Airport activities and airplane transportation for workers are also sources of open-source dust. Wellfield drilling activities—which will be discrete and occur strictly within the padsite—have the potential for emissions and process-source dust that could contain radionuclides originating from ore bodies and mining/process waste materials (i.e., waste rock from drill cuttings). The reader is referred to Section 6 regarding types and constituents of dust, modelled dissemination pathways and predicted changes in COPC. The reader is then referred to Section 10 (specifically the ERA) regarding predicted changes in COPC and potential effects on human health. Together, open-source dust and process-source dust can accumulate and result in changes in soil quality of the intact soil and stockpiled soil, including nutrient concentrations, COPC and other soil properties (pH, CEC, EC). The reader is referred to Section 9.2 for more information on the uptake of metals and COPC by plants. Over time, changes to stockpiled soil (a key growing substrate for reclamation) can affect revegetation and end-land use capability during reclamation and decommissioning.

[11] For example, due to the degradation of the structure and composition of mineral soil and the viability of vegetative propagules.

Based on modelling scenarios, the potential for the dissemination of open-source dust is expected to be highest during equipment travel and major earth work and will occur primarily within, as well as at, the periphery of the Project Area (e.g., along roads and near areas of active soil disturbance during all Project phases). The potential for process-source dust is expected to be highest during wellfield drilling and handling of associated waste material and is expected to occur within the Project Area (e.g., near the wellsite and facilities).

Lastly, vehicle and equipment travel and construction within the Project Area have the potential to cause inadvertent spills, leaks, or contamination events involving hydrocarbons and organic compounds (Gudin and Syratt 1970). Depending on their properties, reactivity and concentration, incidental release(s) of hydrocarbons and organic compounds can result in a wide range of effects, from acute toxicity to altered soil chemical properties (e.g., pH, nutrient availability).

Operation

Should they occur, construction activities involving grading preparations during the Operation phase (e.g., expansion of pads, effluent ponds and/or other facilities) are anticipated to have the same Project-related effects described previously for Construction, referring to effects associated with soil stripping and soil handling. As mentioned, Construction activities, equipment mobilization and worker travel/transportation are expected to result in open-source dust; plant operations, wellfield drilling and associated handling of waste materials are expected to result in discrete emissions and process-source dust (refer to Section 6).

Emissions from the processing plant and other sources may result in the deposition of dust that can accumulate and result in changes in soil quality of intact soil and stockpiled soil, and thereby affect revegetation and end-land use capability during reclamation and decommissioning. Based on modelling scenarios, the potential for the dissemination of open-source dust is expected to vary depending on vehicle travel and discrete construction activities and is expected to occur primarily within, as well as at, the periphery of the Project Area. The potential for discrete process-source dust is expected to be highest during plant operations, wellfield drilling and handling of waste materials and will likely occur within the Project Area.

As mentioned, mineral soil within the Project Area will be stripped and salvaged prior to construction for use in reclamation activities, thereby minimizing potential adverse effects on soil quantity and quality during Operation. Intact soil (e.g., remnant/undisturbed portions of the Project Area and nearby environments adjacent to the Project Area) and soil stockpiles may accumulate open-source and process-source dust. Over time, changes to stockpiled soil can affect revegetation and end-land use capability during reclamation and decommissioning.

Water release to surface waterbodies can change surface water flow and thereby exacerbate erosion and sediment mobilization resulting in potential loss of soil and degradation of soil quality.

Areas of unvegetated/exposed soil (e.g., soil stockpiles and land clearings) are susceptible to degradation due to erosion and sediment mobilization.

As mentioned previously, vehicle and equipment travel and construction within the Project Area have the potential to result in inadvertent spills, leaks, or contamination events involving hydrocarbons and organic compounds (Gudin and Syratt 1970).

Decommissioning

Decommissioning and reclamation of the Project is intended to create a safe, stable, and self-sustaining landscape. Any stockpiled mineral soil remaining during Decommissioning following progressive reclamation activities will be redistributed across the reclaimed landscape as a growing substrate to support the desired end-land use. Project-related effects are expected to be associated with handling and replacement of salvaged soil, production, and dissemination of open-source dust (refer to Section 6), and the potential for inadvertent spills, leaks, and/or contamination events. Based on modeling results, reclamation activities (especially major earthworks and equipment travel) are expected to result in open-source dust. Handling of waste materials are expected to result in process-source dust that can change soil quality within the reclaimed landscape.

9.1.4.2.3 *Organic Matter/Peat*

Construction

Development of the Project has the potential to result in Project-related effects on the quantity of Organic Matter/Peat. Potential effects are associated with grading preparations (i.e., clearing and grubbing of vegetation, stripping of soil and organic materials) and major earthworks (i.e., subgrade cut/fill and construction of sub-base) that can result in degradation and/or loss of peat/organic matter, and alteration of wetland hydrologic functions that support the viability of peat/organic matter.

Where applicable and to the extent practical, peat/organic matter within the Project Area will be stripped and salvaged prior to construction. Disturbance and prolonged stockpiling of peat/organic matter can alter its physical and chemical properties, and thereby reduce its biological/ecological integrity[12].

Changes in topographical contours can alter surface drainage patterns, permanence of surface water, and hydrologic connectivity. These changes can alter the conditions necessary to support wetland vegetation and peat-forming processes leading to *in situ* and/or downgradient effects on peat/organic matter (refer to Section 9.2).

[12] For example, due to the degradation of the structure and composition of the peat/organic materials and the viability of vegetative propagules

Moreover, overland vehicle and equipment travel within the Project Area can increase incidental disturbance of intact organic matter/peat (e.g., dust deposition, rutting, and compaction). Vehicle and equipment travel and construction within the Project Area have the potential to result in inadvertent spills, leaks, or contamination events involving hydrocarbons and organic compounds (Gudin and Syratt 1970). Depending on their properties, reactivity, and concentration, incidental release(s) of hydrocarbons and organic compounds can result in a wide range of effects, from acute toxicity to altered soil chemical properties (e.g., pH, nutrient availability).

Operation

Should they occur, construction type activities involving grading preparations during the Operation phase are anticipated to have the same Project-related effects as described for Construction.

Decommissioning

Decommissioning and reclamation of the Project is intended to create a safe, stable, and self-sustaining landscape. Project-related effects are expected to be associated with handling of salvaged peat/organic materials resulting in potential degradation of structure and composition and even loss of these resources and their functional attributes.

9.1.5 Mitigation Measures

Mitigation in this EIS is defined as the elimination, reduction, or control of potential adverse effects of the Project on the environment throughout all Project phases. As per the Project Description (Denison 2020), Project-specific mitigation measures comprise Project design, implementation of BMPs, development of management plans, implementation of emergency response programs, and provision of training, education, and awareness. General mitigation measures that apply to Terrain, Soil, and Organic Matter/Peat are provided in the following subheadings following this paragraph. Subsequent subsections address specific mitigation measures pertaining to each of Terrain, Soil, and Organic Matter/Peat. Where applicable and to the extent possible, IK, LK, and outcomes of engagement (listed in Section 9.1.2) were considered in the proposed mitigation.

9.1.5.1 Project Design

Potential adverse effects on Terrain, Soil, and Organic Matter/Peat have been eliminated or reduced to the extent possible through Project design. In this respect, the mining process is recognized for minimal adverse environmental effects and releases of radionuclides (Denison 2020). For example, the mining activities—requiring low water and energy consumption and resulting in low emissions and process-source dust—will be restricted/limited to the wellfield and derive small volumes of overburden/waste rock material (sandstone) and process waste rock material (mineralized drill cuttings from wellfield development). The Project then applies latest technology[13] and processes[14] that facilitate a safe, efficient, and environmentally compliant operations. Consequently, the Project Area (i.e., referring to the area of maximum physical disturbance) is relatively small (total Project footprint = 169.6 ha; Construction facilities = 74.8 ha) and has been delineated to an optimal footprint that supports safe activities during all Project phases while reducing disturbance and incidental take of undeveloped land. The Project Area has been sited on terrain that avoids steep or unstable landscape features (Pozniak 2021) and limits disturbance of sensitive areas (e.g., wetlands, waterbodies) and areas that could be prone to instability. Where practical, portions of the Project Area have been sited on existing clearings and/or previously disturbed land and use existing access that reduces new disturbances within the Project Area.

Appropriately siting the Project represents a proactive mitigation measure for minimizing potential adverse effects on the Terrestrial Environment. In addition, the Project will be sequenced, constructed, and maintained according to design specifications and in a manner that is expected to provide a safe and stable landscape during all Project phases. As such, mitigation measures have been engineered into construction design specifications (e.g., facilities pads and road infrastructure with abutments, water management systems, erosion and sediment controls) to eliminate or reduce effects on Terrain, Soil, and Organic Matter/Peat and the downgradient environment to the extent practical. Lastly, Denison is committed to progressive decommissioning[15] (where feasible) throughout the life of the Project. Progressive decommissioning activities will focus on the decontamination, demolition, and removal/disposal of unused infrastructure and equipment/machinery, followed by reclamation of these areas to reduce the physical disturbance of the landscape. Final reclamation of the Project is scheduled to occur during the Decommissioning phase with a defined objective to achieve a safe, stable, and self-sustaining landscape in accordance with a Decommissioning Plan and aligning with provincial and federal regulations and BMPs.

9.1.5.2 Additional Mitigation Measures

Not all potential Project effects can be addressed through design. Therefore, additional mitigation measures are proposed to further reduce or eliminate adverse effects on the Terrain, Soil and Organic Matter/Peat VCs. The following mitigation measures (delineated according to Project phases) are based on proven/accepted guidance and BMPs. If/where applicable, Project-specific management plans and protocols (currently at a conceptual stage) will be developed to the

[13] E.g., battery-powered light vehicles and mobile equipment and AC powered dual rotary drill for ISR wellfield development; carefully contained storage tanks, above-ground pipelines and waste management infrastructure for isolation of process chemicals and waste materials.

[14] E.g., establishing and maintaining a freeze-wall to segregate the mineable zone from surrounding areas, cycling and recycling process chemicals and managing waste materials. Installing scrubbers and related infrastructure to reduce emission and dissemination of COPC.

[15] Kineepik Value Ecosystem Components (Kineepik Metis Local #9).

standard of the day and best-fit to the Project setting and associated sensitivities. The mitigation measures are expected to be effective immediately following implementation. Additional context and rationale as to 'how potential effects will be controlled' for each VC is provided (hereafter) in Sections 9.1.5.2.1, 9.1.5.2.2, and 9.1.5.2.3.

Construction

Project Area boundaries will be clearly delineated (e.g., using fencing, staking, or flagging). Should they occur, areas prone to potential instability and areas in proximity to waterbodies and drainage features will be identified and appropriate setbacks will be established and maintained. Construction will then closely adhere to construction boundaries, plans and schedules, and off-site machine use will be restricted to avoid effects outside the Project Area. To the extent practical, temporary workspaces or laydown areas will be sited on existing clearings and/or previously disturbed land to minimize new disturbances within the Project Area and retain intact soil and vegetation/groundcover.

Construction activities will be sequenced (i.e., site clearing, grading preparations, major earthworks and construction of infrastructure/facilities) so that surface vegetation, mineral soil and organic matter can be salvaged for later use in Project Decommissioning and Reclamation.

Sediment and erosion control measures and surface water management features will be installed and maintained at the Project. Erosion controls (e.g., sediment fencing, check-damns and/or sediment ponds) will be installed as necessary and at the discretion of construction personnel commensurate to site conditions and sensitivities to manage/mitigate erosion and sedimentation. Surface water management features (e.g., culverts and ditches) will be appropriately constructed and maintained (as per Project design specification) along access roads and facility sites to facilitate surface drainage continuity and hydrologic connectivity—especially in proximity to wetlands, water crossings, and waterbodies.

Open-source dust associated with major earthworks and equipment travel will be carefully monitored via general construction best management practices (BMPs). Dust deposition on soil, vegetation, and waterbodies (including wetlands and organic matter/peat) will be limited by controlling access and travel (i.e., traffic management) during peak construction and (if/where necessary) applying dust suppression measures. Process-source dust associated with wellfield drilling and handling of waste materials will be carefully monitored by controlling site access and conducting radiological clearance scanning (as required) of equipment, vehicles and personnel accessing the Project Area. A wash bay/station will be used to clean and decontaminate equipment.

Any discrete leaks, spills, or releases of hydrocarbons associated with general construction activities (major earthworks equipment and equipment/vehicle travel) will be addressed through implementation of a Spill Response Plan in accordance with applicable Project-specific plans and protocols. Any discrete leaks, spills, or releases of hydrocarbons associated with wellfield drilling and waste management will be addressed through implementation of the Spill Response Plan in accordance with Project-specific Plans and Protocols (or equivalent).

Operation

As mentioned for activities during Construction:

- New construction activities will adhere to Project boundaries, sequencing, and scheduling.
- Sediment and erosion control measures and surface water management features will be appropriately installed and maintained.
- Open-source dust and process-source dust will be monitored and mitigated.
- Any discrete leaks, spills, or releases associated with general construction activities or wellfield drilling will be mitigated.

Decommissioning

As mentioned for activities during Construction:

- Sediment and erosion control measures and surface water management features will be appropriately installed and maintained.
- Open-source dust and process-source dust will be monitored and mitigated.
- Any discrete leaks, spills, or releases associated with general construction activities or wellfield drilling will be mitigated.

9.1.5.2.1 Terrain

Potential effects on Terrain will be primarily mitigated via Project design and implementation of sediment and erosion control measures and surface water management features during all Project phases. Monitoring will occur during construction to verify that the Project has been built to the desired design specifications; the reader is referred to Section 9.1.8.1 for further details.

During the Decommissioning phase, the Project will be reclaimed to a safe, stable, and self-sustaining landscape in accordance with the Decommissioning Plan. To the extent practical, reclamation of the Project Area will re-instate predominant landscape features, topographical contours (slope, aspect), and surface drainage patterns in a manner that will tie-in to the existing landscape and maintain surface drainage continuity and hydrologic connectivity. Reclamation/Closure monitoring during the Post-Decommissioning Phase will be completed to verify the status and final conditions of the reclaimed landscape.

9.1.5.2.2 Soil

Potential effects on soil quantity and quality will be primarily mitigated via stripping/salvaging soil prior to construction and implementation of sediment and erosion control measures and surface water management features during all Project phases. Soil resources within the Project Area will be stripped/salvaged and stockpiled in accordance with relevant soil management BMPs, i.e., providing guidance on ground-truthing soil conditions, flagging potential hazards and sensitivities, and modifying practices in relation to environmental conditions and avoiding or minimizing inadvertent/incidental disturbance. A soil monitoring program/protocol (or equivalent) will verify soil salvage volumes and reclamation suitability; the reader is referred to Section 9.1.8.2 for further details.

Soil stockpiling locations will be sited to reduce soil handling and travel distances and designed to minimize the potential for soil degradation and downgradient effects—e.g., having a defined height and width that optimizes soil storage and stockpile stability, and having integrated erosion control measures and surface water management features (if/where necessary). Sediment and erosion control measures will be implemented in accordance with BMPs and commensurate to site conditions and sensitivities.

During all Phases, any leaks, spills, or releases of hydrocarbons that may affect soil quality will be addressed through implementation of a Spill Response Plan in accordance with applicable Project-specific plans and protocols. During all Phases, open-source dust and process-source dust will be carefully monitored and limited by controlling access and travel (i.e., traffic management) during peak construction and (if/where necessary) applying dust suppression measures; mitigation of process-source dust will also include decontamination. Vegetation and soil monitoring comprising scheduled collection of soil from permanent sampling locations for analysis of COPC—will be conducted during the Operation Phase. This will provide a mechanism to evaluate potential effects of dust on soil quality, and other interrelated VCs.; the reader is referred to Section 9.1.8.3 for further details.

During the Decommissioning Phase, the Project will be reclaimed to a safe, stable, and self-sustaining landscape in accordance with the Decommissioning Plan. To the extent practical, salvaged soil will be replaced and redistributed within areas of the Project Area to be reclaimed to provide a suitable growing substrate that will support re-establishment of the desired vegetation cover. Reclamation/Closure monitoring during the Post-Decommissioning Phase will be completed to verify the status and final conditions of the reclaimed landscape.

9.1.5.2.3 Organic Matter/Peat

Potential effects on organic matter/peat will be primarily mitigated via Project design and implementation of sediment and erosion control measures and surface water management features during all Project phases. The Project Area contains minimal areas of wetlands and waterbodies; only small/discrete areas of wetland vegetation (0.44 ha) are expected to be cleared. Should organic soil occur within the Project Area, Organic Matter/Peat will be stripped/salvaged and stockpiled (mixed with mineral soils) prior to Construction in accordance with relevant soil management BMPs, as described above.

Changes in topographical contours can alter surface drainage patterns, permanence of surface water and hydrologic connectivity. These changes can alter the conditions necessary to support wetland vegetation and peat-forming processes. As per Project design specifications, surface water drainages will be managed and maintained via culverts and ditches constructed along access roads and facility sites to facilitate surface drainage continuity and hydrologic continuity—especially in proximity to wetlands, water crossings and waterbodies.

During the Decommissioning Phase, the Project will be reclaimed to a safe, stable, and self-sustaining landscape in accordance with the Decommissioning Plan. To the extent practical, reclamation of the Project Area will re-instate predominant landscape features, topographical contours (slope, aspect) and surface drainage patterns. In areas in proximity to wetlands, water crossings, and waterbodies, the reclamation design is expected to maintain water quality and hydrologic connectivity in support of wetland function and peat-forming processes. Reclamation/Closure monitoring during the Post-Decommissioning Phase will be completed to verify the status and final conditions of the reclaimed landscape.

9.1.6 Residual Effects Evaluation

9.1.6.1 Definitions for Residual Effects Characterization and Significance

Residual Effects Characterization

Definitions of the residual effects characteristics specific to the VCs for Terrain, Soil, and Organic Matter/Peat are defined in Table 9.1-6. The ratings were developed based on review of similar approved projects, influence of IK, LK, and engagement, existing technical knowledge, and professional judgment. Where applicable, qualitative and/or quantitative guidelines were used to evaluate the residual effects criteria.

Table 9.1-6: Terrain, Soil, and Organic Matter/Peat – Definitions of Residual Effects Criteria

Residual Effect Criterion	Definition	Applicable VC(s)	Ratings
Direction	Identifies whether the residual effect will be adverse or positive.	Terrain Soil Organic Matter/Peat	**Adverse** – Residual Effect is negative or undesirable. **Positive** – Residual Effect is beneficial or desirable.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	Terrain	**Low** – Terrain morphology is within the natural range of variation. No change in terrain stability. **Moderate** – Terrain morphology is at the limit of the natural range of variation. No change in terrain stability. **High** – Terrain morphology is outside the natural range of variation. Measurable change in terrain stability.
		Soil	**Low** – Soil quantity and quality are within the natural range of variation and end-land use capability. Little to no measurable loss of soil quantity (volume) or change in soil physical and chemical properties. **Moderate** – Soil quantity and quality are at the limit of the natural range of variation and end-land use capability. Discrete/isolated measurable loss of soil quantity and/or change in the soil physical and chemical properties.

Residual Effect Criterion	Definition	Applicable VC(s)	Ratings
			High – Soil quantity and quality are outside of the limit of the natural range of variation and end-land use capability. Widespread measurable loss of soil quantity and/or change in soil physical and chemical properties.
		Organic Matter/Peat	**Low** – Little or no measurable loss in organic matter/peat quantity. Conditions that support peat-forming processes are within the natural range of variation and end-land use capability. **Moderate** – Discrete/isolated measurable loss in organic matter/peat quantity; conditions that support peat-forming processes are at the limit of the natural range of variation and end-land use capability. **High** – Widespread measurable loss in organic matter/peat quantity. Conditions that support peat-forming processes are outside of the limit of the natural range of variation and end-land use capability.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	Terrain Soil Organic Matter/Peat	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the VC LSA. **Regional** – Effect extends into the VC RSA. **Beyond Regional** – Effect extends beyond VC RSA.
Duration	Length of time over which the residual effect is expected to persist.	Terrain Soil Organic Matter/Peat	**Short-term** – Less than 3 years (i.e., occurs during Construction only). **Medium-term** – 3 years to 38 years (i.e., occurs from the Construction Phase through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	Terrain Soil Organic Matter/Peat	**Infrequent** – Occurs at sporadic intervals. **Frequent** – Occurs on a regular basis. **Continuous** – Occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	Terrain Soil Organic Matter/Peat	**Fully Reversible** – Residual effect is expected to diminish to baseline conditions. **Partially Reversible** – Residual effect is expected to partially diminish to baseline conditions. **Irreversible** – Residual effect is not expected to diminish to baseline conditions.
Context	The extent to which the VC or KI has been affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its ability to recover from	Terrain Soil Organic Matter/Peat	**Level of Disturbance** **Low** – VC is mostly undisturbed or has been slightly/discretely affected by past and present environmental and socio-economic processes and conditions (i.e., high level of natural integrity). **Moderate** – VC has been somewhat disturbed or moderately affected by past and present environmental and socio-economic processes and conditions (i.e., moderate level of natural integrity). **High** – Subcomponent has been highly affected by past and present environmental and socio-economic processes and conditions (e.g., low level of natural integrity).

Residual Effect Criterion	Definition	Applicable VC(s)	Ratings
	that effect (i.e., resilience).		**Sensitivity** **Low** – VC has low sensitivity and propensity to change (i.e., high resilience). **Moderate** – VC has moderate sensitivity and propensity to change (i.e., moderate resilience). **High** – VC has high sensitivity and propensity to change (i.e., weak resilience).
Likelihood	Likelihood that the residual effect will occur including consideration of the likelihood that the mitigation will be successful.	Terrain Soil Organic Matter/Peat	**Unlikely** – Low probability that the residual effect will occur. **Likely** – Moderate to high probability that the residual effect will occur.

Significance Definition

Upon evaluation of all available scientific information and based on the professional judgment of the assessor(s), it is necessary to determine the Significance of the Residual Effect(s) and the level of Confidence in the prediction(s). All residual effects (independent of their significance rating) are carried forward to the CEA. The Significance of the residual effect is rated as **not significant** or **significant** and defined as:

- **Not significant** – a residual effect that is NOT expected to result in a change to the VC/KI that would alter its status or integrity beyond an acceptable level (i.e., where it is not sustainable and/or is unavailable to contribute to ecological functions).
- **Significant** – a residual effect that is expected to result in a change to the VC/KI that would alter its status or integrity beyond an acceptable level (i.e., where it is not sustainable or is unavailable to contribute to ecological functions).

Confidence Definition

In this EA, the precautionary approach to the evaluation of potential effects was adopted, i.e., where areas of uncertainty are recognized and conservative assumptions are applied. In this respect, the Level of Confidence is a measure of how well the residual effect(s) is understood based on the quality of the input data, i.e., considering the reliability of data inputs and analytical methods used to predict Project effects, the confidence in the effectiveness of mitigation measures and certainty of the predicted outcome. The Level of Confidence is rated as Low, Moderate, or High and defined as:

- **Low**: Cause-effect relationships between the Project and the VC are not fully understood and/or necessary data are not entirely available to support the assessment. For example, several unknown external variables exist and/or data for the Project are incomplete. Likewise, the effectiveness of the mitigation measures is not yet proven and/or the modelling results hold a high degree of variance (i.e., given the data inputs). Consequently, there is generally a high degree of uncertainty in the conclusions of the assessment.

- **Moderate**: Cause-effect relationships between the Project and the VC are understood, but the necessary data are (to varying degrees) partially available to support the assessment. For example, some unknown external variables exist and/or data for the Project are incomplete. The effectiveness of the mitigation measures is moderately-well or highly proven and/or the modelling results hold a moderate or low degree of variance. Consequently, there is generally a moderate degree of uncertainty in the conclusions of the assessment.
- **High:** Cause-effect relationships between the Project and VC are fully understood and all necessary data are available to support the assessment. For example, external variables and/or data for the Project are both complete and comprehensive. The effectiveness of the mitigation measures is highly proven and/or the modelling results hold a low degree of variance. Consequently, there is generally a high degree of certainty in the conclusions of the assessment.

9.1.6.2 Terrain

9.1.6.2.1 Residual Effects Characterization

After mitigation, measurable residual changes in the KIs under the Terrain VC (i.e., terrain morphology and terrain stability) are predicted to occur. The residual effects characterization is summarized in Table 9.1-7 and described (hereafter) in further detail:

- The Project is predicted to result in adverse residual effects on Terrain.
- The magnitude is characterized as low because changes in terrain morphology are anticipated to be within the range of natural variation. To the extent possible, the Project Area has been sited on terrain that avoids steep or unstable landscape features. If constructed, maintained, and ultimately reclaimed to the design specifications, the Project is not anticipated to alter terrain stability; there should be no increase in erosion potential or acceleration of surficial erosional processes.
- The geographic extent is predicted to be Local (LSA). Direct effects (e.g., associated with site clearing and grading) will be restricted to the Project Area. However, indirect effects (e.g., alteration/retraining of overland surface water flow and acceleration of erosional processes) have the potential to extend outside of the Project Area and into the LSA for Terrain, Soil, and Organic Matter/Peat.
- The duration of these changes is predicted to occur over the medium-term (3 to 23 years) from Construction up to (but not including) Post-Decommissioning. The Project has been designed to be safe and stable and (where possible) incorporate engineered mitigation to address these effects over this timeframe.

- The frequency of the predicted residual effects is expected to be Infrequent. Most changes to Terrain will occur because of major earthworks during Construction and (to a lesser extent) during Decommissioning. A low-to-moderate potential exists for indirect effects (e.g., retraining of surface drainage patterns resulting in downgradient erosion and sedimentation) to occur gradually and/or irregularly during all other Project phases.
- The residual effects are predicted to be partially reversible. Reversibility is contingent on reinstatement of landform attributes (including slope, aspect). Project features will be reclaimed during decommissioning activities to form a safe, stable, and self-sustaining landscape. However, some features (e.g., the primary access road) are expected to remain in place during the post-decommissioning phase; other features (e.g., clean waste rock pile) may be integrated into the end-landscape.
- The context for these predictions is moderate. Although the RSA is mostly undisturbed/undeveloped, the Project Area is situated at a location where Terrain has experienced anthropogenic disturbance associated with previous mining exploration activities (e.g., access roads, pad sites, and temporary workspaces/laydowns). Hence, the Terrain has been deemed to hold moderate resilience to stress or ecological change.
- The likelihood for these predictions is likely. There is a moderate to high probability that the residual effect(s) will occur.

Table 9.1-7: Terrain – Summary of the Characteristics Ratings for Residual Effects

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Effects will result in change in terrain morphology and terrain stability from baseline condition(s).
Magnitude	Low	Change in terrain morphology anticipated to be within the range of natural variation; no anticipated change in terrain stability.
Geographic Extent	Local	Direct effects on terrain morphology and terrain stability are associated with Construction and Decommissioning that will be limited to the Project Area. However, potential for indirect effects to extend into the LSA.
Duration	Medium-term	Effects on terrain morphology and terrain stability anticipated to occur up to (but not including) Post-Decommissioning.
Frequency	Infrequent	Effects on terrain morphology and terrain stability associated with Construction and Decommissioning, and primarily occur at defined intervals.
Reversibility	Partially Reversible	Reversibility is contingent on reinstatement of predominant landform attributes (including slope, aspect, and surface drainage patterns) and end-land use objectives. Project features will be reclaimed to safe, stable, and self-sustaining landscape. However, some features (e.g., primary access road) will likely remain in place for the purpose of maintenance and aftercare during Post-Decommissioning; other features (e.g., clean waste rock pile) may be integrated into the end-landscape.

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Context	Moderate	Terrain has experienced anthropogenic disturbance associated with previous mining exploration activities (e.g., access roads, pad sites, and temporary workspaces/laydowns). Terrain has moderate resilience to stress or ecological change.
Likelihood	Likely	Moderate to high probability that the residual effects on terrain morphology and terrain stability will occur.

9.1.6.2.2 Significance and Confidence

The significance of the residual effect(s) pertaining to terrain morphology and terrain stability have been deemed **not significant**: the effect(s) is not expected to cause a change in the Terrain VC and/or its KI(s) to the extent that it will alter its status or integrity beyond an acceptable level (i.e., where it is not sustainable or is unavailable to contribute to ecological functions).

The level of confidence in this prediction is moderate. The cause-effect relationship between the Project and the VC is fully understood. However, available baseline data and mapping products pertaining to terrain morphology and terrain stability were developed at a coarse resolution; therefore, the quantification of direct and indirect effects holds a moderate degree of uncertainty affecting the conclusions of the assessment. That said, the effectiveness of the mitigation measures is moderately-well or highly proven: (1) the Project Area has been delineated to an optimal footprint to reduce (to the extent practical) disturbance and incidental take of undeveloped land; (2) the Project Area avoids steep or unstable landscape features, and avoids wetlands, waterbodies and other areas that could be prone to instability; and (3) portions of the Project Area have been sited on existing clearings and/or previously disturbed land and use existing access. The level of confidence in the prediction will improve with the implementation of the proposed monitoring and follow-up actions presented in Section 9.1.8.

9.1.6.3 Soil

9.1.6.3.1 Residual Effects Characterization

After mitigation, measurable residual changes in the KIs under the Soil VC (i.e., soil quantity and soil quality) are predicted to occur. The residual effects characterization is summarized in Table 9.1-8 and described (hereafter) in further detail:

- The Project is predicted to result in adverse residual effects on Soil.
- The magnitude is characterized as low-moderate because changes to soil quantity and soil quality are expected to be within or at the limits of the range of natural variation. To the extent practical, mineral soil resources within the Project Area will be stripped, salvaged, and stockpiled prior to Construction to conserve soil quantity and soil quality. Discrete/isolated measurable loss of soil quantity and/or changes in the soil physical and chemical properties may occur, but effects are not anticipated to result in changes in land use capability. Meanwhile, predicted changes in concentrations of COPC (i.e., soil quality) associated with

open-source dust, process-source dust and process emissions are expected to be within acceptable health and safety guidelines; no threshold exceedances are predicted.

- The geographic extent is predicted to be Local. Direct effects (e.g., associated with site clearing and grading) will be restricted to the Project Area. However, indirect effects (e.g., deposition of dust and downgradient erosion and sedimentation) are expected to extend outside of the Project Area and into the LSA for Terrain, Soil, and Organic Matter/Peat.
- The duration of these changes is predicted to occur over the medium-term (3 to 23 years) from Construction up to (but not including) Post-Decommissioning. Accordingly, the Project has been designed to be safe and stable and (where possible) incorporate engineered mitigation to address these effects over this timeframe.
- The frequency of the residual effects is predicted to be infrequent. Most changes to Soil are expected to occur because of soil stripping and salvaging during Construction and (to a lesser extent) because of soil replacement and redistribution during Decommissioning. A low-moderate potential exists for indirect effects (e.g., deposition of dust and downgradient erosion and sedimentation) to occur gradually and/or irregularly during all other Project phases.
- The residual effects are predicted to be partially reversible. Reversibility is contingent on soil salvage and soil suitability for reclamation. The Project will be reclaimed to a safe, stable, and self-sustaining landscape. Salvaged soil will be replaced and redistributed within areas of the Project Area to be reclaimed to provide a suitable growing substrate that is expected to support re-establishment of the desired vegetation cover. However, discrete/isolated measurable loss of soil quantity and/or changes in the soil physical and chemical properties may occur. Soil suitability for reclamation is expected to be poor, which can affect revegetation performance.
- The context for these predictions is moderate. Although the RSA is mostly undisturbed/undeveloped, the Project Area is situated at a location where Soil has experienced anthropogenic disturbance associated with previous mining exploration activities (e.g., access roads, pad sites, and temporary workspaces/laydowns). Hence, the soil has been deemed to hold moderate resilience to stress or ecological change.
- The likelihood for these predictions is likely. There is a moderate to high probability that the residual effect(s) will occur.

Table 9.1-8: Soil – Summary of the Characteristics Ratings for Residual Effects

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Effects will result in a change in soil quantity and soil quality from baseline condition(s); residual effects are negative or undesirable.
Magnitude	Low-Moderate	Change in soil quantity and soil quality are anticipated to be within or at the limits of the range of natural variation; no anticipated change in land use capability.
Geographic Extent	Local	Direct effects on soil quantity and soil quality are expected to be mitigated within the Project Area. However, potential for indirect effects to extend into the LSA.
Duration	Medium-term	Effects on soil quantity and soil quality are anticipated to occur up to (but not including) Post-Decommissioning.
Frequency	Infrequent	Effects on soil quantity and soil quality are associated with Construction and Decommissioning, and primarily occur at defined intervals.
Reversibility	Partially Reversible	Reversibility is contingent on soil salvage and soil suitability for reclamation. Salvaged soil will be replaced and redistributed within areas of the Project Area to be reclaimed to provide a suitable growing substrate that is expected to support re-establishment of the desired vegetation cover. However, discrete/isolated measurable loss of soil quantity and/or changes in the soil physical and chemical properties may occur. Soil suitability for reclamation is expected to be poor, which can affect revegetation performance. .
Context	Moderate	Soil within Project Area has experienced anthropogenic disturbance associated with previous mining exploration activities. Soil has moderate resilience (i.e., moderate susceptibility) to stress or ecological change.
Likelihood	Likely	Moderate to high probability that the residual effect will occur.

9.1.6.3.2 Significance and Confidence

The significance of the residual effect(s) of change in soil quality and soil quantity has been deemed **not significant**: the effect(s) is not expected to cause a change in the Soil VC and/or its KI(s) to the extent that it will alter its status or integrity beyond an acceptable level; these changes are not expected to alter its status or integrity beyond an acceptable level (i.e., where it is not sustainable or is unavailable to contribute to ecological functions)

The level of confidence in this prediction is moderate. The cause-effect relationship(s) between the Project and the VC are fully understood. However, the soil baseline data and mapping products are at a relatively coarse resolution. However, the effectiveness of the mitigation measures is moderately-well or highly proven: (1) the Project Area has been delineated to an optimal footprint to reduce (to the extent possible) disturbance and incidental take of undeveloped land; (2) portions of the Project Area have been sited on existing clearings and/or previously disturbed land and utilizes existing access; and (3) Project design and management plans are expected to help mitigate adverse effects. The level of confidence in the prediction is expected to improve with the implementation of the proposed monitoring and follow-up presented in Section 9.1.8.

9.1.6.4 Organic Matter/Peat

9.1.6.4.1 Residual Effects Characterization

After mitigation, measurable residual changes in the KI under the Organic Matter/Peat VC (i.e., quantity of organic matter/peat) is predicted to occur. The residual effects characterization is summarized in Table 9.1-9 and described (hereafter) in further detail.

- The Project is predicted to result in adverse residual effects on Organic Matter/Peat.
- The magnitude is characterized as low because potential changes to the quantity of organic matter/peat are expected to be within or at limits of the range of natural variation. Lowland sites account for <1% of the Project Area thereby limiting direct effects on organic matter/peat. Should it occur, discrete/isolated stripping/salvaging of organic matter/peat will result in little or limited loss in organic matter/peat quantity. Conditions that support peat-forming processes are expected to be within the natural range of variation and end-land use capability.
- The geographic extent of the residual effects is predicted to be local. Direct effects (e.g., associated with site clearing and grading) will be restricted to the Project Area. However, indirect effects (e.g., changes in surface water quality and hydrologic connectivity that could affect peat-forming processes) have the potential to extend outside of the Project Area and into the LSA for Terrain, Soil, and Organic Matter/Peat
- The duration of these changes is predicted to occur over the medium-term (3 to 23 years) from Construction up to (but not including) Post-Decommissioning. Accordingly, the Project has been designed to be safe and stable and (where possible) incorporate engineered mitigation to address these effects over this timeframe.
- The frequency of the residual effects is predicted to be infrequent. Most changes to Organic Matter/Peat are expected to occur because of soil stripping/salvaging and major earthworks during Construction and (to a lesser extent) because of major earth works and soil replacement and redistribution during Decommissioning. A low-moderate potential exists for indirect effects (e.g., changes in surface water quality and hydrologic connectivity that could affect peat-forming processes) to occur gradually and/or irregularly during all other Project phases.
- The residual effects are predicted to be partially reversible. Reversibility is contingent on the ability to re-establish hydrologic connectivity and water quality that support peat-forming processes. Project features will be reclaimed to a safe, stable, and self-sustaining landscape that includes re-instating topographic contours and surface drainage patterns. However, some features (e.g., primary access road) will likely remain in place for the purpose of maintenance and aftercare during the Post-Decommissioning phase; other features (e.g., clean waste rock pile) may be integrated into the end-landscape.

- The context for these predictions is low-moderate. Organic Matter/Peat within the RSA is mostly undisturbed/undeveloped; organic matter/peat within the Project Area is mostly undisturbed by previous anthropogenic activities. Organic matter/peat has moderate resilience (i.e., moderate susceptibility) to stress or ecological change depending on hydrologic connectivity and water quality conditions.
- The likelihood for these predictions is likely. There is a moderate to high probability that the residual effect will occur.

Table 9.1-9: Organic Matter/Peat – Summary of the Characteristics Ratings for Residual Effects

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Potential effects will result in change in the organic matter/peat from baseline condition(s).
Magnitude	Low	Potential change in quantity of organic matter/peat quantity is anticipated to be within or at limits of the range of natural variation; no anticipated change in land use capability.
Geographic Extent	Local	Direct effects on soil quantity and soil quality are expected to be mitigated within the Project Area. Potential for indirect effects to extend into the LSA.
Duration	Medium-term	Effect anticipated to occur up to (but not including) Post-Decommissioning.
Frequency	Infrequent	Effect associated with Construction and Decommissioning, and primarily occurs at defined intervals.
Reversibility	Partially Reversible	Reversibility is contingent on the ability to salvage/replace organic matter/peat (should it be directly affected) and re-establish hydrologic connectivity and water quality (should it be indirectly affected). Project features will be reclaimed to a safe, stable, and self-sustaining landscape that includes re-instating topographic contours and surface drainage patterns; however, some features (e.g., primary access road) will likely remain in place for the purpose of maintenance and aftercare during Post-Decommissioning.
Context	Low-Moderate	Organic matter/peat within Project Area is mostly undisturbed by anthropogenic activities. Organic matter/peat has moderate resilience (i.e., moderate susceptibility) to stress or ecological change depending on hydrologic connectivity and water quality conditions.
Likelihood	Likely	Moderate to high probability that the residual effect will occur.

9.1.6.4.2 Significance and Confidence

The significance of the residual effect(s) of a change in quantity of organic matter/peat has been deemed **not significant**: the effect(s) is not expected to cause a change in the VC and/or its KI(s) to the extent that it will alter its status or integrity beyond an acceptable level; these changes are not expected to alter its status or integrity beyond an acceptable level (i.e., where it is not sustainable or is unavailable to contribute to ecological functions)

The level of confidence in this prediction is moderate. The cause-effect relationship(s) between the Project and the VC are understood. However, baseline data and mapping products pertaining to organic matter/peat were developed at a coarse resolution. The effectiveness of the mitigation measures is moderately-well or highly proven: (1) the Project Area has been delineated to an optimal footprint to reduce (to the extent possible) disturbance and incidental take of undeveloped land; (2) siting of the Project Area avoids direct clearing of wetlands to minimize effects on organic matter/peat and/or previously disturbed land and utilizes existing access; and (3) Project design and management plans are expected to help mitigate adverse effects. The level of confidence in the prediction is expected to improve with the implementation of the proposed monitoring and follow-up presented in Section 9.1.8.

9.1.6.5 Summary of Project-Related Residual Effects

The summary of the assessment and characterization of Project-related residual effects specific to the VCs for Terrain, Soil, and Organic Matter/Peat is presented in Table 9.1-10. For each VC, the residual effects were predicted to be **not significant**: the effects are not expected to cause a change in the VCs and/or their respective KI(s) to the extent that they will alter their status or integrity beyond an acceptable level (i.e., where they are not sustainable or are unavailable to contribute to ecological functions).

For each VC, the level of confidence in these predictions is moderate. The cause-effect relationships between the Project and the VC are understood. However, baseline data and mapping products pertaining were developed at a coarse resolution, resulting in a moderate level of uncertainty. . That said, the effectiveness of the mitigation measures is moderately-well or highly proven: (1) the Project Area has been delineated to an optimal footprint to reduce (to the extent possible) disturbance and incidental take of undeveloped land; (2) siting of the Project Area avoids unstable and/or sensitive features and utilizes existing accesses and disturbed areas; and (3) Project design and management plans are expected to help mitigate adverse effects. The level of confidence in the prediction is expected to improve with the implementation of the proposed monitoring and follow-up presented in Section 9.1.8.

All residual effects (whether they are deemed significant or not significant) are carried forward into the CEA (Section 9.1.7).

Table 9.1-10: Terrain, Soil, and Organic Matter/Peat – Summary of Potential Project-Related Residual Effects

Valued Component	Key Indicator	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Terrain	Terrain Morphology Terrain Stability	Change in terrain morphology within the natural range of variability. No changes in terrain stability; no increase in erosion potential or acceleration of surficial erosional processes.	A	L	LSA	MT	IF	PR	M	L	NS	M
Soil	Soil Quantity Soil Quality	Change in soil quantity (volume) and soil quality (textural properties) within or at the limits of the natural range of variability.	A	L-M	LSA	MT	IF	PR	M	L	NS	M
Organic Matter/Peat	Quantity of Organic Matter/Peat	Change in the quantity of organic matter/peat within or at the limits of the natural range of variability.	A	L	LSA	MT	IF	PR	L-M	L	NS	M

Notes:

Direction:	Adverse (A), Positive (P)
Magnitude:	Low (L), Moderate (M), High (H)
Geographic Extent:	Project Area (PA), Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA)
Duration:	Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency:	Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility:	Fully Reversible (FR), Partially Reversible (PR), Irreversible (IR)
Context:	Low (L), Moderate (M), High (H)
Likelihood:	Unlikely (U), Likely (L)
Significance:	Not Significant (NS), Significant (S)
Level of Confidence:	Low (L), Moderate (M), High (H)

9.1.7 Cumulative Effects Assessment

The CEA considers whether residual adverse effects of the Project on a given VC will overlap spatially and/or temporally with the same residual adverse effects on the VC resulting from other past, present, and reasonably foreseeable projects or activities. The CEA follows standard methodology as per provincial (e.g., Guidelines for an Environmental Assessment under the [Saskatchewan] *Environmental Assessment Act* 1980) and federal guidance (e.g., Assessing Cumulative Environmental Effects under the *Canadian Environmental Assessment Act* 2012). The methodology for the CEA is discussed in greater detail within Section 5.9. Cumulative effects are presented within each VC-specific section of the EIS and are summarized within Section 16 Assessment Summary and Conclusions.

Other past, present, and reasonably foreseeable projects or activities within the Terrestrial Environment RSA that may interact cumulatively with the VCs for Terrain, Soil, and/or Organic Matter/Peat are shown on Figure 9.1-9. Where applicable and to the extent possible, IK, LK, and outcomes of engagement (listed in Section 9.1.2) were considered in the selection of these projects or activities and the CEA. Projects or activities included in the CEA for Terrain, Soil, and Organic Matter/Peat include:

- **Seismic and Geologic/Mineral Exploration – Proposed and Reasonably Foreseeable**

Various proposed and reasonably foreseeable seismic and geologic/mineral exploration projects are expected to occur within the Project LSA and RSA. The size, scale, and location of these projects are not yet determined. Project activities (including construction of access roads, exploration pads, and staging areas) are assumed to involve clearing of vegetation and stripping and salvaging of soil. These construction activities are not anticipated to result in changes to terrain morphology or terrain stability; activities may result in discrete changes in the quantity and quality of soil and/or organic matter/peat.

- **Cree Lake Winter Trail – Completed Recreational Trail Project**

This development refers to a winter access trail. In the absence of construction details and specifications, construction activities are assumed to have involved clearing of vegetation, stripping and salvaging of soil, and surficial earthworks, but no major terrain recontouring and/or subgrade preparations. These construction activities are not anticipated to have resulted in changes to terrain morphology or terrain stability; activities may have resulted in discrete changes in the quantity and quality of soil and/or organic matter/peat.

- **Highway 914 Road Maintenance – Ongoing and Reasonably Foreseeable Road Project**

The Saskatchewan Ministry of Highways and Infrastructure conducts regular road construction, repair, and maintenance on Highway 914. Maintenance activities may include vegetation management, road re-surfacing, and/or improvement of surface water management infrastructure (e.g., culvert replacement and recontouring of ditches and drainages). Although there are no proposed road maintenance activities along the segment of Highway 914 intersecting the RSA (i.e., that would involve major earthworks and/or stripping/salvaging of mineral soil or organic matter/peat), road upgrades resulting in marginal widening of the existing highway transportation corridor may occur in the future. These construction activities are not anticipated to result in changes to terrain morphology or terrain stability; activities may result in discrete changes in the quantity and quality of soil and/or organic matter/peat.

- **Recreation and Harvesting – Past, Present and Reasonably Foreseeable**

Land within the RSA is used for recreation activities (e.g., hiking and off-road vehicle access) and harvesting (e.g., hunting and fishing) via existing roads, trail networks, and cleared-vegetation corridors. These activities are not expected to involve any vegetation site clearing and/or soil salvage.

- **Traditional Land Use – Past, Present and Reasonably Foreseeable**

Land within the RSA is used for traditional land use; these activities may include all or some of the activities described under harvesting and recreation (above). A potential for spatial overlap occurs with the RSA via existing roads, trail networks, and cleared-vegetation corridors. These activities are not expected to involve any vegetation site clearing and/or soil salvage.

These activities have been carried forward in the CEA. In the absence of comprehensive activity details and spatial information, these projects and activities were considered from a strictly qualitative perspective based on available information and understanding of the scope of these activities.

Denison Mines

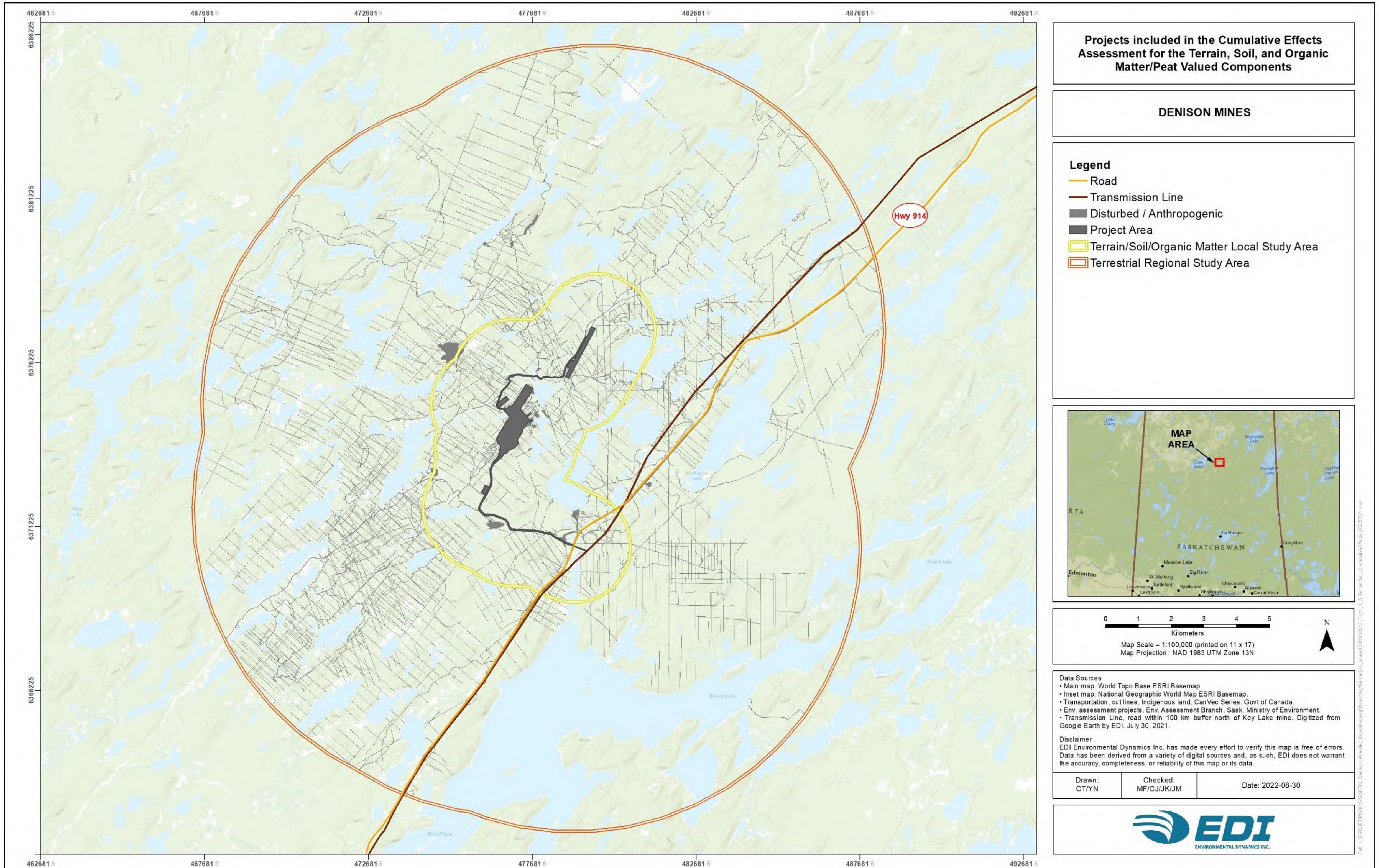


Figure 9.1-9: Terrain, Soil, and Organic Matter/Peat – Other Past, Present, and Reasonably Foreseeable Projects or Activities within the Terrestrial Environment Regional Study Area

9.1.7.1 Terrain

9.1.7.1.1 Potential Cumulative Effects

Based on available information and understanding of other past, present, and reasonably foreseeable projects or activities within the RSA for Terrain, Soil, and Organic Matter/Peat, potential exists for cumulative effects pertaining to changes in terrain morphology or terrain stability to occur. Potential cumulative effects are associated with clearing of vegetation, stripping and salvaging of soil, and surficial earthworks (described in Section 9.1.4.2.1). Anticipated change in terrain morphology and terrain stability are expected to be within the natural range of variability.

<u>Climate Change Considerations</u>

As described in Section 15.5.2 of Section 15 Effects of the Environment on the Project, ensemble output data from 24 different global climate models was used to present a range of possible climate conditions for the Tomblin Lake Region under two emissions scenarios. The ensemble outputs forecast a range of potential futures relevant to the region where the Project is located and presents results over a long-term horizon spanning the life of the Project. In general, these outputs predict/forecast warmer, snowier winters followed by longer, hotter summers over time (Section 15.5.2 of Section 15). While total precipitation is modeled to increase over the life of the Project (i.e., an average predicted mean annual increase of 6-12%; Section 15.5.2 of Section 15), warmer temperatures (i.e., increasing approximately 2°C by mid-century, and 3°C to 5°C by 2080) may result in increased evaporation, potentially leading to somewhat drier growing seasons.

The effects of climate on landscape patterns and processes can be complex due to the interrelation of biotic (living) and abiotic (non-living) components. Price et al. 2013 have comprehensively reviewed and summarized the anticipated consequences of climate change for Canada's boreal forest ecosystems—including the Project area, LSA and RSA. Modelled climate change scenarios hold an inherent level of uncertainty in the magnitude and extent of predicted effects; nevertheless, there is consensus on the broad potential effects on terrain:

- Warmer seasonal temperatures (summer and winter) and longer summers are expected to change the distribution of cryosolic soil and permafrost terrain (Kurz et al. 2013).
- Thawing of cryosolic soil and permafrost terrain may result in subsidence and other changes in surface drainage patterns, permanence, and soil moisture regime; over time, these changes may indirectly affect landscape patterns and processes, including erosion potential and (to varying degrees, depending on location, slope position and aspect) terrain stability.

Upland terrain characterized by Brunisolic soils predominate the RSA where upland represents 72.8 % (29,231 ha) of the area, while lowland, lakes and waterbodies represent 27.2% (10,940 ha). The Project is in a mapped area designated as Sporadic Discontinuous Permafrost (Heginbottom et al. 1995); large and/or expansive areas of continuous cryosolic soil and permafrost terrain do not occur within the RSA. For this reason, the potential effects listed above are not expected to affect terrain stability within the Project Area within the life of the Project.

9.1.7.1.2 Additional Mitigation Measures

It is assumed that the projects and activities included in the CEA include mitigation measures and BMPs set by the applicable jurisdictional and regulatory agencies. Additional mitigation—i.e., that extends beyond the mitigation considered in the assessment of Project-related effects (Section 9.1.5.1)—is not considered necessary to avoid or minimize the predicted cumulative effects on Terrain.

9.1.7.1.3 Cumulative Effects Characterization and Determination of Significance

Cumulative effects characterization and determination of significance were completed using the same assessment framework introduced in the assessment of residual effects (Section 9.1.6). Cumulative effects characterization for the Terrain VC is summarized in Table 9.1-11 and described (hereafter) in detail:

- Cumulative effects are predicted to be adverse. The magnitude is characterized as low because changes in terrain morphology are anticipated to be within the range of natural variation.
- Given the location and distribution of past, present, and reasonably foreseeable projects and activities, the geographic extent of cumulative effects is predicted to be Regional.
- The duration of cumulative effects is predicted to occur over the medium-term (3 to 23 years) from the Project's Construction up to (but not including) Post-Decommissioning.
- The frequency of the cumulative effects is expected to be infrequent. Most changes to Terrain will be associated with site clearing (vegetation and soil stripping) and construction earthworks.
- The cumulative effects are predicted to be partially reversible. In the absence of project-specific details, it is expected that most project and activities will be reclaimed back to the pre-development condition and therefore (at the least) partially diminish to baseline.
- The context for these predictions is moderate. The RSA for Terrain, Soil, and Organic Matter/Peat has been deemed to hold moderate resilience to stress or ecological change.
- The likelihood for these predictions is likely. A moderate to high probability exists that the residual effect(s) will occur.

The significance of the cumulative effect(s) has been deemed **not significant**: the effect(s) is not expected to cause a change in the VC and/or its KI(s) to the extent that it will alter its status or integrity beyond an acceptable level; the VC is expected to be sustainable and remain available to contribute to ecological functions in the RSA.

The level of confidence in this prediction is moderate. The cause-effect relationship(s) between the Project and the VC are understood and the effectiveness of the mitigation measures is moderately-well or highly proven. Despite adequate regional context, there is a moderate level of uncertainty inherent to all past, present, and reasonably foreseeable Projects within the RSA.

Table 9.1-11: Terrain – Summary of Cumulative Effects

Cumulative Effects	Project Phases	Cumulative Effects Characterization[1]								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Change in terrain morphology and terrain stability (within or at the limits of the natural range of variability)	Construction Operations Decommissioning	L	RSA	MT	IF	PR	M	L	NS	M

[1] Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility: Fully Reversible (FR), Partially Reversible (PR), Irreversible (IR)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (U), Likely (L)
Significance: Not Significant (NS), Significant (S)
Level of Confidence: High (H), Moderate (M), Low (L)

9.1.7.2 Soil

9.1.7.2.1 Potential Cumulative Effects

Based on available information and understanding of other past, present, and reasonably foreseeable projects or activities within the RSA for Terrain, Soil, and Organic Matter/Peat, potential for cumulative effects exists pertaining to changes in soil quantity and/or soil quality associated with the Gryphon Mine Project. Potential cumulative effects are associated with clearing of vegetation, stripping and salvaging of soil, and surficial earthworks (described in Section 9.1.4.2.2). Anticipated changes in soil quantity and soil quality within the RSA are expected to be within the natural range of variation.

Climate Change Considerations

As described in Section 15.5.2 of Section 15, ensemble output data from 24 different global climate models was used to present a range of possible climate conditions for the Tomblin Lake Region under two emissions scenarios. Price et al. (2013) have comprehensively reviewed and summarized the anticipated consequences of climate change for Canada's boreal forest ecosystems. Modelled climate change scenarios hold an inherent level of uncertainty in the magnitude and extent of predicted effects; nevertheless, there is consensus on the broad potential effects on soil:

- Warmer seasonal temperatures (summer and winter) and longer summers may change evapotranspiration and soil-moisture regimes; these changes may then result in alterations to vegetation cover composition (refer to Section 9.2 for further details).
- Warmer seasonal temperatures (summer and winter) and longer summers are expected to increase the frequency, duration, and intensity of fire disturbance; fire disturbance increases areas of exposed/unvegetated soil which increases erosion potential and soil quality (structure/composition).

Upland terrain characterized by Brunisolic soils predominate the RSA (72.8 % of the area). These soils are common throughout the Boreal Forest and adapted to periodic disturbance (e.g., fire) and seasonal variation (e.g., temperature, precipitations). Should they occur, these effects can result in isolated changes in soil mineralization and fertility patterns (Price et al. 2013). Within the life of the Project, the potential effects on soil quality and quantity mentioned above are not expected to exceed the natural range of variability.

9.1.7.2.2 Additional Mitigation Measures

It is assumed that the projects and activities included in the CEA will incorporate/apply mitigation measures and BMPs set by the applicable jurisdictional and regulatory agencies. Additional mitigation—i.e., that extends beyond the mitigation considered in the assessment of Project-related effects (Section 9.1.5.2)—is not considered necessary to avoid or minimize the predicted cumulative effects on Soil.

9.1.7.2.3 Cumulative Effects Characterization and Determination of Significance

Cumulative effects characterization and determination of significance were completed using the same assessment framework introduced in the assessment of residual effects (Section 9.1.6). Cumulative effects characterization for the Soil VC is summarized in Table 9.1-12 and described (hereafter) in detail:

- Cumulative effects are predicted to be adverse. The magnitude is characterized as low because changes in soil quantity and soil quality are anticipated to be within the range of natural variation.
- Given the location and distribution of past, present, and reasonably foreseeable projects and activities, the geographic extent of cumulative effects is predicted to be Regional.
- The duration of cumulative effects is predicted to occur over the medium-term (3 to 33 years) from Construction up to (but not including) Post-Decommissioning.
- The frequency of the cumulative effects is expected to be infrequent. Most changes to Soil will be associated with site clearing (vegetation and soil stripping) and construction earthworks.
- The cumulative effects are predicted to be partially reversible. In the absence of project-specific details, it is expected that most project and activities will be reclaimed to a safe, stable, and self-sustaining landscape, and therefore (at the least) partially diminish to baseline.

- The context for these predictions is moderate. The RSA for Terrain, Soil, and Organic Matter/Peat has been deemed to hold moderate resilience to stress or ecological change.
- The likelihood for these predictions is likely. A moderate to high probability exists that the residual effect(s) will occur.

The significance of the cumulative effect(s) has been deemed **not significant**: the effect(s) is not expected to cause a change in the VC and/or its KI(s) to the extent that it will alter its status or integrity beyond an acceptable level; the VC is expected to be sustainable and remain available to contribute to ecological functions in the RSA.

The level of confidence in this prediction is moderate. The cause-effect relationship(s) between the Project and the VC are understood and the effectiveness of the mitigation measures is moderately-well or highly proven. Despite adequate regional context, there is a moderate level of uncertainty inherent to all past, present, and reasonably foreseeable Projects within the RSA.

Table 9.1-12: Soil – Summary of Cumulative Effects

Cumulative Effects	Project Phases	Cumulative Effects Characterization[1]								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Change in soil quantity and soil quality (within or at the limits of the natural range of variability)	Construction Operations Decommissioning	L	RSA	MT	IF	PR	M	L	NS	M

[1] Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility: Fully Reversible (FR), Partially Reversible (PR), Irreversible (IR)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (U), Likely (L)
Significance: Not Significant (NS), Significant (S)
Level of Confidence: High (H), Moderate (M), Low (L)

9.1.7.3 Organic Matter/Peat

9.1.7.3.1 Potential Cumulative Effects

Based on available information and understanding of other past, present, and reasonably foreseeable projects or activities within the RSA for Terrain, Soil, and Organic Matter/Peat, there is potential for cumulative effects pertaining to changes in the quantity of organic matter/peat. Potential cumulative effects are associated with clearing of vegetation, stripping and salvaging of soil, and surficial earthworks (described in Section 9.1.4.2.3). The quantity of organic matter/peat is expected to be within the natural range of variation.

Climate Change Considerations

As described in Section 15.5.2 of Section 15, ensemble output data from 24 different global climate models was used to present a range of possible climate conditions for the Tomblin Lake Region under two emissions scenarios. Price et al. (2013) have comprehensively reviewed and summarized the anticipated consequences of climate change for Canada's boreal forest ecosystems. Modelled climate change scenarios hold an inherent level of uncertainty in the magnitude and extent of predicted effects; nevertheless, there is consensus on the broad potential effects on organic matter/peat:

- Warmer seasonal temperatures (summer and winter) and longer summers are expected to change evapotranspiration and soil-moisture regimes; these changes are expected to drive alterations in vegetation cover composition and decomposition rates that can result in the conversion/transformation of organic to mineral soils.
- Warmer seasonal temperatures (summer and winter) and longer summers are expected to increase the frequency, duration, and intensity of fire disturbance; changes in soil-moisture regimes are expected to increase the potential for burning of organic matter / peat and alter conditions conducive for peat-forming processes.

Upland terrain characterized by Brunisolic soils predominate the RSA (72.8 % of the area). Organic soils also occur within the RSA (27.2%; 10,940 ha). These soils are common throughout the Boreal Forest and adapted to periodic disturbance (e.g., fire) and seasonal variation (e.g., temperature, precipitations). Should they occur, these effects can result in isolated changes in soil mineralization and fertility patterns (Price et al. 2013). Within the life of the Project, the potential effects on soil quality and quantity mentioned above are not expected to exceed the natural range of variability.

9.1.7.3.2 Additional Mitigation Measures

It is assumed that the projects and activities included in the CEA include mitigation measures and BMPs set by the applicable jurisdictional and regulatory agencies. Additional mitigation—i.e., that extends beyond the mitigation considered in the assessment of Project-related effects (Section 9.1.5.2)—is not considered necessary to avoid or minimize the predicted cumulative effects on Organic Matter/Peat.

9.1.7.3.3 Cumulative Effects Characterization and Determination of Significance

Cumulative effects characterization and determination of significance were completed using the same assessment framework introduced in the assessment of residual effects (Section 9.1.6). Cumulative effects characterization for the Organic Matter/Peat VC is summarized in Table 9.1-13 and described (hereafter) in detail:

- Cumulative effects are predicted to be adverse. The magnitude is characterized as low because changes in the quantity of organic matter/peat are anticipated to be within the range of natural variation.
- Given the location and distribution of past, present, and reasonably foreseeable projects and activities, the geographic extent of cumulative effects is predicted to be Regional.
- The duration of cumulative effects is predicted to occur over the medium-term (3 to 33 years) from Construction up to (but not including) Post-Decommissioning.
- The frequency of the cumulative effects is expected to be infrequent. Most changes to Organic Matter/Peat will be associated with site clearing (vegetation and soil stripping) and construction earthworks.
- The cumulative effects are predicted to be partially reversible. In the absence of project-specific details, it is expected that most project and activities will be reclaimed to a safe, stable, and self-sustaining landscape, and therefore (at the least) partially diminish to baseline.
- The context for these predictions is moderate. The RSA for Terrain, Soil, and Organic Matter/Peat has been deemed to hold moderate resilience to stress or ecological change.
- The likelihood for these predictions is likely. There is a moderate to high probability that the residual effect(s) will occur.

The significance of the cumulative effect(s) has been deemed **not significant**: the effect(s) is not expected to cause a change in the VC and/or its KI(s) to the extent that it will alter its status or integrity beyond an acceptable level; the VC is expected to be sustainable and remain available to contribute to ecological functions in the RSA.

The level of confidence in this prediction is moderate. The cause-effect relationship(s) between the Project and the VC are understood and the effectiveness of the mitigation measures is moderately-well or highly proven. Despite adequate regional context, there is a moderate level of uncertainty inherent to all past, present, and reasonably foreseeable Projects within the RSA.

Table 9.1-13: Organic Matter/Peat – Summary of Cumulative Effects

Cumulative Effects	Project Phases	Cumulative Effects Characterization[1]								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Change in the quantity or organic matter/peat (within or at the limits of the natural range of variability)	Construction Operations Decommissioning	L	RSA	MT	IF	PR	M	L	NS	M

[1] Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility: Fully Reversible (FR), Partially Reversible (PR), Irreversible (IR)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (U), Likely (L)
Significance: Not Significant (NS), Significant (S)
Level of Confidence: High (H), Moderate (M), Low (L)

9.1.7.4 Cumulative Effects Assessment Summary

Based on available information and understanding of other past, present, and reasonably foreseeable projects or activities within the RSA for Terrain, Soil, and Organic Matter/Peat, there is potential for cumulative effects pertaining to the VCs for Terrain, Soil, and Organic Matter/Peat. Potential cumulative effects are associated with clearing of vegetation, stripping and salvaging of soil, and surficial earthworks. The KIs and associated MPs for Terrain (change in terrain morphology and change in terrain stability), Soil (change in soil quantity and change in soil quality) and Organic Matter/Peat (change in the quantity of organic matter/peat) are expected to be within the natural range of variation; no additional mitigation measures are recommended. After characterization of the cumulative effects, the significance of the cumulative effects was deemed **not significant** for both VCs; the level of confidence in these predictions is moderate.

9.1.8 Monitoring and Follow-up

For the purposes of this EIS, monitoring programs are designed to meet regulatory requirements (e.g., permit or license conditions) and demonstrate compliance with environmental commitments made in the EIS. Follow-up programs are those that are proposed to address any uncertainties identified during the EA process (e.g., to verify predictions made during the EA; determine the effectiveness of proposed and implemented mitigation measures) and to determine if/when to implement adaptive management measures. Denison has committed to working with the regulators, Indigenous groups, and other interested parties to finalize the details of the monitoring and follow-up programs outlined in this EIS.

9.1.8.1 Construction/Geotechnical Monitoring

Providing a safe and stable landscape during all Project phases is contingent (in part) on identifying geotechnical risk and applying appropriate mitigation. Construction monitoring will be conducted during and immediately following Construction to verify that the Project is constructed to design specifications (i.e., in a manner that meets geotechnical requirements) and that mitigation measures are both appropriate and effective in relation to the level of geotechnical risk. This will provide a procedure to adapt mitigation measures (if/where necessary). Adaptive management processes will be applied to update and refine the environmental management plans (e.g., incorporating additional maintenance, monitoring, and/or BMPs) to reduce effects during the lifetime of the Project. Where appropriate, Interested Parties, Indigenous groups, and government agencies will be involved in developing mitigation and adaptive management measures.

Construction and geotechnical monitoring will be implemented in accordance with the Environmental Management System (EMS), which will include erosion and sediment controls, soil and vegetation monitoring and the Decommissioning Plan. The timing/frequency of monitoring and reporting requirements will be determined in consultation with qualified personnel responsible for construction and geotechnical oversight (e.g., Professional Engineer).

Construction monitoring procedures will clearly define and delineate indicators and descriptors to identify potential deficiencies (e.g., types of slope failures and leading causes), triggers and corrective actions. These procedures will identify the key personnel (e.g., managers, superintendents, and technical leads) responsible for document review, approval, and implementation.

9.1.8.2 Soil Salvage Monitoring

Reclamation of the Project Area and return of the land to an equivalent land capability is contingent (in part) on effectively salvaging soil and organic matter/peat and maintaining their quantity and quality as a viable growth substrate until implementation of reclamation during Decommissioning. Soil and organic matter/peat monitoring will be conducted during soil salvage and stockpiling activities prior to Construction. This will provide a mechanism to verify that soil and organic matter/peat are delineated, stripped, handled, and stockpiled as recommended, and that there is an inventory of salvaged growth substrates at the Project.

Periodic monitoring of soil stockpiles will then be conducted (as/when necessary) during the Operation Phase to evaluate the stability of salvaged soil, e.g., in relation to potential erosion and/or degradation. These monitoring activities will provide a mechanism to verify that mitigation measures are both appropriate and effective and provide a procedure to adapt mitigation measures if/where necessary. If/where mitigation measures are not deemed to be successful, adaptive management processes will be employed to revise the environmental management plans (e.g., incorporating additional maintenance, monitoring and/or BMPs) to reduce effects during the lifetime of the Project. Where appropriate, Indigenous groups and government agencies will be involved in developing mitigation and adaptive management measures.

Monitoring of soil salvage activities will be implemented in accordance with other mitigation and management plans outlined within an EMS, which will include erosion and sediment controls, soil and vegetation monitoring, and a Decommissioning Plan. Soil salvage will be conducted under the guidance and supervision of a qualified environmental professional with experience ground-truthing site conditions to confirm/verify soil salvage depths and identify potential hazards (e.g., Professional Agrologist or Registered Professional Biologist with dedicated expertise in soil science).

Soil inventory data, including volume and location, will be recorded by construction supervisors at the time of soil stockpiling. Soil monitoring procedures will clearly define and delineate indicators and descriptors to identify potential deficiencies (e.g., soil salvage hazards and leading causes), triggers, and corrective actions. These procedures will identify the key personnel (e.g., managers, superintendents, and technical leads) responsible for document review, approval, and implementation.

9.1.8.3 Soil Quality Monitoring (Constituents of Potential Concern)

Soil quality monitoring—comprising scheduled collection of soil from permanent sampling locations for analysis of COPC—will be conducted during the Operation Phase. This will provide a mechanism to evaluate potential effects of dust on soil quality, and other interrelated VCs. If/where mitigation measures are not deemed to be successful, adaptive management processes will be employed to revise the environmental management plans (e.g., incorporating additional maintenance, monitoring and/or BMPs) to reduce effects during the lifetime of the Project. Where appropriate, Interested Parties, Indigenous groups, and government agencies will be involved in developing mitigation and adaptive management measures.

Soil quality monitoring will be conducted under the guidance and supervision of a qualified environmental professional with experience conducting soil sampling including sample collection, chain of custody and interpretation of data (e.g., Professional Agrologist or Registered Professional Biologist with dedicated expertise in soil science).

Soil quality monitoring data will be compiled and reported annually/periodically. Soil quality monitoring procedures will clearly define and delineate indicators and descriptors to identify potential deficiencies (e.g., COPC exceedances), triggers, and corrective actions. These procedures will identify the key personnel (e.g., managers, superintendents, and technical leads) responsible for document review, approval, and implementation.

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9.2 Vegetation and Ecosystems, Listed Plant Species and Wetlands

This subsection addresses potential Project-related effects on the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs. This subsection includes the following steps as part of the assessment:

- scope of the assessment;
- summary of the existing conditions of the VCs;
- identification and description of potential interactions between the Project and the VCs;
- identification and description of mitigation measures and monitoring activities to eliminate, reduce, or control the potential adverse Project-related effects on VCs;
- characterization of potential Project residual effects on VCs (i.e., after mitigation) including determination of significance and level of confidence in the predictions; and,
- identification and characterization of cumulative effects.

Figure 9.2-1 is a graphic representation of the assessment process used in this EIS.

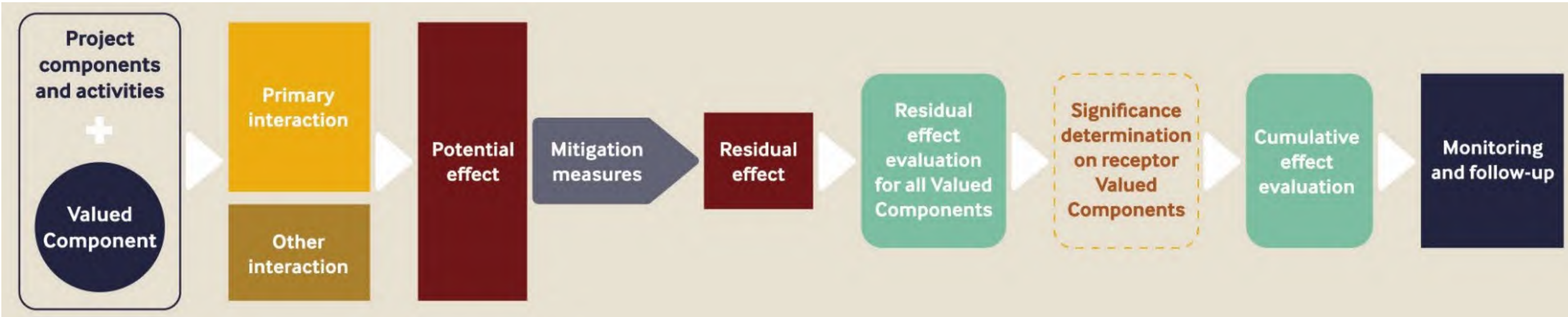

Figure 9.2-1: Environmental Assessment Process for the Wheeler River Project

9.2.1 Scope of the Assessment

9.2.1.1 Valued Component Selection

The process and rationale for selection of VCs and establishment of KIs and associated MPs is described in Section 5. Vegetation and Ecosystems, Listed Plant Species, and Wetlands were selected based on their:

- likelihood of interaction with the Project as identified during baseline investigations;
- contributing roles to biodiversity, ecosystem function, and maintenance of wildlife habitat;
- contributions to environmental, socio-economic, and cultural values of Indigenous groups, the public and other Interested Parties;
- regulatory context; and,
- historic use in previous assessments for the nearby Key Lake (Key Lake Mining Corporation 1979), McArthur River (AREVA Resources Canada Inc. 2009), and Millennium (Cameco Corporation 2013) operations.

One concept that was highlighted throughout Denison's engagement during the VC selection process was that several participants indicated that all environmental components are important for survival, for future generations, for traditional livelihoods to continue, and, therefore, all VCs should all be protected as different aspects of the environment are connected to one another and to human health (e.g., 21-EN-SUR-446.24, 21-EN-SUR-446.28). In addition, the importance of traditional uses of vegetation such as collection of berries, medicinal plants, and timber for construction and firewood have been identified (YNLR 2022; CanNorth 2017; ERFN and SVS 2022). This supports the inclusion of Vegetation and Ecosystems, Listed Plant Species, and Wetlands in the assessment.

The Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs are interrelated, to varying extents, and are linked to other VCs, including:

Atmospheric and Acoustic

- Air Quality – dust deposition and air emissions have the potential to disperse trace metals and radionuclides into the ambient air, which can subsequently be deposited onto Vegetation and Ecosystems, Listed Plant Species, and Wetlands and be taken up into plant tissues.

Geology and Groundwater

- Geology – changes in geology can influence Vegetation and Ecosystems, Listed Plant Species, and Wetlands through changes in Terrain.
- Groundwater Quality – groundwater contributes to local moisture regimes, and groundwater quality can influence the persistence of Vegetation and Ecosystems, Listed Plant Species, and Wetlands.

- Groundwater Quantity – groundwater contributes to local moisture regimes, and groundwater quantity contributes to site drainage and discharge, which can influence the persistence of Vegetation and Ecosystems, Listed Plant Species, and Wetlands.

Aquatic Environment

- Surface Water Quality – surface water contributes to local moisture regimes, and surface water quality can influence the persistence of Vegetation and Ecosystems, Listed Plant Species, and Wetlands.
- Surface Water Quantity – surface water contributes to local moisture regimes, and surface water quantity contributes to site drainage and discharge, which can influence the persistence of Vegetation and Ecosystems, Listed Plant Species, and Wetlands.
- Sediment Quality – Vegetation and Ecosystems, Listed Plant Species, and Wetlands contribute to ecosystem form and function that stabilize riparian areas and influence quality of surface water runoff to aquatic systems.

Terrestrial Environment

- Terrain – terrain interacts with Vegetation and Ecosystems, Listed Plant Species, and Wetlands by contributing to landscape form and function, ecosystem moisture and nutrient regimes, and future land capability.
- Organic Matter/Peat – organic matter/peat is derived from Vegetation and Ecosystems and Wetlands.
- Soil Quantity – soil quantity interacts with Vegetation and Ecosystems, Listed Plant Species, and Wetlands by contributing to landscape form and function, ecosystem moisture and nutrient regimes, and future land capability.
- Soil Quality – soil quality interacts with Vegetation and Ecosystems, Listed Plant Species, and Wetlands by contributing to landscape form and function, ecosystem moisture and nutrient regimes, and future land capability.
- Ungulates – Vegetation and Ecosystems, Listed Plant Species, and Wetlands provide habitat for feeding, reproduction, rearing, and/or cover for ungulates.
- Furbearers – Vegetation and Ecosystems, Listed Plant Species, and Wetlands provide habitat for feeding, reproduction, rearing, and/or cover for furbearers.
- Woodland Caribou – Vegetation and Ecosystems, Listed Plant Species, and Wetlands provide habitat for feeding, reproduction, rearing, and/or cover for woodland caribou.
- Raptors – Vegetation and Ecosystems, Listed Plant Species, and Wetlands provide habitat for feeding, reproduction, rearing, and/or cover for raptors.
- Migratory Breeding Birds – Vegetation and Ecosystems, Listed Plant Species, and Wetlands provide habitat for feeding, reproduction, rearing, and/or cover for migratory breeding birds.

- Bird Species at Risk – Vegetation and Ecosystems, Listed Plant Species, and Wetlands provide habitat for feeding, reproduction, rearing, and/or cover for bird species at risk.

Human Environment

- Indigenous Land and Resource Use – Vegetation and Ecosystems, Listed Plant Species, and Wetlands contribute to Indigenous land and resource use, including plants harvested for food, medicine, or other uses.
- Other Land and Resource Use – Vegetation and Ecosystems, Listed Plant Species, and Wetlands provide resource values such as tourism, guided outfitting, protected areas, mining, and forestry.
- Human Health – Vegetation has been, and continues to be, harvested for food, and as such, is part of the exposure pathway from the environment to vegetation to humans.

Figure 9.2-2 to Figure 9.2-4 are graphic representations of the main linkages among the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs and other VCs, illustrating the flow of assessment information into and from the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs.

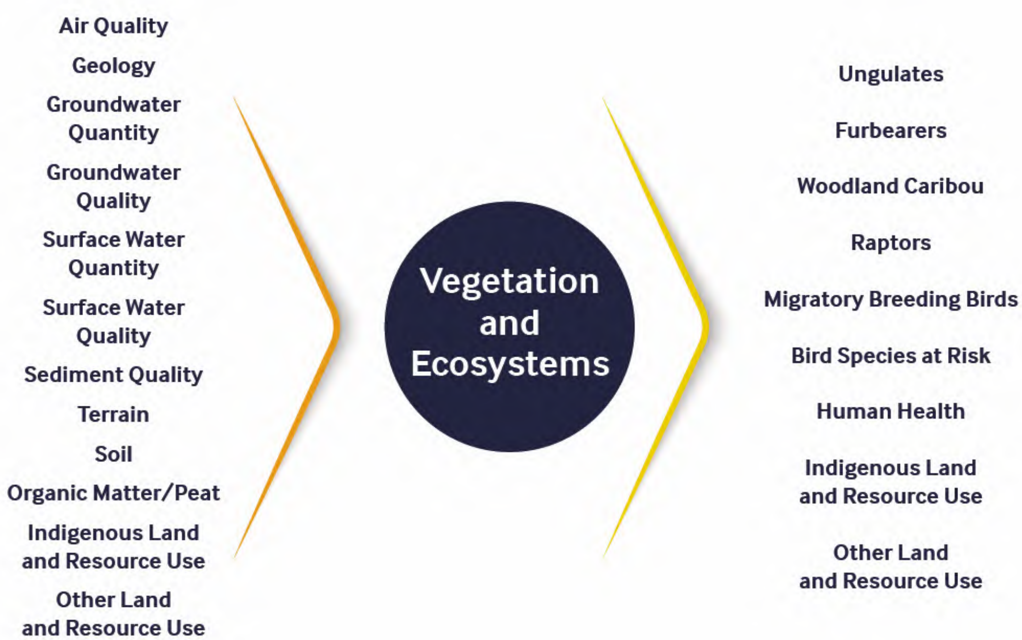

Figure 9.2-2: Integrated Assessment Approach - Key Connections between Vegetation and Ecosystems and Other Valued Components

Figure 9.2-3: Integrated Assessment Approach - Key Connections between Listed Plant Species and Other Valued Components

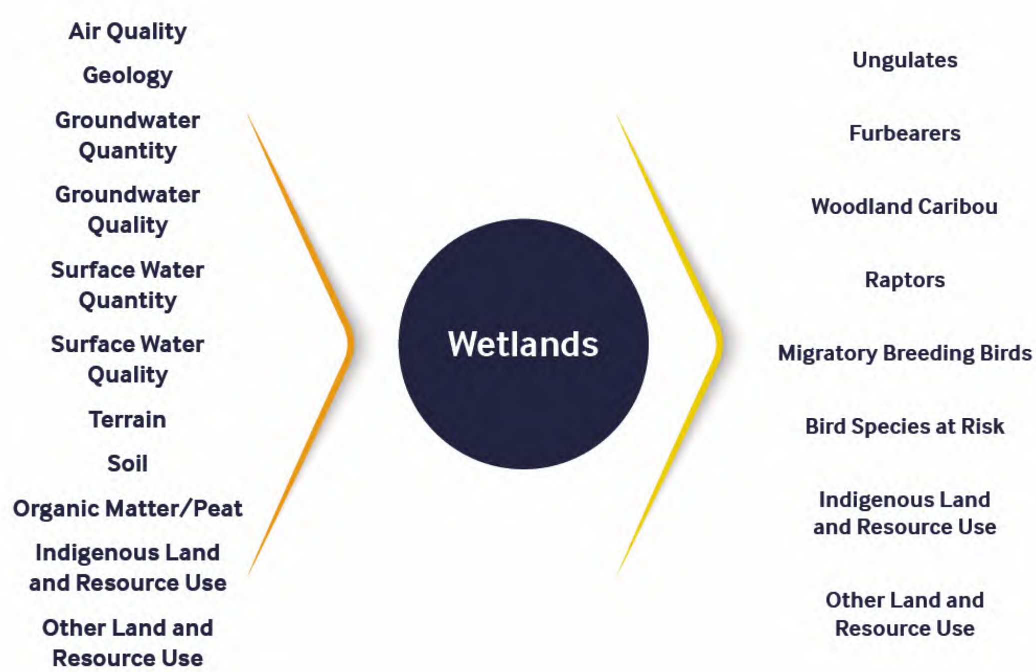

Figure 9.2-4: Integrated Assessment Approach - Key Connections between Wetlands and Other Valued Components

9.2.1.2 Key Indicators and Measurable Parameters

The KIs and associated MPs for Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs are summarized, respectively, in Table 9.2-1, Table 9.2-2, and Table 9.2-3. These definitions are used in subsequent headings.

Table 9.2-1: Key Indicators and Measurable Parameters for the Vegetation and Ecosystems Valued Component

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Vegetation abundance	• Project activities may result in a change in vegetation abundance. • Contributes to biodiversity, soil building processes, nutrient cycling, productivity, carbon storage, and habitat for wildlife species and listed plant species. • Cultural importance (18-EN-VILX-3.80, 19-LK-ERFNTrap-134.124, 20-LK-LEASESUR-267.40). • Historically addressed for other mining projects in northern Saskatchewan.	Change in areal extent of habitat types.
Concentrations of constituents of potential concern (COPC) in vegetation [1]	• Project activities may result in the deposition of COPC on plants and soil, which may result in uptake and resultant changes in the concentrations of COPC in plant tissue. • Uptake of COPC can affect plants by reducing plant health, changing plant abundance and community composition, and potentially changing their nutritional value and toxicity to wildlife and humans (Shaw 1989). • Historically addressed for other mining projects in northern Saskatchewan. • Constituents of potential concern include metals and trace elements (aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium. uranium, vanadium) and radionuclides (lead-210, polonium-210, radium-226, and thorium-230).	Change in concentrations of COPC in plant tissue.

1 A quantitative assessment modelling dispersion and uptake of COPCs in the environment was completed for the Project as part of the ERA, which is in Appendix 10-A in Section 10. This approach is aligned with the CSA N288.6 guidance. The ERA will be updated throughout the life of the Project and will provide a key tool for environmental performance reporting. In the ERA, COPCs in plant tissue was estimated for blueberry, lichen, browse, and Labrador tea. The uptake of these plants to various terrestrial receptors, including humans, was subsequently evaluated. The selection of this KI and associated MP for the Vegetation and Ecosystems VC is not intended to repeat the information from the ERA, but provide a separate evaluation of indirect effects of COPCs in vegetation, primarily through a potential change in areal extent of habitat types as a result of indirect effects from COPC uptake.

Table 9.2-2: Key Indicators and Measurable Parameters for the Listed Plant Species Valued Component

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Listed plant species	• Project activities may result in a change in the number of listed plant occurrences and/or populations. • Of provincial and/or federal management concern. • Contributes to biodiversity and habitat for wildlife species. • Historically addressed for other mining projects in northern Saskatchewan.	Change in the number of listed plants.

Table 9.2-3: Key Indicators and Measurable Parameters for the Wetlands Valued Component

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Wetlands	• Project activities may result in a change in the extent of Wetlands. • Of provincial and federal management concern • Contributes to biodiversity and habitat for wildlife species and listed plant species. • Cultural importance. • Contributes to biodiversity, maintenance of hydrologic cycles, nutrient cycling, water quality, and carbon storage (18-EN-ERFN-5.67). • Sensitive to disturbance. • Historically addressed for other mining projects in northern Saskatchewan.	Change in areal extent of Wetlands.

9.2.1.3 Spatial and Temporal Boundaries

The areas used to assess the effects of the Project on the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs are (Figure 9.2-5):

- **Project Area:** the area within which the Project and all components/activities are located (i.e., the area of maximum physical disturbance). The Project Area is considered to be a conservative estimate of the area of direct disturbance effects on VCs in this assessment.
- **Vegetation LSA:** the area that surrounds the Project Area where all direct effects and most indirect effects are likely to occur on the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs. The Vegetation LSA is defined as the Project Area plus a 250 m buffer along roads and a 500 m buffer around all other infrastructure (1,161.8 ha).

  Considerations used to establish the spatial boundaries of the Vegetation LSA include distances typical of microclimatic edge effects and dust deposition. Changes in microclimate resulting from forest edges (e.g., gradients of light intensity, temperature, wind, humidity) typically range from 25 m to greater than 240 m, depending on aspect and presence of shrubby vegetation at the forest-edge boundary (Chen 1991, Bannerman 1998, Kremsater and Bunnell 1999).

Dust also has variable deposition distance, depending on particle size and weather conditions. Studies have shown that more than 80% of the dust generated by vehicle movements is greater in size than 10 µm and concentrations decrease within 30.5 m of a roadway (Golder 2010); however, particles of all sizes will travel further (i.e., over 100 m) in high winds. Regardless of particle size, in open conditions 70 to 75% of dust has been observed to be deposited in the first 10 m, 93% deposited within 30 m, and approximately 97% deposited within 125 m from the road edge (Walker and Everett 1987).

- **Terrestrial RSA:** the area that surrounds and includes the Vegetation LSA, established to assess the potential, largely indirect effects of the Project on Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs in a regional context. The Terrestrial RSA (40,173.6 ha) is defined as a minimum 8 km buffer around the Vegetation LSA and has been delineated to capture all indirect effects of the Project on the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs and provide context for the type, distribution, extent, and prevalence of plant species and ecosystems in the region. The Terrestrial RSA also defines the area within which cumulative effects are likely to occur (i.e., CEA boundary).

Temporal boundaries identify when an effect is expected to occur in relation to specific Project phases and activities. The temporal boundaries are based on the timing and duration of Project activities, with the associated interactions with each VC and KI (where applicable). In the EA, the temporal boundaries are described as appropriate for each activity and cumulatively for the life of the Project.

The temporal boundaries for the EA represent the timeframes that the Project is expected to interact with and potentially affect Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs. The temporal boundaries are aligned with the Project development schedule (see Table 9.2-4): Construction; Operation; Decommissioning; and Post-Decommissioning.

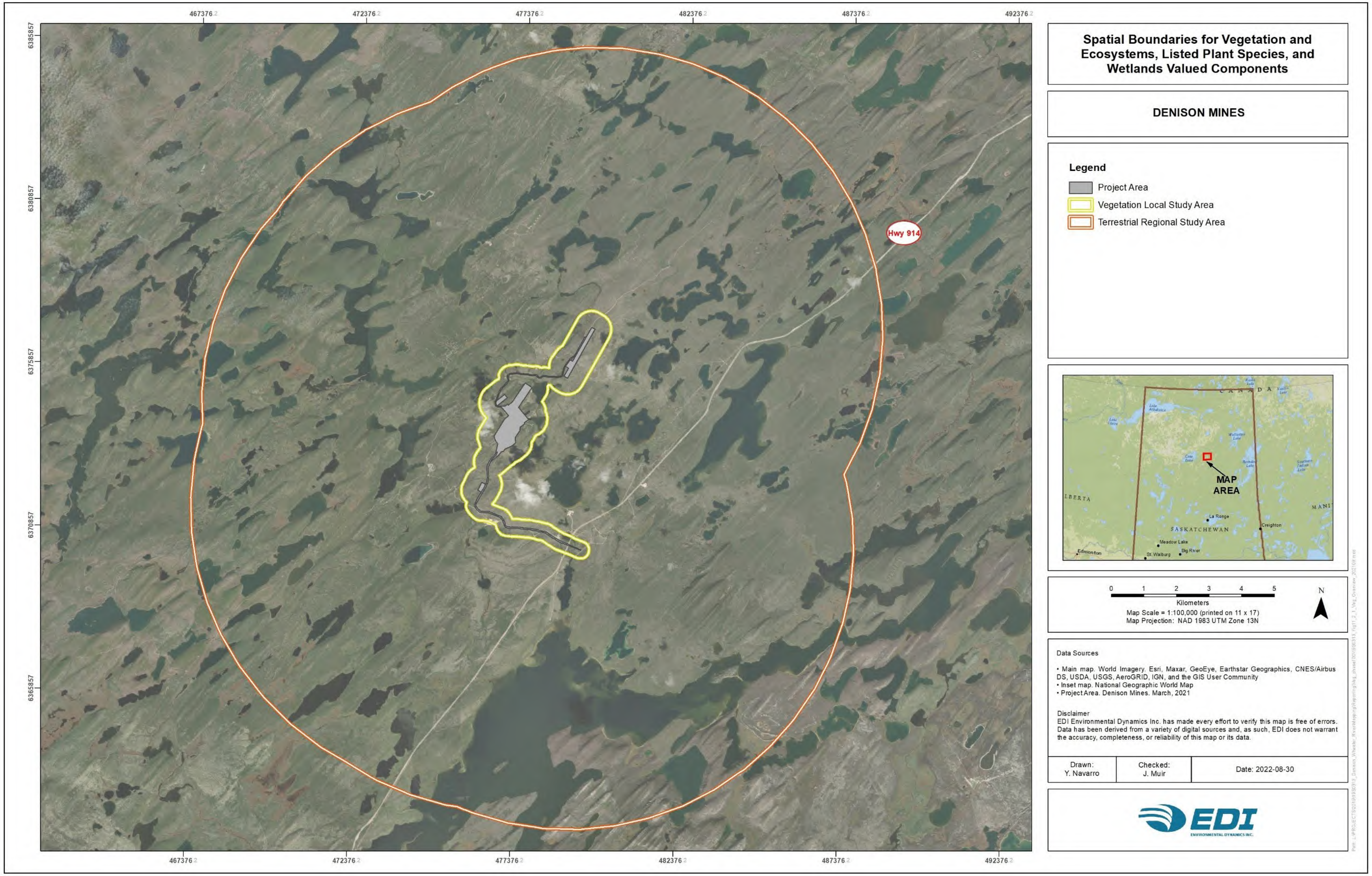

Figure 9.2-5: Spatial Boundaries for Vegetation and Ecosystems, Listed Plant Species, and Wetlands Valued Components

Table 9.2-4: Phases of the Project

Phase and Year	Description of Activities	
Construction Year 1 to 3	• Development of access roads and air strip • Site preparation and earthworks; clearing, leveling and grading of the project area • Power generation – generators • Installation of main substation and distribution of power around site • Wellfield and freeze hole drilling; ground freezing • Batch plant operation (concrete); crusher at borrow area • Development of surface infrastructure (camp, operations centre, plants, ponds, pads, and support facilities)	• Waste management (composting, domestic and industrial landfill operation, recycling) • Water management (including treatment and site run-off) • Groundwater supply • Surface water withdrawal • Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel) • On-site and off-site operation of vehicles and transport of materials • Air transportation for workers • Regulatory site inspections • Engagement - site visit from Interested Parties
Operation Year 3 to 18	• Operation of the ISR wellfield • Wellfield and freeze wall drilling • Operation and expansion of freeze wall • Batch plant operation (grout and cement) crusher at borrow area • Expansion of pond and pads • Operation of the processing plant and production of uranium concentrate • Water withdrawal from groundwater or surface water body • Management of surface water (including seepage and site run-off) • Water treatment, both domestic and industrial • Water release to surface water body • Waste management (composting, domestic and industrial landfill operation, recycling) • Hazardous waste management (temporary storage, handling, and off-site transportation)	• Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates • On-site and off-site operation of vehicles and transport of materials • Power supply – primarily power from the grid, also generators and back-up generators • Package and transport of nuclear substances • Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel) • Air transportation for workers • Progressive decommissioning and reclamation • Regulatory site inspections • Engagement - site visit from Interested Parties
Decommissioning Year 18 to 23	• Site water management, treatment and release • Mining horizon remediation and thawing of freeze wall • Process water treatment and release • Closure of ISR and freeze wells and related infrastructure • Decontamination of surface facilities and injection, recovery and monitoring wells • Asset removal (including site power transmission lines and electrical infrastructure)	• Generators • Waste management (composting and landfill operation) • Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal) • On-site and off-site operation of vehicles and transport of materials • Reclamation of disturbed areas • Regulatory site inspections • Engagement - site visit from Interested Parties

Phase and Year	Description of Activities	
	• Demolition and disposal of non-salvageable surface infrastructure and materials • Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	
Post-Decommissioning Year 23 to 38	• Environmental monitoring	• Regulatory site inspections • Engagement - site visit from Interested Parties

9.2.2 Information from Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

Within this EIS, IK and LK are viewed as complementary and influential alongside western science to produce a full understanding of the potential effects of the Project, whether measurable or perceived. Denison has recorded and stored information regarding IK, LK, and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 20-LK-LEASESUR-267.20). These numbers are referenced throughout the EIS. In accordance with methodologies provided in Sections 3, 4, and 5 of the EIS, IK, LK, and engagement have been incorporated within the assessment of Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs as available and appropriate. Appendix 9-A provides a summary of unique identification numbers referenced within Section 9.2.

9.2.3 Existing Environment

The Project is located within the Wheeler Upland Landscape Area of the Athabasca Plain Ecoregion within the Boreal Shield Ecozone of Saskatchewan (Acton et al. 1998). As described in Section 9.1, the terrain is characterized by eskers (long winding ridges) and drumlins (elongated oval-shaped hills) with small variations in elevation (ranging 480 to 590 m above sea level). Parent materials are associated with glacio-fluvial and morainal deposits, and surface textures are predominantly sand textured (sand, loam sand/sandy loam and silty sand). Brunisolic soils dominate upland areas, which are typically characterized as acidic, holding low fertility and organic matter content, and lacking a well-developed mineral-organic surface horizon; as such, effective rooting depths can be relatively shallow (<30 cm) in some locations (Section 9.1). Gleysolic and Organic soils are common within poorly drained areas (e.g., wetlands; Acton et al. 1998).

Fire disturbance is naturally prevalent within this area of the province, and vegetation communities are commonly in various seral stages from post-fire regeneration (Acton et al. 1998). Upland forests are characterized by open stands of jack pine (*Pinus banksiana*) within drier soil moisture regimes (e.g., south-facing aspects, linear till ridges, on soils shallow to bedrock), with mixed stands of jack pine and black spruce (*Picea mariana*) common on north-facing aspects (Acton et al. 1998).

Drainage is typically poorly developed, consisting of lakes and waterbodies draining into one another by means of small creeks. Wetland ecosystems are dominated by shallow peatlands (with peat deposits up to 3 to 4 m thick). Fens occur along streams and seepage areas, dominated by brown mosses, sedges (*Carex* spp.), shrubs, and sometimes tamarack (*Larix laricina*), whereas nutrient-poor bogs occur upslope from fens and are characterized by peat mosses (*Sphagnum* spp.), shrubs, herbs, and stunted black spruce (Acton et al. 1998). Shallow open water wetlands associated with shallow lakes are characterized by pondweeds (*Potamogeton* spp.), bulrushes (e.g., *Scirpus* spp.), and sedges (Acton et al. 1998).

Project-specific investigations pertaining to the Terrestrial Environment were conducted by Omnia Ecological Consulting (Omnia; Calgary, AB) from 2017 to 2019. Details on the methods, survey parameters and assumptions, and comprehensive data summaries/findings are presented in the Project-specific baseline report (Omnia 2020; see Appendix 9-B) and a supplementary baseline annex report completed in 2021 (EDI 2021; see Appendix 9-C). The following subsections summarize vegetation baseline conditions from these sources.

9.2.3.1 Vegetation and Ecosystems Valued Component

9.2.3.1.1 Vegetation Abundance

Project baseline studies for vegetation presented a description of the ecosystems/habitat types (i.e., ecosite classifications) within the Terrestrial RSA. Vegetation communities and ecosystems are represented by provincial ecosite classifications for the Boreal Shield Ecozone in accordance with the *Field Guide to the Ecosites of Saskatchewan's Provincial Forests* (McLaughlan et al. 2010). These ecosite classifications were summarized within a 1:20,000 interpreted ecosite mapping product compiled within the Terrestrial RSA with the use of the following inputs:

- 1:5,000 anthropogenic features mapping;
- historical fires data;
- provincial Predicted Ecosite Mapping;
- current and historical imagery; and
- field sampling/ground truthing sites (Omnia 2020, see Appendix 9-B).

As the Boreal Shield Ecozone experiences a largely natural fire regime that results in the most area burned per unit area and the highest proportion of very large fires (more than 50,000 ha) in the province (Parisien et al. 2004), much of the vegetation within the Terrestrial RSA (70.6%) is comprised of post-fire regeneration (i.e., shrubby structural stages; Table 9.2-5; Appendix 9-B).

The jack pine dominated BS3 ecosite is the most common ecosite on the Boreal Shield, occurring in almost every topographic position and slope (Figure 9.2-6; Table 9.2-5). It is closely tied with the

BS7 ecosite, which can be either dominated by black spruce or a mixture of black spruce and jack pine, and as a result tends to have a greater canopy closure and stem density than the BS3 ecosite. The successional relationship between BS3 and BS7 are interdependent: with sufficient abundance of pine, the BS7 may follow a successional pathway toward BS3, and in the absence of disturbance, BS3 ecosites may transition toward BS7 (McLaughlan et al. 2010).

Native plants harvested/collected for cultural use such as berries[16] (YNLR 2022; CanNorth 2017; ERFN and SVS 2022) are common within the various vegetation communities and ecosystems within the Terrestrial RSA. For example, a local land user shared that he eats blueberries while out walking but does not actively harvest blueberries or drink Labrador tea (19-LK-ERFNTrap-134.124). Another individual identified plant collecting as an important component of their land-based activities (20-LK-LEASESUR-267.40). For the English River First Nation (ERFN), berries are recognized as an important food source, with blueberries the most common berry type, followed by raspberry, Saskatoon berry, bog cranberry, and wild strawberry (CanNorth 2017; ERFN and SVS 2022). Other vegetation used by the ERFN include wild rice, wild mint, Labrador tea, wild roots, mushrooms, and carrot (CanNorth 2017). A variety of traditional medicinal plants are used by the ERFN including rat root, wild mint, Labrador tea, spruce gum, sweet grass, and yarrow (CanNorth 2017).

Table 9.2-5: Summary of Vegetation and Ecosystems

Habitat Type / Ecosite Code[1]	Habitat Type / Ecosite Description[1]	Structure Code[2]	Vegetation LSA (ha)	Vegetation LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
AN	Anthropogenic	Various[3]	68.0	5.9	599.0	1.5
BS3	Jack pine / blueberry / lichen	6	329.0	28.3	10,374.8	25.8
BS3/BS7	Jack pine / blueberry / lichen and black spruce / blueberry / lichen	3a	59.8	5.2	4,556.4	11.3
		3b	564.1	48.6	10,525.5	26.2
		5	31.1	2.7	2,412.1	6.0
		Total	655.1	56.4	17,494.0	43.5
BS4	Jack pine – black spruce / feathermoss	6	6.2	0.5	332.8	0.8
BS7	Black spruce / blueberry / lichen	6	2.3	0.2	281.0	0.7
BS9	Black spruce – jack pine / feathermoss	6	3.1	0.3	148.5	0.4
BS14	White birch / lingonberry – Labrador tea	5	-	-	1.8	<0.1
BS16	Black spruce / balsam poplar / river alder swamp	6	-	-	8.8	<0.1

[16] 18-EN-VILX-3.80, 19-LK-ERFNTrap-134.124, 20-LK-LEASESUR-267.40.

Habitat Type / Ecosite Code[1]	Habitat Type / Ecosite Description[1]	Structure Code[2]	Vegetation LSA (ha)	Vegetation LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS17	Black spruce treed bog	5	18.2	1.6	1,157.1	2.9
BS18	Labrador tea shrubby bog	3	23.3	2.0	967.6	2.4
		3a	-	-	20.3	0.1
		3b	-	-	2.0	<0.1
		Total	23.3	2.0	989.9	2.5
BS19	Graminoid bog	2	2.8	0.2	160.5	0.4
BS19/24	Graminoid bog or graminoid fen	2	1.5	0.1	2.4	<0.1
BS20	Open bog	1	0.6	<0.1	65.5	0.2
BS21	Tamarack treed fen	5	1.9	0.2	66.5	0.2
BS22	Leatherleaf shrubby poor fen	3a	-	-	28.5	0.1
BS23	Willow shrubby rich fen	3b	0.6	<0.1	20.9	0.1
BS24	Graminoid fen	2	-	-	9.0	<0.1
BS25	Open fen	1	0.4	<0.1	5.7	<0.1
BS26	Rush sandy shore	2	-	-	15.1	<0.1
BS27	Sedge sandy shore	2	4.2	0.4	29.3	0.1
Lake[4]	-	0	-	-	4,279.7	10.7
Waterbody[4]	-	0	44.9	3.9	4,101.9	10.2
Total[5]			**1,161.8**	**100.0**	**40,172.5**	**100.0**

Notes:

1 Ecosystems are described in detail in the Guide to the Ecosites of Saskatchewan's Provincial Forests (McLaughlan et al. 2010).

2 Modified from the Field Manual for Describing Terrestrial Ecosystems (BC Ministry of Environment, Lands, and Parks, and BC Ministry of Forests 1998). 0 = unvegetated; 1 = sparse / bryophyte / lichen; 2 = herb/graminoid; 3a = low shrub; 3b = tall shrub; 5 = young forest, 6 = mature forest.

3 Areas of anthropogenic disturbance have various vegetation structures depending on the intensity and duration of the original disturbance, as well as the time elapsed since disturbance.

4 Lakes have been defined as either named lakes or waterbodies observed to exhibit an average depth of ≥2 m (Ecometrix Incorporated 2020). Waterbodies are defined as areas of open water observed to exhibit an average depth of <2 m (Ecometrix Incorporated 2020), or unnamed areas of open water without any existing bathymetric information.

5 Some numbers are rounded for presentation purposes. Therefore, the totals may not equal the sum of the individual values.

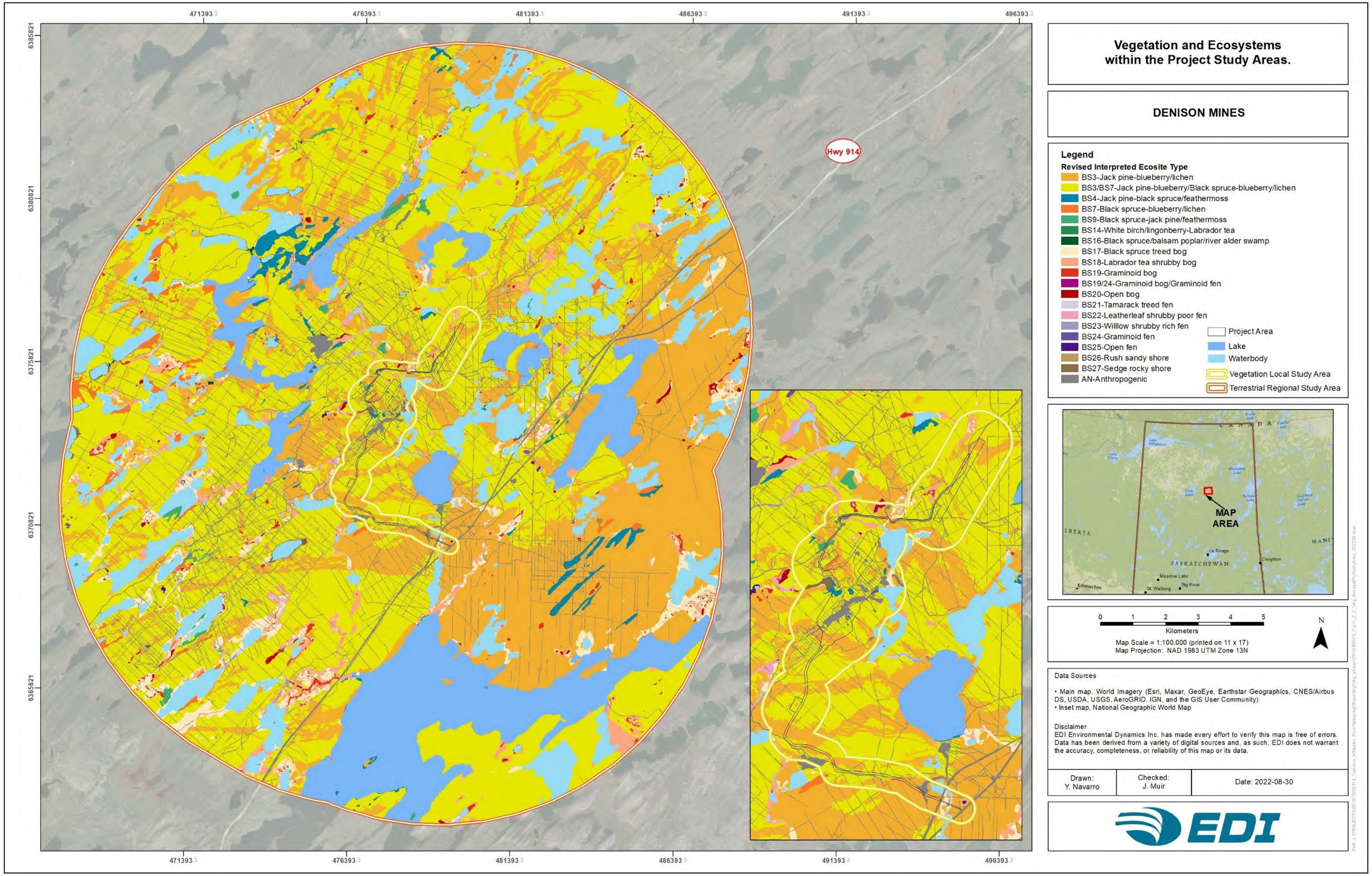

Figure 9.2-6: Vegetation Communities and Ecosystems within the Project Study Areas

9.2.3.1.2 Constituent Concentrations in Vegetation

A vegetation and soil sampling program was conducted between August 2 and 7, 2017, to determine baseline concentrations of COPC in vegetation and soil (Appendix 9-B). Samples were collected at 10 PSP for radon. At each plot, the following samples were collected:

- terrestrial lichen (500 g);
- the current year's growth of blueberry leaves, stems and berries (500 g); and
- a sample of mineral soil to a depth of five centimetres (100 g).

Sample collection ranged from 25 to 200 m from the radon PSPs to fulfill weight requirements. All samples were shipped frozen or dried to the Saskatchewan Research Council for chemical analysis. Metals and trace elements were analyzed by inductively coupled plasma – mass spectrometry and radionuclides were analyzed by extraction and beta counting (lead-210) or alpha spectroscopy (polonium-210, radium-226 and thorium-230; Appendix 9-B).

The reader is referred to Section 6 for additional details related to modelling of dust and associated COPC. Soil samples were analysed to determine baseline conditions for essential and non-essential metals, nutrients and radionuclide constituents, including:

- Aluminum
- Antimony
- Arsenic
- Barium
- Beryllium
- Boron
- Cadmium
- Chromium
- Cobalt
- Copper
- Iron
- Lead
- Lead-210
- Manganese
- Molybdenum
- Nickel
- Polonium-210
- Radium-226
- Selenium
- Silver
- Strontium
- Thallium
- Thorium-230
- Tin
- Titanium
- Uranium
- Vanadium

Table 9.2-6 and Table 9.2-7 summarize metals, trace elements and radionuclide constituents in lichen and blueberry tissues collected at PSPs in 2017. Analytes were generally consistent across all PSPs, with the exception of sample site RSV10, which exhibited elevated metals concentrations in terrestrial lichens, including aluminum, beryllium, boron, cadmium, chromium, cobalt, iron, lead, nickel, titanium, uranium, and zinc, and elevated radionuclides lead-210 and polonium-210 in blueberry tissues. Site RSV9 exhibited elevated concentrations of calcium, copper, lead, manganese, lead-210 and polonium-210 in soil samples as well. Sites RSV9 and RSV10 are the sites situated closest to Highway 914, the main transportation corridor between Cameco Corporation's Key Lake Mill and McArthur River Mine (Figure 9.2-7**;** Appendix 9-B).

Other PSPs exhibiting elevated analyte concentrations included increased levels of thorium-210 at RSV4, and elevated levels of aluminum, chromium, iron, lead, titanium, and vanadium at RSV6 (Figure 9.2-7; Appendix 9-B).

The COPC are further assessed in the ERA (Appendix 10-A in Section 10).

Table 9.2-6: Summary of Metals, Trace Elements, and Radionuclides in Lichen collected at Permanent Sample Plots in 2017

Parameter	Units	RSV1	RSV2	RSV3	RSV4	RSV5	RSV6	RSV7	RSV8	RSV9	RSV10	Mean	Standard Deviation
Metals and Trace Elements													
Aluminum	µg/g	440	410	620	470	440	670	760	620	540	1700	667	361.14
Antimony	µg/g	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Arsenic	µg/g	0.11	0.1	0.12	0.13	0.09	0.16	0.18	0.18	0.1	0.24	0.14	0.045
Barium	µg/g	12	16	25	16	18	21	16	14	9.8	14	16.18	4.15
Beryllium	µg/g	0.01	0.01	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.06	0.02	0.01
Boron	µg/g	1	1	2	1	1	2	1	<1	2	3	1.45	-
Cadmium	µg/g	0.07	0.06	0.09	0.07	0.08	0.1	0.08	0.1	0.08	0.12	0.09	0.02
Chromium	µg/g	1	1.1	1.5	1.3	1	3.2	2.2	3.5	1.2	6.8	2.28	1.74
Cobalt	µg/g	0.08	0.08	0.1	0.08	0.09	0.23	0.17	0.32	0.14	0.39	0.17	0.11
Copper	µg/g	1.6	1.5	1.8	1.5	1.5	1.7	1.6	1.3	1.6	2	1.61	0.18
Iron	µg/g	220	190	280	230	180	350	390	370	260	840	331	183.65
Lead	µg/g	0.82	0.52	0.8	0.6	0.51	1	1.8	1.3	0.41	1.4	0.92	0.43
Manganese	µg/g	95	83	112	102	148	107	78	194	137	191	124.7	39.6
Molybdenum	µg/g	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Nickel	µg/g	0.67	0.94	0.94	0.9	0.58	1.6	1.1	1.7	0.7	3.3	1.243	0.77
Selenium	µg/g	0.11	0.09	0.2	0.1	0.12	0.14	0.12	0.12	0.05	0.14	0.119	0.04
Silver	µg/g	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.01	<0.01	0.03	0.015	-
Strontium	µg/g	4.2	6.3	10	5	6.2	8.3	5	4.6	4.6	7.1	6.13	1.78
Thallium	µg/g	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
Tin	µg/g	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	0.07	0.03	-
Titanium	µg/g	10	11	18	14	9.7	23	21	17	12	45	18.1	9.99
Uranium	µg/g	0.06	0.06	0.07	0.06	0.06	0.11	0.12	0.14	0.19	0.8	0.17	0.22

Parameter	Units	RSV1	RSV2	RSV3	RSV4	RSV5	RSV6	RSV7	RSV8	RSV9	RSV10	Mean	Standard Deviation
Vanadium	µg/g	0.6	0.5	0.8	0.6	0.5	1	1.1	1	0.7	2.2	0.9	0.48
Zinc	µg/g	13	11	14	14	14	16	14	21	20	26	16.3	4.36
Radionuclides													
Lead-210	Bq/g	0.55	0.51	0.52	0.55	0.4	0.51	0.63	0.61	0.31	0.63	0.52	0.1
Polonium-210	Bq/g	0.36	0.36	0.32	0.36	0.23	0.37	0.45	0.42	0.2	0.46	0.35	0.08
Radium-226	Bq/g	0.0033	0.0027	0.0021	0.003	0.0025	0.0024	0.0026	0.003	0.007	0.01	0.004	0.002
Thorium-230	Bq/g	0.0005	<0.0006	0.0007	0.002	0.0008	0.002	0.002	0.001	0.003	0.007	0.0019	-

Values below detection limits were set to half the value for calculating the mean.

Source: Omnia 2020 (see Appendix 9-B).

Table 9.2-7: Summary of Metals, Trace Elements, and Radionuclides in Blueberry tissue collected at Permanent Sample Plots in 2017

Parameter	Units	RSV1	RSV2	RSV3	RSV4	RSV5	RSV6	RSV7	RSV8	RSV9	RSV10	Mean	Standard Deviation
Metals and Trace Elements													
Aluminum	µg/g	43	63	73	120	50	370	28	45	69	86	94.7	94.99
Antimony	µg/g	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Arsenic	µg/g	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
Barium	µg/g	56	61	58	76	54	54	48	46	58	75	58.6	9.48
Beryllium	µg/g	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Boron	µg/g	7	8	17	22	12	12	7	13	9	10	11.7	4.52
Cadmium	µg/g	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Chromium	µg/g	<0.5	<0.5	<0.5	0.7	<0.5	4.5	<0.5	<0.5	<0.5	0.6	0.76	-
Cobalt	µg/g	0.11	0.03	0.24	0.04	0.02	0.08	0.03	0.04	0.07	0.03	0.07	0.06
Copper	µg/g	4.7	5.6	4.9	3.9	4.1	4.9	4.1	4.1	4	4.8	4.51	0.52
Iron	µg/g	30	37	55	69	28	190	24	26	40	43	54.2	47.2

Parameter	Units	RSV1	RSV2	RSV3	RSV4	RSV5	RSV6	RSV7	RSV8	RSV9	RSV10	Mean	Standard Deviation
Lead	µg/g	0.04	0.06	0.02	0.04	0.02	0.15	0.01	0.01	0.02	0.04	0.04	0.04
Manganese	µg/g	1050	1190	1820	1790	1570	1590	710	1210	940	2340	1421	465
Molybdenum	µg/g	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Nickel	µg/g	1.2	1.4	1.6	1.1	1	2.6	0.67	1.3	0.82	3	1.469	0.72
Selenium	µg/g	<0.05	0.05	0.1	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	0.05	-
Silver	µg/g	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Strontium	µg/g	5.8	22	9.4	6.4	6.8	6.1	4.2	8.2	12	8.3	8.92	4.82
Thallium	µg/g	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
Tin	µg/g	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
Titanium	µg/g	0.77	1.2	0.9	3.6	0.67	17	0.53	0.52	0.97	1.3	2.75	4.83
Uranium	µg/g	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	0.02	0.02	0.01	-
Vanadium	µg/g	<0.1	<0.1	<0.1	<0.1	<0.1	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	-
Zinc	µg/g	10	16	13	13	12	16	9.9	14	12	15	13.09	2.09
Radionuclides													
Lead-210	Bq/g	0.014	0.017	0.022	0.01	0.016	0.012	0.013	0.007	0.025	0.037	0.017	0.008
Polonium-210	Bq/g	0.004	0.005	0.008	0.003	0.006	0.002	0.005	0.004	0.008	0.017	0.006	0.004
Radium-226	Bq/g	0.0026	0.003	0.005	<0.0003	<0.0002	0.003	<0.0002	0.0019	0.0037	0.0033	0.0023	-
Thorium-230	Bq/g	<0.0004	<0.0005	<0.001	0.0009	<0.0004	<0.001	<0.0004	<0.0004	<0.0004	<0.0004	0.000335	-

Values below detection limits were set to half the value for calculating the mean.

Source: Omnia 2020 (see Appendix 9-B).

9.2.3.2 Listed Plant Species Valued Component

Listed plants are defined as plant species of conservation concern provincially and/or federally, including species listed:

- as S1 (Critically Imperilled), S2 (Imperilled), or S3 (Vulnerable) by the Saskatchewan Conservation Data Centre (SK CDC) (SK CDC 2022a);
- on the SK CDC tracking list (SK CDC 2022b);
- under the *Wild Species at Risk Regulations* (Government of Saskatchewan 1999);
- as endangered, threatened or special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC; Government of Canada 2022); and
- under Schedule 1 of the *Species at Risk Act* (SARA; Government of Canada 2022).

Surveys for listed vascular plants in 2017 were completed in accordance with the Government of Saskatchewan Rare Vascular Plant Survey Protocol (SK MOE 2017; Omnia 2020 see Appendix 9-B). Listed plant survey transects were completed on a preliminary Project Area, stratified by provincial Predicted Ecosite Mapping ecosite type. In total, 20 transects were completed from July 9 to 12, 2017, and 74 transects were completed from July 28 to August 2, 2017, including duplicate surveys of the 20 previously-completed transects (Appendix 9-B).

Two listed plant species were observed during the surveys: Alaskan clubmoss (*Diphasiastrum sitchense*) and three-seeded sedge (*Carex trisperma*). Alaskan clubmoss is a low-growing evergreen forb with ground-trailing horizontal stems (Harms and Leighton 2011). Nine occurrences of Alaskan clubmoss were observed, outside and northwest of the Vegetation LSA, predominantly associated with open transitional zones between upland jack pine stands and forested bogs (Figure 9.2-7; Appendix 9-B). Alaskan clubmoss is listed S3 (Vulnerable) in Saskatchewan (SK CDC 2022). This S3 status may reflect a paucity of listed plant surveys completed in the region, as it was routinely observed during the 2017 listed plant surveys.

Three-seeded sedge was identified outside and northwest of the Vegetation LSA during the 2017 surveys. Listed as S3 (Vulnerable) in Saskatchewan in 2017, this species has subsequently been revised to S4 (Apparently Secure) in Saskatchewan and is no longer considered to be a listed plant (SK CDC 2022).

Aside from these observations, no other listed plant species have historically been reported within the Terrestrial RSA (SK MOE 2022). Since the 2017 listed vascular plant surveys were completed, the Project Area has been refined. The current Project Area remains in the vicinity of the 2017 preliminary Project Area, within similar ecosites. In discussions with SK CDC staff, it was determined that the completed listed plant surveys were adequate to represent the dominant ecosites within the Project Area; however, additional pre-construction listed plant surveys will be required on the final Project footprint within ecosites that were not sampled in 2017 (Omnia 2020 see Appendix 9-B).

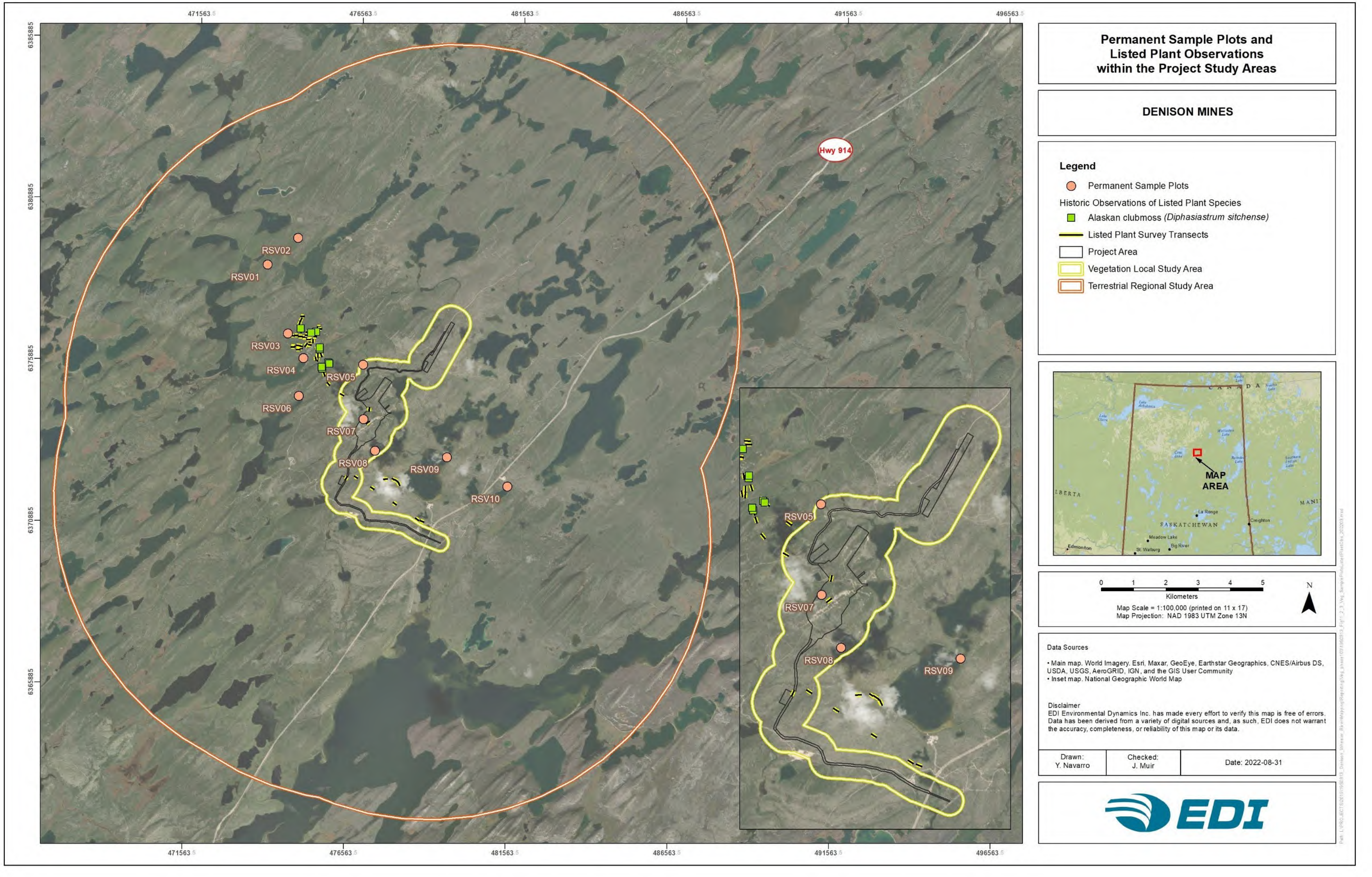

Figure 9.2-7: Permanent Sample Plots and Listed Plant Observations within the Project Study Areas

9.2.3.3 Wetlands Valued Component

Wetlands are defined as *"land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity which are adapted to a wet environment"* (National Wetlands Working Group 1997). As such, ecosites have been determined to be wetland ecosystems where these conditions are expected to occur. This includes both wetland ecosites and sparsely vegetated ecosites where the water table is within 50 cm of the ground surface (McLaughlan et al. 2010). No wetlands within the Terrestrial RSA have been designated as Ramsar Wetlands of International Importance (The RAMSAR Convention Secretariat 2022).

Wetlands (e.g., muskeg) perform natural water filtration functions (18-EN-ERFN-5.67), comprising up to 8.5% and 16.6% of the Vegetation LSA and Terrestrial RSA, respectively (Table 9.2-8; Figure 9.2-8). Waterbodies were conservatively included here as wetlands, as they have the potential to be classified as shallow open water wetlands (i.e., water bodies 2 m deep or less; Warner et al. 1997). Waterbodies represent the most common wetland ecosystem within the Vegetation LSA and the Terrestrial RSA, comprising 3.9% (44.9 ha) and 10.7% (4,101.9 ha), respectively. The black spruce treed bog is the second most common wetland ecosystem within the Vegetation LSA (18.2 ha, 1.6%) and the Terrestrial RSA (1,157.1 ha; 2.9%). The Labrador tea shrubby bog is the most common wetland ecosystem in the Vegetation LSA, comprising 2.0% (23.3 ha), and the second most common wetland ecosystem in the Terrestrial RSA (989.9 ha, 2.5%). All other wetland ecosites are relatively uncommon, each comprising less than 0.5% of the Vegetation LSA and Terrestrial RSA (Table 9.2-8).

Table 9.2-8: Summary of Wetlands

Ecosite Code[1]	Ecosite Description[1]	Structure Code[2]	Vegetation LSA (ha)	Vegetation LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
Swamps						
BS16	Black spruce / balsam poplar / river alder swamp	6	--	--	8.8	<0.1
Swamps Subtotal			**--**	**--**	**8.8**	**<0.1**
Bogs						
BS17	Black spruce treed bog	5	18.2	1.6	1,157.1	2.9
BS18	Labrador tea shrubby bog	3	23.3	2.0	967.6	2.4
		3a	--	--	20.3	0.1
		3b	--	--	2.0	<0.1
		Total	23.3	2.0	989.9	2.5
BS19	Graminoid bog	2	2.8	0.2	160.5	0.4
BS19/24[3]	Graminoid bog or graminoid fen	2	0.8	0.1	1.2	<0.1
BS20	Open bog	1	0.6	<0.1	65.5	0.2

Ecosite Code[1]	Ecosite Description[1]	Structure Code[2]	Vegetation LSA (ha)	Vegetation LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
Bogs Subtotal			**45.6**	**3.9**	**2,374.2**	**5.9**
Fens						
BS19/24[3]	Graminoid bog or graminoid fen	2	0.8	0.1	1.2	<0.1
BS21	Tamarack treed fen	5	1.9	0.2	66.5	0.2
BS22	Leatherleaf shrubby poor fen	3a	-	-	28.5	0.1
BS23	Willow shrubby rich fen	3b	0.6	<0.1	20.9	0.1
BS24	Graminoid fen	2	-	-	9.0	<0.1
BS25	Open fen	1	0.4	<0.1	5.7	<0.1
Fens Subtotal			**3.6**	**0.3**	**131.8**	**0.3**
Shallow Open Water						
BS26	Rush sandy shore	2	-	-	15.1	<0.1
BS27	Sedge rocky shore	2	4.2	0.4	29.3	0.1
Waterbody[4]	--	0	44.9	3.9	4,101.9	10.7
Shallow Open Water Subtotal			**49.0**	**4.2**	**4,146.3**	**10.3**
Total Wetlands[5]			**98.3**	**8.5**	**6,661.1**	**16.6**

Notes:

1 Ecosystems are described in detail in the Guide to the Ecosites of Saskatchewan's Provincial Forests (McLaughlan et al. 2010).

2 Modified from the Field Manual for Describing Terrestrial Ecosystems (BC Ministry of Environment, Lands, and Parks, and BC Ministry of Forests 1998). 0 = unvegetated; 1 = sparse / bryophyte / lichen; 2 = herb/graminoid; 3a = low shrub; 3b = tall shrub; 5 = young forest, 6 = mature forest.

3 This ecosite type is an artifact of mapping uncertainty, as baseline mappers were unable to distinguish between these ecosites due to a lack of available information (e.g., soil information, vegetation field plots, water quality data). As such, this ecosite has conservatively been split between bog and fen classifications.

4 Areas of open water <2 m deep are defined as shallow open water wetland ecosystems (National Wetlands Working Group 1997); as such, unnamed waterbodies and areas of open water observed to exhibit an average depth of <2 m (Ecometrix Incorporated 2020) have been conservatively included as wetland ecosystems.

5 Some numbers are rounded for presentation purposes. Therefore, the totals may not equal the sum of the individual values.

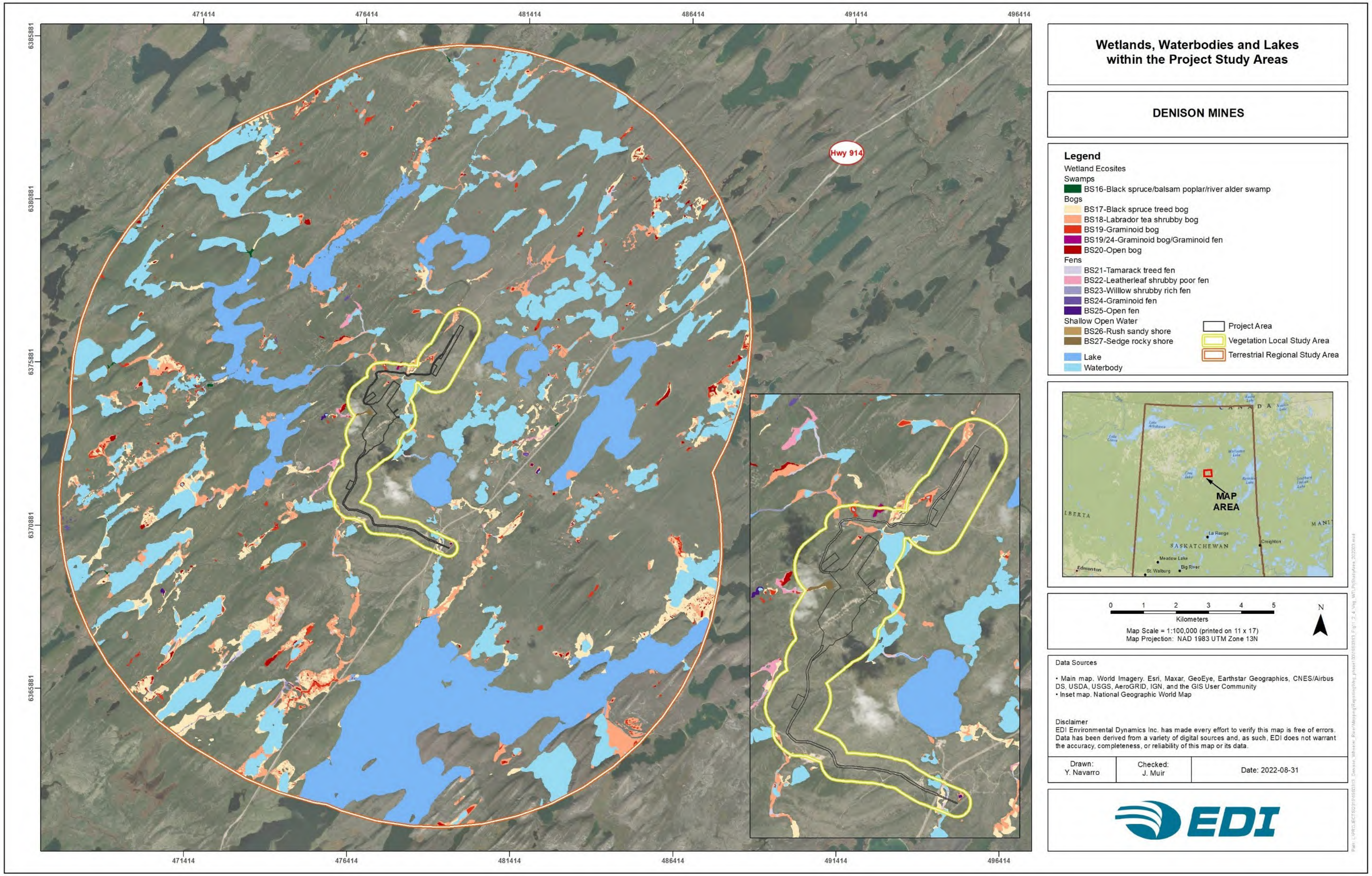

Figure 9.2-8: Wetlands, Waterbodies and Lakes within the Project Study Areas

9.2.4 Assessment of Project-related Effects

9.2.4.1 Potential Interactions Between the Project and Valued Components / Key Indicators

The Project will require the Construction, Operation, and Decommissioning of several components (as described in Section 2). Potential interactions between these Project components and activities and the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs and their associated KIs are summarized by Project phase and activity in Table 9.2-9.

Potential interactions in Table 9.2-9 are ranked as:

- **Primary Interaction** (✓): Project activity is expected to interact with the VC / KI which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- **Other Interaction (✓):** Project activity is expected to interact with the VC / KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- **No Interaction:** Project activity is not expected to interact with the VC or the KI, no adverse effects are expected, and rationale is provided for not considering this potential interaction further.

Table 9.2-9: Potential Project Interactions for Vegetation and Ecosystems, Listed Plant Species, and Wetlands Valued Components

Project Phase/Activity	Vegetation and Ecosystems Valued Component		Listed Plant Species Valued Component and Key Indicator	Wetlands Valued Component and Key Indicator
	Vegetation Abundance Key Indicator	Constituent Concentrations in Vegetation Key Indicator		
Construction Activities				
Development of access roads and air strip	✓	✓	✓	✓
Site preparation and earthworks; clearing, leveling and grading of the Project Area	✓	✓	✓	✓
Power generation - generators	✓	✓	✓	✓
Installation of main substation and distribution of power around site	✓	✓	✓	✓
Wellfield and freeze hole drilling; ground freezing	✓	✓	✓	✓
Batch plant operation (concrete); crusher at borrow area	✓	✓	✓	✓
Development of surface infrastructure (camp, operations centre, plants, ponds, pads and support facilities)	✓	✓	✓	✓

Project Phase/Activity	Vegetation and Ecosystems Valued Component		Listed Plant Species Valued Component and Key Indicator	Wetlands Valued Component and Key Indicator
	Vegetation Abundance Key Indicator	Constituent Concentrations in Vegetation Key Indicator		
Waste management (composting, domestic and industrial landfill operation, recycling)		✓		
Water management (including treatment and site runoff)	✓	✓	✓	✓
Groundwater supply	✓		✓	✓
Surface water withdrawal	✓	✓	✓	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	✓	✓	✓	✓
On-site and off-site operation of vehicles and transportation of materials	✓	✓	✓	✓
Air transportation for workers	✓	✓	✓	✓
Regulatory site inspections	✓	✓	✓	✓
Engagement – site visit from Interested Parties	✓	✓	✓	✓
Operation Activities[1]				
Operation of the ISR wellfield		✓		
Wellfield and freeze wall drilling	✓	✓	✓	✓
Operation and expansion of freeze wall	✓	✓	✓	✓
Batch plant operation (grout and cement); crusher in borrow area	✓	✓	✓	✓
Expansion of pond and pads	✓	✓	✓	✓
Operation of the processing plant and production of uranium concentrate		✓		
Water withdrawal from groundwater or surface water body	✓		✓	✓
Management of surface water (including seepage and site runoff)	✓	✓	✓	✓
Water treatment, both domestic and industrial		✓		
Water release to surface water body	✓	✓	✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)		✓		
Hazardous waste management (temporary storage, handling, and off-site transportation)	✓	✓	✓	✓
Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates	✓	✓	✓	✓
On-site and off-site operation of vehicles and transport of materials	✓	✓	✓	✓

Project Phase/Activity	Vegetation and Ecosystems Valued Component		Listed Plant Species Valued Component and Key Indicator	Wetlands Valued Component and Key Indicator
	Vegetation Abundance Key Indicator	Constituent Concentrations in Vegetation Key Indicator		
Power supply – primarily power from the grid, also generators and back-up generators	✓	✓	✓	✓
Package and transport of nuclear substances	✓	✓	✓	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	✓	✓	✓	✓
Air transportation for workers	✓	✓	✓	✓
Progressive decommissioning and reclamation	✓	✓	✓	✓
Regulatory site inspections	✓	✓	✓	✓
Engagement – site visit from Interested Parties	✓	✓	✓	✓
Decommissioning Activities				
Site water management, treatment, and release	✓	✓	✓	✓
Mining horizon remediation and thawing of freeze wall	✓	✓	✓	✓
Process water treatment and release	✓	✓	✓	✓
Closure of ISR and freeze wells and related infrastructure	✓	✓	✓	✓
Decontamination of surface facilities and injection, recovery and monitoring wells		✓		
Asset removal (including site power transmission lines and electrical infrastructure)	✓	✓	✓	✓
Demolition and disposal of non-salvageable surface infrastructure and materials	✓	✓	✓	✓
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	✓	✓	✓	✓
Generators	✓	✓	✓	✓
Waste management (composting and landfill operation)		✓		
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)	✓	✓	✓	✓
On-site and off-site operation of vehicles and transportation of materials	✓	✓	✓	✓
Reclamation of disturbed areas	✓	✓	✓	✓
Regulatory site inspections	✓	✓	✓	✓
Engagement – site visit from Interested Parties	✓	✓	✓	✓

Project Phase/Activity	Vegetation and Ecosystems Valued Component		Listed Plant Species Valued Component and Key Indicator	Wetlands Valued Component and Key Indicator
	Vegetation Abundance Key Indicator	Constituent Concentrations in Vegetation Key Indicator		
Post-Decommissioning Activities				
Environmental monitoring	✓	✓	✓	✓
Regulatory site inspections	✓	✓	✓	✓
Engagement - Site visit from Interested Parties	✓	✓	✓	✓

1 Operational activities include maintenance.

Not all activities are expected to interact with each of the three VCs, and the interaction is based on consideration of the VC- and KI-specific interaction potential. The activities of waste management, operation of the in situ recovery (ISR) wellfield, operation of the processing plant, water treatment, and decontamination of surface facilities were deemed to have no interaction and were not carried forward in the assessment, with the exception of the constituent concentrations in vegetation KI, as they are not expected to result in detectable changes in the MPs associated with the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs.

For the constituent concentrations in vegetation KI of the Vegetation and Ecosystems VC, no interaction is anticipated with groundwater supply, water withdrawal from groundwater or surface water waterbody, as water use is not expected to result in changes in the availability of COPC. On the other hand, an interaction between waste management, the operation of the ISR wellfield, operation of the processing plant and production of uranium concentrate, water treatment, and decontamination of surface facilities is possible with the constituent concentrations in vegetation KI, as air emissions from various sources such as the processing plant, and waste disposal areas such as precipitates and waste rock piles, and release of treated effluent, have the potential to contribute to changes in the level of COPC in plant tissue.

It is recognized that some interactions are the primary contributors to potential adverse effects on VCs and KIs. While all interactions are considered in the effects assessment, the primary contributors (i.e., the grey shaded cells in Table 9.2-9) are the focus of the effects assessment for each VC. Project activities with the potential for adverse effects on the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs are primarily expected to involve site preparation and earthworks, including clearing, leveling, and grading, as well as Construction and Operation activities that may result in the introduction and/or proliferation of invasive plants, edge effects, changes to water quantity and quality, and dust deposition. Based on professional judgement and understanding of the nature of Project activities and their sequencing, these types of activities were used to filter the Project activity list and determine expected interactions; potential Project-related effects are discussed in Section 9.2.4.2.

9.2.4.2 Potential Project-related Effects

Based on the timing and nature of the interactions identified in Table 9.2-9, the following adverse effects have a potential to occur on the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs:

Vegetation and Ecosystems VC

Vegetation abundance KI

- Change in areal extent of habitat types.

Concentrations of COPC in vegetation KI

- Change in level of COPC in plant tissue.

Listed Plant Species VC/KI

- Change in the number of listed plants.

Wetlands VC/KI

- Change in areal extent of wetlands.

The potential effects are described in the following subsections as they relate to the phases during which each potential effect is expected to occur (Table 9.2-10). Mitigation measures for each potential effect are described in Section 9.2.5.

In support of this EIS, an ERA was prepared with the objectives of predicting and assessing the risk to representative human and ecological receptors resulting from exposure to radiological and non-radiological COPC expected to be released throughout all Project phases (Appendix 10-A in Section 10). The ERA used the expected sources of atmospheric and liquid releases to predict the transport of these constituents through the environment and resulting exposure and effects on ecological receptors (including representative aquatic and terrestrial plants). Since the ERA assessed the effects of radiological and non-radiological emissions on representative plant species, these potential Project-related effects are not assessed in Section 9.2, and, where applicable, a reference is provided to the ERA.

Table 9.2-10: Potential Project-related Effects on Vegetation and Ecosystems, Listed Plant Species, and Wetlands Valued Components During all Project Phases

Project Phase/Potential Effect	Vegetation and Ecosystems Valued Component		Listed Plant Species Valued Component and Key Indicator	Wetlands Valued Component and Key Indicator
	Vegetation Abundance Key Indicator	Concentrations of Constituents of Potential Concern in Vegetation Key Indicator		
Construction				
Direct disturbance	✓		✓	✓
Introduction and/or Proliferation of Invasive Plants	✓		✓	✓
Edge Effects	✓		✓	✓
Changes to Water Quantity and Quality	✓	✓	✓	✓
Dust Deposition	✓	✓	✓	✓
Operation				
Direct disturbance	✓		✓	✓
Introduction and/or Proliferation of Invasive Plants	✓		✓	✓
Edge Effects	✓		✓	✓
Changes to Water Quantity and Quality	✓	✓	✓	✓
Dust Deposition	✓	✓	✓	✓
Decommissioning				
Direct disturbance	✓		✓	✓
Introduction and/or Proliferation of Invasive Plants	✓		✓	✓
Edge Effects	✓		✓	✓
Changes to Water Quantity and Quality	✓	✓	✓	✓
Dust Deposition	✓	✓	✓	✓
Post-Decommissioning				
Direct disturbance	✓		✓	✓
Introduction and/or Proliferation of Invasive Plants	✓		✓	✓
Edge Effects	✓		✓	✓
Changes to Water Quantity and Quality	✓	✓	✓	✓
Dust Deposition	✓	✓	✓	✓

9.2.4.2.1 Change in Areal Extent of Habitat Types, Number of Listed Plants, and Areal Extent of Wetlands

Direct Disturbance

Local Knowledge and engagement have identified concerns over potential effects of mine infrastructure on berries, and changes in the access to berries within the Terrestrial RSA (ERFN and SVS 2022). The majority of Project effects on Vegetation and Ecosystems, Listed Plant Species, and Wetlands are expected to occur during Construction. Site preparation and earthworks, including clearing, soil salvaging, stockpiling, leveling, and grading are expected to occur within the Project Area resulting in changes in areal extent of habitat types, changes in the areal extent of wetlands, and potential loss of the number of listed plants within these areas. Some Project components (e.g., site power transmission lines) will require vegetation clearing but minimal soil disturbance (Figure 9.2-8). As such, wetlands at those locations are expected to experience altered structure (e.g., cleared of trees and tall shrubs) but maintain wetland function.

With the use of single span bridges and implementation of best management practices, direct wetland disturbance during Construction associated with the crossings of Kratchkowsky Creek and Hart Creek is expected to be avoided. It should be noted that SaskPower proposes to tap the existing I3P 138 kV line near Highway 914 and build approximately 4.5 km of new 138 kV line from the I3P tap to the Project site. SaskPower will be responsible for conducting activities such as line routing, environmental studies, and permitting, public consultation, and engineering design work as applicable to the load interconnection. As such, wetland disturbance related to the SaskPower Transmission Corridor is expected to be addressed through the SaskPower permitting process.

Direct disturbance of Vegetation and Ecosystems, Listed Plant Species, and Wetlands is expected to be limited during Operation; however, expansion of the ponds and pads is anticipated to require clearing and grading activities in the Project Area. Affected areas of natural vegetation are expected to support Vegetation and Ecosystems and potentially, Listed Plant Species or Wetlands. Maintenance activities within access and transmission line rights-of-way (ROW) would be expected to limit the progression of succession and/or limit the height of vegetation until Post-Decommissioning.

The effect of Project activities during Decommissioning on Vegetation and Ecosystems, Listed Plant Species, and Wetlands is expected to be positive due to the initiation of vegetation regeneration within the Project Area (with continued regeneration of areas progressively reclaimed during Operation). Direct loss of Vegetation and Ecosystems, Listed Plant Species, and/or Wetlands is not expected during Decommissioning and Post-Decommissioning; the effects are expected to be positive as a result of revegetation growth within reclaimed areas, assisted by natural encroachment[17].

Introduction and/or Proliferation of Invasive Plants

Vegetation clearing and soil disturbance during Construction are expected to create conditions suitable for the introduction and proliferation of invasive plants. Vehicles and construction equipment can inadvertently transport seeds and other invasive plant propagules in tires or the undercarriage to previously unaffected areas. The effects of invasive plants on native vegetation diversity are well documented and recognized as the second greatest threat to listed species after habitat loss (Enserink 1999). Competition with native species can lead to a reduction in the growth and vigour of native species (including Vegetation and Ecosystems, Listed Plant Species, and Wetlands), as well as changes in the diversity, structure and function of ecosystems and habitats.

The potential for the introduction and proliferation of invasive plants by transport on vehicles and equipment is expected to continue throughout Operation during wellfield and freeze wall drilling, expansion of ponds and pads, drill waste rock, process precipitates and industrial wastewater treatment plant precipitates, on-site and off-site operation of vehicles and transport of materials, package and transport of nuclear substances, and air transportation for workers (i.e., landing and taking off of airplanes). Progressive decommissioning and reclamation has the potential to introduce invasive plants on vehicles and equipment and if seed used for revegetation is not supplied from a native seed source (Polster 2003) with a certificate of analysis indicating an absence of invasive plant seeds.

The potential for the introduction and proliferation of invasive plants is expected to continue throughout Decommissioning (e.g., during closure of the ISR and freeze wells and infrastructure, asset removal, demolition and disposal of non-salvageable surface infrastructure and materials, remediation of contaminated areas, reclamation of disturbed areas, and operation of vehicles and transportation of materials). The potential for the introduction and proliferation of invasive plants is expected to continue throughout Post-Decommissioning, but at lower levels due to reduced vehicle traffic.

Edge Effects

Edge habitat refers to an area on either side of a border between vegetation communities. Edges between vegetation communities often result in altered microclimatic conditions that can influence environmental conditions further away from the edge (Bannerman 1998). Edge effects are expected to extend into areas of native vegetation and habitats at the interface of disturbed areas and undisturbed native ecosystems, and could include altered microclimatic conditions that can influence quality in habitat away from the edge (Bannerman 1998). Where edge effects occur,

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[17] 21-EN-ERFN-473.2, 21-EN-ERFN-473.21.

Vegetation and Ecosystems, Listed Plant Species, and Wetlands may experience changes in light intensity, temperature, wind, moisture, relative humidity, and patterns of snow accumulation and melt relative to undisturbed conditions. This can, in turn, affect plant health and alter natural disturbance regimes (e.g., blowdown), plant population persistence, and the structure and function of ecosystems and habitats. If changes to microclimatic conditions or vegetative structure at an edge exceed a species habitat preference or physiological tolerance, then edge habitat may result in lower occupancy or use, reduced survival, or lowered reproductive success.

Edge effects at the interface of disturbed areas and native ecosystems are expected to occur along the edges of the Project Area resulting from vegetation clearing during site preparation and earthworks during Construction. Edge effects are expected to continue throughout Operation, Decommissioning, and Post-Decommissioning, decreasing over time as revegetation and tree growth within reclaimed areas of the Project create a gradual structural transition at forest edges, aided by natural encroachment.

Changes to Water Quantity and Quality

Local Knowledge and engagement have identified concerns over potential changes in surface water[18] and groundwater[19] quality and quantity (e.g., spills, pollution, parameters such as arsenic). The quantity of water received by Vegetation and Ecosystems, Listed Plant Species, and Wetlands has the potential to be influenced by construction of water management infrastructure (e.g., run-off collection) and subsequent diversion of natural drainage patterns, as well as groundwater supply and surface water supply and release, which have the potential to alter local moisture gradients. These potential changes to local hydrology have the potential result in changes in the areal extent of habitat types and wetlands and the number of listed plants and influencing the persistence of native species and community function.

Potential increased overland surface water flows can also cause soil erosion and mobilize sediment, resulting in sediment deposition on Vegetation and Ecosystems, Listed Plant Species, and Wetlands downgradient. Increased sediment deposition can influence vegetation through physical blockage of photosynthesis and respiration, alteration of nutrient concentrations, and modification of local hydrology. Ground freezing during freeze wall development has the potential to alter groundwater flows in the vicinity of the Project, which may alter moisture regimes and result in changes in the areal extent of habitat types and wetlands and the number of listed plants.

Water quality can be influenced by factors such as incidental chemical release to the environment (e.g., fuel leak/spill, landfill operation), and the chemical composition of sediment and dust (both from open source/fugitive sources and process sources). These substances can alter soil chemistry, be absorbed directly by plants, or be transported to downgradient ecosystems and habitats.

[18] 18-EN-ERFN-5.67, 18-EN-VB-4.36, 18-EN-VILX-3.32, 21-EN-LLRIB-392.14.
[19] 18-EN-VILX-3.104, 19-EN-ERFN-140.25, 19-LK-ERFNTrap-134.262, 21-EN-YOUTH-448.1.

Potential effects on Vegetation and Ecosystems, Listed Plant Species, and Wetlands will depend on the type and concentration of the constituent chemicals. For example, increased receipt of nutrients resulting from mobilization of open source/fugitive dust can be beneficial to vegetation at low to moderate concentrations but can have adverse effects at high concentrations (Adamus et al. 2001).

Potential changes in water quantity and quality are expected to continue throughout Operation. Reduced soil infiltration and groundwater recharge, surface water supply and release and groundwater supply, and diversion of natural drainage patterns from surface water management systems (e.g., seepage and site runoff) within the Project Area can result in changes in the areal extent of habitat types and wetlands and the number of listed plants by altering local moisture gradients, increasing soil erosion and mobilizing sediment downgradient. These changes have the potential to reduce vegetation health and habitat function. Operation of the freeze wall has the potential to alter groundwater flows, resulting in altered moisture regimes and potentially resulting in conditions that may alter Vegetation and Ecosystems, Listed Plant Species, and Wetlands.

In addition to the factors potentially influencing water quantity, water quality may be influenced by waste management (including hazardous and contaminated waste), storage and disposal of drill waste rock, process precipitates, and industrial wastewater treatment precipitates, the package and transport of nuclear substances, and fuel management during Operation.

Potential changes to water quantity and quality may continue during Decommissioning. Reduced soil infiltration and groundwater recharge within the Project Area may persist in areas without suitable decompaction of soils, and recontouring may result in drainage patterns that alter local moisture gradients, increase soil erosion and mobilize sediment downgradient, thereby affecting Vegetation and Ecosystems, Listed Plant Species, and Wetlands. Thawing of the freeze wall is expected to reinstate groundwater flows in the vicinity of the Project, which is expected to re-establish local moisture regimes important to vegetation communities and ecosystems. Water quality can be influenced by factors such as incidental chemical release to the environment (e.g., fuel leak/spill, landfill operation), mining horizon remediation, treatment and release of site water and process water, waste management (including hazardous and contaminated waste), and the chemical composition of sediment and dust.

Potential changes to water quantity and quality may continue during Post-Decommissioning. Reduced soil infiltration and groundwater recharge within the Project Area may persist.

Dust Deposition

Open source/fugitive dust can be generated by vegetation clearing; leveling and grading of the Project Area; wind erosion of exposed soils; development of access, air strip, and surface infrastructure; wellfield and freeze hole drilling; batch plant operation; movement of vehicles and equipment; and air transportation (i.e., landing and taking off of airplanes). Combustion during power generation can also generate air particulates, which can settle as dust on vegetation and soil.

Vegetation growth may be adversely affected by open source (fugitive) dust through changes in soil pH, microclimate, nutrient availability, physical blockage of respiration and transpiration, and leaf temperature and chemistry (Farmer 1993). The potential effects of dust deposition will likely be greatest during dry periods and reduced during wet periods as precipitation events are expected to wash dust from vegetation.

Process source dust can be generated by wellfield and freeze hole drilling and has the potential to contain metals and trace elements, as well as radionuclides originating from ore bodies and mining/process waste materials (e.g., waste rock from drill cuttings). Vegetation growth may be adversely affected by process source dust through uptake of metals, trace elements, or radionuclides.

The following Operation activities may generate open source/fugitive dust: power generation, operation of vehicles and transportation of materials, air transportation, drilling the wellfield and freeze wall, and expanding the ponds and pads. Drilling the wellfield and freeze wall, operation of the processing plant, contaminated waste management, storage and disposal of drill waste rock, process precipitates, and industrial wastewater treatment plant precipitates, and packaging and transporting nuclear substances are activities during Operation that may generate process source dust.

During Decommissioning, both open source/fugitive and process source dust can be generated during activities such as mining horizon remediation, closure of the ISR and freeze wells and infrastructure, salvageable asset removal, demolition and disposal of non-salvageable surface infrastructure and materials, remediation of contaminated areas, reclamation of disturbed areas, waste management, and operation of vehicles and transportation of materials. During Post-Decommissioning, open source/fugitive dust generation may result from occasional vehicle traffic during monitoring and inspection activities but is expected to be limited; no process source dust is anticipated to be generated during Post-Decommissioning.

9.2.4.2.2 Change in the Concentrations of Constituents of Potential Concern in Vegetation

A quantitative assessment modelling dispersion and uptake of COPCs in the environment was completed for the Project as part of the ERA, which is in Appendix 10-A. This approach is aligned with the CSA N288.6 guidance. The ERA will be updated throughout the life of the Project and will provide a key tool for environmental performance reporting. In the ERA, COPCs in plant tissue was estimated for blueberry, lichen, browse, and Labrador tea. The uptake of these plants to various terrestrial receptors, including humans, was subsequently evaluated. The purpose of this section of the EIS was not to repeat the information from the ERA, but provide a separate evaluation of indirect effects of COPCs in vegetation, primarily through a potential change in areal extent of habitat types as a result of indirect effects from COPC uptake.

Local Knowledge and engagement have identified concerns over potential changes in the quality of berries within the Terrestrial RSA (ERFN and SVS 2022). During Construction, COPC may be transported and deposited onto vegetation and soil primarily by dust deposition and air emissions. Site clearing, construction, and associated equipment travel/mobilization are expected to result in the production and dissemination of open-source (i.e., fugitive) dust originating from roads, vehicle and equipment travel and areas of exposed soil and/or surface materials. Dust generated by movement of vehicles, equipment, and aircraft is expected to contain concentrations of metals and trace elements originating from oil, grease, hydraulic fluids, fuel additives and wear of vehicle and equipment parts (e.g., brake lining, tires). Mobilization of this dust has the potential to deposit trace metals on plants and soil, resulting in uptake within plant tissues (Trombulak and Frissell 2000). Similarly, air emissions from fossil fuel combustion from vehicles, equipment, air transportation (i.e., landing and taking off of airplanes), and power generation may disperse metals and trace elements into the ambient air, which can subsequently be deposited onto plants and soil during Construction and be taken up into plant tissues.

During Construction, wellfield drilling activities have the potential for emissions and process-source dust that could contain radionuclides originating from ore bodies and mining/process waste materials (i.e., waste rock from drill cuttings). The potential for process source dust is expected to be highest during wellfield drilling and handling of associated waste material and will occur within the Project Area.

Together, open-source dust and process-source dust can accumulate and result in changes in soil quality and/or be taken up by plants through roots and leaves and accumulate within plant tissue. Uptake of COPC can affect plants by reducing plant health, changing plant abundance and ecosystem composition, and potentially changing their nutritional value and toxicity to wildlife (Shaw 1989). Local Knowledge, and engagement noted concern for spills, contamination, and pollution[20] as well as chemicals potentially harming plants and animals[21].

Dust and air emissions are expected to be transported downwind and deposited in response to local atmospheric conditions and particle size. The predominant wind direction within the Terrestrial RSA is from the west (approximately 10–11% of the time), with southerly and easterly winds being the next most frequent at approximately 7–8% each (Section 6). Modelling indicates that dustfall concentrations closely follow the shape of the roadways, indicating that one of the largest contributors is unpaved road dust (see Section 6). Vehicle emissions have been observed to be responsible for alteration of vegetation up to 200 m from the road edge (Forman and Alexander 1998).

[20] 21-EN-SUR-446.65, 21-EN-SUR-446.66, 21-EN-SUR-446.67, 21-EN-SUR-446.89.
[21] 21-EN-VPL-444.26, 21-EN-LLRIB-392.14, ERFN and SVS 2022.

Local Knowledge and engagement have identified concerns over potential changes in surface water[22] and groundwater[23] quality (e.g., spills, pollution, parameters such as mercury and arsenic). Water quality may be influenced by factors such as incidental chemical release to the environment (e.g., fuel leak/spill), exposure of waste and overburden to weathering, and the chemical composition of sediment and dust.

Constituents of potential concern from sources such as mineralized drill cuttings and impurities derived from uranium processing also have the potential to leach from storage areas, travel downgradient, and be deposited on plants and soil. These substances can alter soil chemistry, be absorbed directly by plants, or be transported to downgradient vegetation communities and ecosystems. Release of effluent to surface water also has the potential to mobilize COPC into natural waterbodies, which can then be transported to vegetation communities and ecosystems.

The potential for deposition of COPC by means of dust deposition, air emissions, and surface water transport is expected to be highest during Project Operation. The transport of dust containing metals and trace elements onto vegetation communities and ecosystems has the potential to result from the majority of activities during Operation, including wellfield and freeze wall drilling, expansion of the ponds and pads, operation of the processing plant, hazardous and contaminated waste management, storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates, operation of vehicles and transportation of materials, the packaging and transportation of nuclear substances, and air transportation (i.e., landing and taking off of airplanes). Air emissions from fossil fuel combustion from vehicles, equipment, and air transportation, and power generation during Operation have the potential to disperse metals and trace elements.

The transport of dust containing radionuclides onto vegetation communities and ecosystems during Project Operation could result from wellfield and freeze wall drilling, operation of the ISR processing plant, hazardous and contaminated waste management, storage and disposal of drill waste rock and industrial wastewater treatment plant precipitates, and the packaging and transportation of nuclear substances.

Water quality can be influenced by factors such as incidental chemical release to the environment (e.g., fuel leak/spill), and the chemical composition of sediment and dust. Exposure of the ISR wellfield, processing plant, and waste pad to weathering can also result in transport of COPC (i.e., metals, trace elements, and radionuclides) through surface water. Surface water can transport COPC to vegetation communities and ecosystems, which may then be taken up into plant tissues.

[22] 18-EN-ERFN-5.67, 18-EN-VB-4.36 18-EN-VB-4.38, 18-EN-VILX-3.32, 21-EN-LLRIB-392.14.
[23] 18-EN-VILX-3.104, 18-EN-VILX-3.105, 19-EN-ERFN-140.25, 19-LK-ERFNTrap-134.262, 21-EN-YOUTH-448.1, KML and NVP 2022.

The mobilization distance of surface water-borne COPC is variable and depends on local hydrology and topography, weather patterns, and preceding dry periods (Hwang et al. 2016). Such constituents have the potential to travel long distances (e.g., following heavy precipitation, along steep gradients, within rapid velocity streams) and into receiving waterbodies downgradient. Release of effluent to surface and groundwater also has the potential to mobilize COPC into natural waterbodies, which can then be transported to vegetation communities and ecosystems.

During Decommissioning, deposition of COPC by dust, air emissions, and surface water transport are expected to continue, although at reduced levels. Transport of COPC resulting from dust deposition has the potential to result from the majority of activities during Decommissioning, including during closure of the ISR and freeze wells and infrastructure, salvageable asset removal, demolition and disposal of non-salvageable surface infrastructure and materials, remediation of contaminated areas, reclamation of disturbed areas, and operation of vehicles and transportation of materials. Air emissions from fossil fuel combustion from vehicles, equipment, and power generation may also disperse COPC.

Water quality is expected to continue to have the potential to be influenced by factors such as incidental chemical release to the environment (e.g., fuel leak/spill, landfill operation), mining horizon remediation, treatment and release of site water and process water, waste management (including hazardous and contaminated waste), and the chemical composition of sediment and dust. Surface water can transport COPC to vegetation communities and ecosystems, which may then be taken up into plant tissues.

During Post-Decommissioning, the potential exists for deposition of metals and trace elements on vegetation and soil by road dust and air emissions originating from occasional vehicle traffic and equipment during monitoring and inspection activities.

These potential effects are further discussed in the ERA (Appendix 10-A in Section 10).

9.2.5 Mitigation Measures

Mitigation in this EIS is defined as the elimination, reduction or control of potential adverse effects of the Project on the environment throughout all Project phases. Mitigation measures refer to Project-specific mitigation and can include but are not limited to: Project design; implementation of BMPs; development of management plans; implementation of emergency response programs; and provision of training and education, and promoting awareness. The following subsections address mitigation measures related to potential effects on the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs (refer to Section 9.2.4.2).

9.2.5.1 Project Design Measures

Potential adverse effects on Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs will be avoided or minimized to the extent possible through Project design:

- The Project Area (i.e., the area of maximum physical disturbance) has been reduced to the extent practicable resulting in limited vegetation disturbance, considering human safety.
- Much of the proposed Project footprint will be developed within previously disturbed areas, including roads currently used for exploration activities, thereby minimizing additional habitat disturbance.
- The powerline to the main substation at the site is short (approximately 7 km) and will be tied into the existing provincial power line adjacent to Highway 914.
- During Operation, progressive reclamation will be completed where possible, and the progress and success of these activities will be assessed annually[24].
- Cleared brush will be stockpiled, when possible, to be used in progressive reclamation.
- Ongoing decommissioning of Project components will be completed when possible.
- Dust deposition on vegetation and waterbodies (including potential deposition of COPC) will be reduced by:
  - directing processing plant exhaust from drying and packaging areas through a scrubber prior to release outside of the building;
  - designing the stack height based on results of air dispersion modelling to be an appropriate height for optimal dispersion;
  - controlling access to the property with both a north and south security gate;
  - making a wash bay available to clean items, equipment, and vehicles that may have been in contact with potentially contaminated materials. Contaminated water from the wash bay will be collected in a sump tank and routed to the water treatment plant for treatment and discharge;
  - conducting radiological clearance scanning as required for any items, equipment and vehicles leaving the Project Area; and
  - watering and traffic controls on roads.
- Bulk storage tanks for processing chemicals such as sulphuric and/or hydrochloric acid, sodium hydroxide, and hydrogen peroxide will sit inside appropriately designed and sized secondary containment basins, physically separated from the containment basins for other chemical systems.

[24] KML and NVP 2022.

- Surface pipelines will be designed to have secondary containment or catchment and have leak detection systems in place at key locations.
- A freeze wall will be established around the uranium deposit to reduce groundwater disturbance.
- Mining solution and process water will be reused throughout the mining process, reducing freshwater use requirements to the extent feasible and reducing the volume of treated effluent requiring discharge. Make-up water will be preferentially sourced from site runoff where possible.
- Double-walled high-density polyethylene (HDPE) or equivalent piping will be used in the wellfields and will be freeze protected and secured to minimize pipe movement.
- Contaminated wastes (e.g., mineralized drill cuttings, solid impurities removed from mining solution, dewatered reject solids) will be properly contained on a double lined waste pad with leak detection capabilities and an associated monitoring program. An adjacent pond will be used to collect runoff from the pad and water in the waste pond will be piped to the water treatment plant. Such waste will be disposed of either on site or off site at an approved facility.
- The ISR wellfield and processing plant will be designed to re-use most of the solutions inside each circuit; any excess water will be treated and then released to a surface water body once acceptable water quality is achieved. All treated effluent released to surface water will meet federal and provincial regulatory discharge limits.

As not all effects on Vegetation and Ecosystems, Listed Plant Species, and Wetlands can be addressed through design, additional mitigation measures are planned, as described in the following subsections.

9.2.5.2 Additional Vegetation-specific Mitigation Measures

Additional mitigation measures specific to the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs and tailored to Project features will be incorporated into the various monitoring and management plans developed under the EMS, which will include erosion and sediment controls, soil and vegetation monitoring, a Decommissioning Plan, air quality monitoring plan, Spill Response Plan, Waste Management Plan, and the surface water monitoring. The EMS will be developed to address mitigation measures specific to Vegetation and Ecosystems, Listed Plant Species, and Wetlands based on proven and accepted approaches following standard industry guidelines and BMPs.

The programs and plans within the EMS will provide guidance to avoid or minimize potential adverse effects of the Project on Vegetation and Ecosystems, Listed Plant Species, and Wetlands, including monitoring and follow-up programs, as appropriate. It will be in place during all phases of the Project and will be subject to ongoing review and revision, as required. If monitoring identifies a need for additional or revised mitigation measures, a process of adaptive management (as described in the plan) will be triggered so that the appropriate responses are timely and effective.

Mitigation measures specific to the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs discussed in the following subsections are applicable during all Project phases and expected to be effective immediately following implementation.

9.2.5.2.1 Disturbance Reduction

- Disturbance to vegetation and soils will be avoided by clearly delineating Project Area boundaries (e.g., with the use of fencing, staking, or flagging), adhering to construction plans and schedules, and by restricting off-site machine use.
- Wetland boundaries in the proximity of planned disturbances will be clearly delineated (e.g., with the use of fencing, staking, or flagging) to facilitate avoidance to the extent practicable.
- Should they occur, areas prone to potential instability and areas in proximity to water bodies and drainage features will be identified and appropriate setbacks will be established and maintained.
- Temporary workspaces or laydown areas will be sited and constructed within existing disturbance or on previously compacted soils, where practicable. In areas requiring clearing only, grubbing will be avoided, and roots and groundcover will be retained to the extent feasible.
- Pre-construction listed plant surveys will be completed within the Project Area.
- Listed plants located adjacent to planned disturbances will be clearly delineated (e.g., with the use of fencing, staking, or flagging) to facilitate avoidance to the extent practicable and reduce the potential for accidental encroachment outside of the Project footprint.
- Should Listed Plants be identified within the Vegetation LSA prior to Construction, site- and species-specific mitigation measures to avoid and/or limit Project effects will be determined by a Qualified Vegetation Ecologist. Specific mitigation measures will depend on the species, its life history characteristics, time of year, and the location of the occurrence in relation to Project activities.
- Herbicide use will be avoided within 100 m of any known listed plant occurrences. Where herbicide use is unavoidable, use will be restricted to direct application instead of broadcast spraying and completed by qualified personnel.

9.2.5.2.2 Soils Handling and Reclamation

- Construction activities will be sequenced (i.e., site clearing, grading preparations, major earthworks and construction of infrastructure/facilities) so that surface vegetation, mineral soil and organic matter can be salvaged for later use in Project Decommissioning.
- Soil resources within the Project Area will be stripped/salvaged and stockpiled within the Project Area in accordance with relevant soil management BMPs, i.e., providing guidance on

ground-truthing soil conditions, flagging potential hazards and sensitivities, and modifying practices in relation to environmental conditions and avoiding or minimizing inadvertent/incidental disturbance.

- A soil monitoring program/protocol (or equivalent) will be undertaken to verify soil salvage volumes and reclamation suitability (Section 9.1.8.2).
- Soil stockpiling locations will be sited to reduce soil handling and travel distances and designed to minimize the potential for soil degradation and downgradient effects, e.g., having defined height and width that optimize soil storage and stockpile stability, and having integrated erosion control measures and surface water management features (if/where necessary). Sediment and erosion control measures will be implemented in accordance with BMPs and commensurate to site conditions and sensitivities.
- Sediment and erosion control measures and surface water management features will be installed and maintained at the Project. Erosion controls (e.g., sediment fencing, check-damns and/or sediment ponds) will be installed as necessary and at the discretion of construction personnel commensurate to site conditions and sensitivities to manage/mitigate erosion and sedimentation.
- Progressive reclamation and ecosystem-based revegetation will be conducted on disturbed areas as soon as practicable with the use of suitable native species and in accordance with the Reclamation and Closure Plan.
- Soil materials will be de-compacted, as necessary, to establish suitable conditions for revegetation.
- Reclaimed areas will be re-sloped to approximate pre-construction contours, or stable contours, and revegetated as soon as practicable following disturbance.
- Terrain will be re-contoured and scarified to create terrain diversity, variation in slope steepness, length, aspect, and shape to promote seed retention and establishment of plant ecosystems similar to the pre-existing condition.
- During Decommissioning, the Project will be reclaimed to a safe, stable, and self-sustaining landscape in accordance with the Decommissioning Plan. To the extent practical, reclamation of the Project Area will re-instate predominant landscape features, topographical contours (slope, aspect), and surface drainage patterns in a manner that will tie-in to the existing landscape and maintain surface drainage continuity and hydrologic connectivity.

9.2.5.2.3 Surface Water Management

- Snow melt and runoff will be controlled within the Project Area to prevent the potential release of contaminated runoff from affecting vegetation in adjacent areas.
- Sediment and erosion control measures will be implemented in accordance with the EMS.

- Surface water management features (e.g., culverts and ditches) will constructed and maintained (as per Project design specification) along access roads and facility sites to facilitate surface drainage continuity and hydrologic connectivity—especially in proximity to wetlands, water crossings, and waterbodies.
- Hydrologic connectivity is expected to be maintained across the Project Area with the engineering, construction, and maintenance of surface water management features (e.g., culverts and ditches) as appropriate and as per Project design specifications along access roads and at facility sites.
- A post-construction surface monitoring program will be developed to document the performance of surface water management structures adjacent to wetlands to evaluate areas (if any) where additional surface water management is considered to be necessary to maintain natural drainage. The monitoring program is expected to verify the presence and condition of surface water management structures, including any areas of water impoundment (e.g., upgradient of a road), erosion, or dead or dying vegetation. The monitoring program is expected to identify issues (if any) in a timely manner and allow the adaptive management process, in consideration of the vegetation monitoring results, as vegetation species composition can be a lagging indicator of hydrologic change. Culverts will be regularly inspected to identify where maintenance, repair, upgrade, and/or replacement are necessary to maintain natural surface drainage and the resultant wetland connectivity.

9.2.5.2.4 Invasive Plant Management

- Equipment and vehicles will arrive at the Project Area clean, and will be inspected for soil, plant material, and seeds, and cleaned as appropriate, to limit the potential for the introduction of invasive plants and noxious weeds.
- Areas with a high risk for the potential spread of invasive plants and noxious weeds (i.e., within or adjacent to existing infestations) will be avoided to the extent practicable; if work must occur in these areas, invasive plant management will be implemented before starting work.
- Gravel, fill, straw matting, or similar materials to be used for erosion control will be inspected to minimize the potential for seeds or propagules of invasive plants being brought to site.
- All employees and contractors on the Project will receive an employee orientation appropriate to the work they are undertaking, including instruction on the definition of invasive plants and their potential effects, mitigation measures to avoid the introduction and spread of invasive plants, and training on the presence and identification of common invasive plant species and those known to occur within the Project Area.
- Invasive plant monitoring will be conducted periodically by personnel skilled in invasive plant identification during all Project phases to assess, evaluate, and document invasive plant occurrences within the Project Area. Invasive plant surveys will be completed during a biologically appropriate time of year (e.g., when invasive plants can be identified) within areas

identified as most susceptible to invasive plant introduction and spread, including roads, ROW, debris and vegetation management areas (e.g., slash piles, timber decks, exposed soil or stockpiles) and other regularly disturbed habitats.

- Three general treatment options may be used alone or in combination to control of invasive plants in the Project Area:
  - mechanical control – involves the physical removal of the plants;
  - chemical control – involves application of synthetic and/or natural herbicides; and,
  - biological control measures – involves use of living organisms (e.g., rusts, insects) to control selected invasive plant species.
- The type of treatment option selected for an invasive plant occurrence will be based on a combination of specific information including the identity of the invasive plant species and its provincial designation, the size and extent of the occurrence, time of year, the proximity of the occurrence to other susceptible areas (e.g., rare plant occurrences, wetlands, waterbodies), and the available control options. Where possible, control of invasive plants will be completed in consultation with a qualified professional to minimize potential effects on native vegetation, ecosystems and wetlands.
- Seed used during re-vegetation will be certified weed free, with a valid "Certificate of Seed Analysis".
- Progressive reclamation will be employed as appropriate to limit the amount of disturbance at a given time.

9.2.5.2.5 Road and Traffic Management

- Traffic and access control measures will be implemented in with erosion and sediment control in place, including reducing traffic volume by scheduling truck convoys, using high-volume haul trucks, and closing Project site and access roads to the public (e.g., private vehicles, snowmobiles, all-terrain vehicles, and foot traffic).
- Speed limits will be implemented for a variety of reasons, including to reduce the potential for open source/fugitive dust deposition.

9.2.5.2.6 Dust Suppression

- During all phases, open-source dust and process-source dust will be carefully monitored and reduced by controlling access and travel (i.e., traffic management) during peak construction and (if/where necessary) applying dust suppression measures.
- Dust deposition on soil, vegetation, and waterbodies (including wetlands) will be reduced by controlling access and travel (i.e., traffic management) during peak construction and (if/where necessary) applying dust suppression measures.
- Process-source dust associated with wellfield drilling and handling of waste materials will be carefully monitored by controlling site access and conducting radiological clearance scanning

(as required) of equipment, vehicles and personnel accessing the Project Area. A wash bay/station will be used to clean and decontaminate equipment.

- Vehicle and equipment routes will be planned to minimize travel distances, where possible.
- Dust-generating activities (e.g., earthworks, material handling) will be avoided to the extent feasible during dry or high wind conditions.
- Dropping material from height will be avoided to the extent feasible.
- Vehicle and equipment speed will be minimized or reduced by enforcing speed limits.
- Water will be applied at least twice per day to unpaved roads and surfaces.
- Unpaved road surfaces will be maintained via grading or other maintenance practices to reduce the amount of fines present in the roadbed material.

9.2.5.2.7 Waste and Hazardous Materials Management

- Hazardous materials will be handled, stored (e.g., wildlife-proof containers), and disposed of appropriately and in accordance with a Waste Management Plan.
- Appropriate hazardous materials management practices will be implemented in accordance with industry guidelines and a Waste Management Plan to minimize the risk of accidental spills or leakage.
- Appropriate spill response kits will be positioned adjacent to areas where hazardous materials are stored in accordance with the Spill Response Plan.
- A minimum 100-m distance from any waterbody will be maintained for fuel storage, refueling activities, or equipment servicing in accordance with the Spill Response Plan.
- Appropriate fuel, chemical, and materials management practices will be followed in accordance with the Spill Response Plan to minimize the risk of accidental spills or leakage of diesel fuel, other hydrocarbons, and other hazardous materials.
- Air emissions will be reduced to the extent practical through implementation of the air quality programs within the EMS.
- Standard operating procedures will be employed, and regular inspections of equipment and machinery will be completed to verify they are in good working order.
- All exhausts (e.g., mobile equipment, generators) will be verified to be in good working condition.
- Vehicles and equipment will be turned off when not being used.
- All vehicles and equipment will be equipped with industry-standard emission control systems; unnecessary idling of vehicles will be prohibited.
- Vehicles and equipment will be maintained in good working condition (e.g., no leaks) and furnished with industry-standard spill response kits.

- Mitigation measures to reduce the potential for dispersion of radiological contaminants of potential concern to vegetation will be implemented in accordance with the Radiation Protection Plan.
- Where required, clean (i.e., uncontaminated) construction and fill materials will be used to minimize effects on existing vegetation.
- Education on and enforcement of proper waste and hazardous materials management practices will be provided to employees and contractors.

9.2.5.2.8 Constituents of Potential Concern in Vegetation

- A vegetation and soil sampling program—comprising scheduled collection of soil and plant tissues from permanent sampling locations for analysis of COPC—will be conducted periodically during all Project phases to identify if plants within the Vegetation LSA are accumulating COPC within their tissues (Section 9.2.8).

9.2.6 Residual Effects Evaluation

9.2.6.1 Definitions for Residual Effects Characterization and Significance

Residual Effects Characteristics

Residual effects on the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs have been assessed in relation to the RSA, and characterized in terms of direction, magnitude, geographic extent, frequency, duration, reversibility, context, and likelihood (Table 9.2-11). No local, regional, or provincial standards exist against which changes in plant populations and communities can be evaluated. For each selected VC, guidelines were used to evaluate the magnitude of each residual effect. These guidelines are based on the ability to detect change as a result of Project effects (Table 9.2-10). Quantitative guidelines were used to evaluate the magnitude for each predicted residual effect and have been defined based on approaches and data in EAs for similar approved projects, existing technical knowledge, and professional judgement.

Scientific research and reviews of ecological thresholds indicate that habitat loss is the primary cause of species decline, and the likelihood of species populations and ecosystems crossing abundance or extinction thresholds increases once habitat is reduced by 30 to 40% (Andrén 1994, Dykstra 2004, Price et al. 2007). As such, 30% was used as a conservative quantitative boundary between moderate and high magnitude characterizations for Vegetation and Ecosystems and Wetlands VCs.

For Listed Plant Species, an accepted guideline for plant collection is that 1 in 20 plants can be collected without damage to a population or its ability to persist (Resources Information Standards Committee 2018). Saskatchewan Species Detection Protocols take this further, limiting collection to less than 4% of individuals in a population (Government of Saskatchewan 2021). Thus, 4% has been conservatively used to differentiate low and moderate magnitudes for potential Project effects on plant species provincially-listed as Vulnerable (S3), or those listed as Special Concern by *SARA* and/or COSEWIC.

Rigorous magnitude characterizations have been employed for plant species provincially-listed as Critically Imperilled (S1) or Imperilled (S2) or those listed as Endangered or Threatened by SARA and/or COSEWIC, as they are typically at higher risk of extirpation. For these listed plant species, any level of detectable disturbance (more than 0%) triggers a moderate magnitude, and 4% disturbance represents the quantitative boundary between moderate and high magnitudes.

General definitions of the residual effects characteristics are provided in Table 5.8-1 in Section 5. Residual effects characteristics specific to Vegetation and Ecosystems, Listed Plant Species and Wetlands VCs are defined in Table 9.2-11.

Table 9.2-11: Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Negative effect or effect is not desirable. **Positive** – Beneficial effect or effect is desirable.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Low** *Valued Component – Vegetation and Ecosystems* ▪ measurable decrease in the spatial extent of vegetation communities and ecosystems; less than a 10% loss, or less than 10% of Vegetation and Ecosystems with the potential for uptake of COPC. *Valued Component – Listed Plant Species* ▪ measurable decrease of less than 4% loss of individuals within a population or occurrences of a plant species provincially-listed as Vulnerable (S3) or a plant species listed as Special Concern by SARA and/or COSEWIC. No measurable decrease of a plant species provincially-listed as Critically Imperilled (S1) or Imperilled (S2) or a plant species listed as Endangered or Threatened by SARA and/or COSEWIC. *Valued Component – Wetlands* ▪ measurable decrease in the spatial extent of Wetlands, but less than a 10% loss; all original wetland classes are present. **Moderate** *Valued Component – Vegetation and Ecosystems* ▪ measurable decrease in the spatial extent of vegetation communities and ecosystems; between 10% and 30% loss, or between 10% and 30% of Vegetation and Ecosystems with the potential for uptake of COPC. *Valued Component – Listed Plant Species* ▪ measurable decrease between 4% and 10% of individuals within a population or occurrences for a plant species provincially-listed as Vulnerable (S3) or a plant species listed as Special Concern by SARA and/or COSEWIC; up to 4% loss of individuals within a population or occurrences of a plant species provincially-listed as Critically Imperilled (S1) or Imperilled (S2) or a plant species listed as Endangered or Threatened by SARA and/or COSEWIC.

Residual Effect Characteristic	Definition	Rating
		Valued Component – Wetlands ▪ measurable decrease in the spatial extent of Wetlands between 10% and 30% loss; measurable changes in the diversity of wetland classes; some original wetland classes may be absent. **High** *Valued Component – Vegetation and Ecosystems* ▪ measurable decrease in the spatial extent of vegetation communities and ecosystems equal to or greater than 30% loss, or equal to or greater than 30% of Vegetation and Ecosystems with the potential for uptake of COPC. *Valued Component – Listed Plant Species* ▪ measurable decrease of greater than 10% of individuals in a population or occurrences of a plant species provincially-listed as Vulnerable (S3) or a plant species listed as Special Concern by SARA and/or COSEWIC; greater than 4% loss of individuals within a population or occurrences of a plant species provincially-listed as Critically Imperilled (S1) or Imperilled (S2) or a plant species listed as Endangered or Threatened by SARA and/or COSEWIC. *Valued Component – Wetlands* ▪ measurable decrease in the spatial extent of Wetlands greater than 30% loss; some original wetland classes are absent.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the Vegetation LSA. **Regional** – Effect extends beyond the Vegetation LSA into the Terrestrial RSA. **Beyond Regional** – Effect extends beyond the Terrestrial RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions. **Partially Reversible** – A residual effect that partially diminishes to baseline conditions. **Irreversible** – A residual effect that will not diminish to baseline conditions.
Context	The extent to which the VC or KI has been affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-	**Low** – VC/KI has high resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or a lack of historic and ongoing anthropogenic or natural disturbance. No listed species present. **Moderate** – VC/KI has moderate resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or an intermediate level of historic or ongoing

Residual Effect Characteristic	Definition	Rating
	related residual effect, and its ability to recover from that effect (i.e., resilience)	anthropogenic or natural disturbance with the capacity to assimilate more change. Presence of listed species **High** – VC/KI has weak resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or a high level of historic or ongoing anthropogenic or natural disturbance. Presence of *SARA*-listed species
Likelihood	Likelihood that the residual effect will occur including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability that the residual effect will occur. **Unlikely** – A low probability that the residual effect will occur.

Significance and Confidence

Significant effects are those adverse effects that result in a change to the VC/KI that will alter its status or integrity beyond an acceptable level (e.g., where it is not sustainable or is unavailable to contribute to ecological functions). A residual effect that does not meet the aforementioned criteria is considered not significant.

In this EA, the precautionary approach to the evaluation of potential effects was adopted, recognizing areas of uncertainty and using conservative assumptions and approaches within the assessment process. Areas of uncertainty in the process and in predictions for each VC are identified and discussed in each VC-specific section, or on a KI-specific basis as applicable.

Level of confidence was considered in relation to:

- scientific certainty relative to the quantification of the effect, including the quality and or quantity of data and the understanding of effect mechanisms;
- scientific certainty relative to the effectiveness of the proposed mitigation; and
- professional judgment based on prior experience in predicting effects and the known effectiveness of proven mitigation measures.

Confidence predictions are defined as low, moderate, or high. Where a high degree of uncertainty regarding a residual adverse effect is evident, the confidence level may be low. A high level of confidence is assigned to predictions that have direct, site-specific quantitative data to support the predictions. Low or moderate uncertainty are manageable through monitoring and follow-up programs to confirm the absence, presence, and extent of residual adverse effects.

9.2.6.2 Vegetation and Ecosystems Valued Component

9.2.6.2.1 Change in Areal Extent of Habitat Types

The assessment considered the effect of changes in the areal extent of habitat types on the vegetation abundance KI by means of direct disturbance/loss during clearing during Construction, as well as the indirect effects resulting from the introduction and/or proliferation of invasive plants, edge effects, changes to water quantity and quality, and dust deposition during all Project phases.

Direct disturbance/loss of habitat types has been mitigated by reducing the size of the Project Area to the extent practicable during Project design; however, some habitats are predicted to be cleared during Construction. Up to 169.6 ha (0.4%) of habitats within the Terrestrial RSA are anticipated to be removed with clearing during Construction (Table 9.2-12). This includes 24.8 ha that have experienced historic anthropogenic disturbance (14.6% of the Project Area), 144.5 ha of terrestrial habitats, and 0.5 ha of wetland habitats (Table 9.2-12). Habitat types with the greatest extent of direct loss include 2.9 ha of the jack pine – black spruce / feathermoss upland forested ecosite (BS4; 0.9% of the Terrestrial RSA), and 110.2 ha of the jack pine / blueberry / lichen and black spruce / blueberry / lichen upland forested ecosite (BS3/BS7; 0.6% of the Terrestrial RSA; Table 9.2-12).

This assessment has conservatively assumed comparable probability of indirect effects within the Vegetation LSA (i.e., the area within the Vegetation LSA and outside of the Project Area). Given this, 992.2 ha (2.5%) of habitats within the Terrestrial RSA may experience indirect Project effects during all Project phases as described in Section 9.2.4. This includes up to 851.0 ha (3%) of terrestrial habitats within the Terrestrial RSA, and up to 97.7 ha (1.5%) of wetland habitats within the Terrestrial RSA (Table 9.2-12).

Table 9.2-12: Summary of Vegetation and Ecosystems

Ecosite Code[1]	Ecosite Description[1]	Structure Code[2]	Area of Direct Disturbance Within Project Area (ha)	Area of Indirect Disturbance within Vegetation LSA (ha)	Total Area Within Terrestrial RSA (ha)	Proportion Directly Disturbed within Terrestrial RSA (%)	Proportion Indirectly Disturbed within Terrestrial RSA (%)
Terrestrial Habitats							
BS3	Jack pine / blueberry / lichen	6	31.1	297.9	10,374.8	0.3	2.9
BS3/BS7[4]	Jack pine / blueberry / lichen **and** black spruce / blueberry / lichen	3a	3.6	56.2	4,556.4	0.1	1.2
		3b	92.7	471.4	10,525.5	0.9	4.5
		5	13.9	17.2	2,412.1	0.6	0.7
		Total	110.2	544.9	17,494.0	0.6	3.1
BS4	Jack pine – black spruce / feathermoss	6	2.9	3.3	332.8	0.9	1.0
BS7	Black spruce / blueberry / lichen	6	<0.1	2.2	281.0	<0.1	0.8
BS9	Black spruce – jack pine / feathermoss	6	0.3	2.8	148.5	0.2	1.9

Ecosite Code[1]	Ecosite Description[1]	Structure Code[2]	Area of Direct Disturbance Within Project Area (ha)	Area of Indirect Disturbance within Vegetation LSA (ha)	Total Area Within Terrestrial RSA (ha)	Proportion Directly Disturbed within Terrestrial RSA (%)	Proportion Indirectly Disturbed within Terrestrial RSA (%)
BS14	White birch / lingonberry – Labrador tea	5	-	-	1.8	-	-
Subtotal Terrestrial Habitats			**144.5**	**851.0**	**28,632.9**	**0.5**	**3.0**
Wetland Habitats							
BS16	Black spruce / balsam poplar / river alder swamp	6	-	-	8.8	-	-
BS17	Black spruce treed bog	5	0.4	17.8	1,157.1	<0.1	1.5
BS18	Labrador tea shrubby bog	3	<0.1	23.3	967.6	<0.1	2.4
		3a	-	-	20.3	-	-
		3b	-	-	2.0	-	-
		Total	<0.1	23.3	989.9	<0.1	2.4
BS19	Graminoid bog	2	-	2.8	160.5	-	1.8
BS19/24[4]	Graminoid bog or graminoid fen	2	-	1.5	2.4	-	64.2
BS20	Open bog	1	-	0.6	65.5	-	0.8
BS21	Tamarack treed fen	5	-	1.9	66.5	-	2.9
BS22	Leatherleaf shrubby poor fen	3a	-	-	28.5	-	-
BS23	Willow shrubby rich fen	3b	0.1	0.5	20.9	0.5	2.2
BS24	Graminoid fen	2	-	-	9.0	-	-
BS25	Open fen	1	-	0.4	5.7	-	6.2
BS26	Rush sandy shore	2	-	-	15.1	-	-
BS27	Sedge sandy shore	2	-	4.2	29.3	-	14.2
Waterbody[5]	--	0	<0.1	44.9	4,101.9	<0.1	1.1
Subtotal Wetland Habitats			**0.5**	**97.7**	**6,661.1**	**<0.1**	**1.5**
AN	Anthropogenic	Various[3]	24.8	43.2	599.0	4.1	7.2
Lake[5]	-	0	-	-	4,279.7	-	-
Total Habitats[6]			**169.6**	**992.2**	**40,172.5**	**0.4**	**2.5**

Notes:

1 Ecosystems are described in detail in the Guide to the Ecosites of Saskatchewan's Provincial Forests (McLaughlan et al. 2010).

2 Modified from the Field Manual for Describing Terrestrial Ecosystems (BC Ministry of Environment, Lands, and Parks, and BC Ministry of Forests 1998). 0 = unvegetated; 1 = sparse / bryophyte / lichen; 2 = herb/graminoid; 3a = low shrub; 3b = tall shrub; 5 = young forest, 6 = mature forest.

3 Areas of anthropogenic disturbance have various vegetation structures depending on the intensity and duration of the original disturbance, as well as the time elapsed since disturbance.

4 This ecosite type is an artifact of mapping uncertainty, as baseline mappers were unable to distinguish between these ecosites due to a lack of available information (e.g., soil information, vegetation field plots, water quality data).

5 Areas of open water <2 m deep are defined as shallow open water wetland ecosystems (National Wetlands Working Group 1997); as such, waterbodies have been conservatively included as Wetlands.

6 Some numbers are rounded for presentation purposes. Therefore, the totals may not equal the sum of the individual values.

Residual Effects Characteristics

The residual effects characterization for change in areal extent of habitat types is provided in Table 9.2-13. Change in areal extent of habitat types is expected to be adverse in direction as the Project, to be built and operated safely, is expected to reduce the extent of some habitat types within the Terrestrial RSA.

The magnitude of the change in areal extent of habitat types is predicted to be low. Up to 1,161.8 ha (2.9 %) of all habitats within the Terrestrial RSA are predicted to be affected by the Project (0.4% directly disturbed, and up to 2.5% indirectly disturbed), including up to 851.0 ha (3%) of terrestrial habitats within the Terrestrial RSA, and up to 97.7 ha (1.5%) of wetland habitats within the Terrestrial RSA (Table 9.2-12).

The residual effect is predicted to be local in geographic extent. The direct loss of habitat types is expected to be limited to the Project Area during Construction, and indirect effects are expected to be restricted to the Vegetation LSA during all Project phases.

The duration of change in areal extent of habitat types is predicted to be long-term (more than 38 years). Habitat types affected by the Project are expected to regenerate over time within reclaimed areas of the Project Area; those areas progressively reclaimed during Operation will regenerate throughout the remainder of Operation, and beyond, and remaining reclaimed areas will regenerate following Decommissioning. Edge effects are expected to lessen over time following the end of Decommissioning as a result of natural encroachment of native species, and are predicted to persist until revegetation and tree growth on the Project Area create a more gradual structural transition along forest edges (e.g., a tall shrub or pole/sapling structural stage, approximately 20 years following Decommissioning).

The frequency of change in areal extent of habitat types is predicted to be frequent. While direct disturbance to habitat types as a result of clearing during Construction is expected to occur once, alteration within the Vegetation LSA by indirect effects is anticipated to occur frequently throughout Construction, Operation, and Decommissioning, and infrequently during Post-Decommissioning.

The change in areal extent of habitat types is predicted to be partially reversible. Reclamation will focus on an end-land use of forested habitats, as appropriate. Thus, forested habitats cleared within the Project Area are expected to regenerate on reclaimed areas of the Project Area over time following the end of Operation. Primary access roads will remain 'as-built' for the purpose of maintenance and aftercare, resulting in small areas that are not expected to be reclaimed. The introduction/spread of invasive plants is expected to be reduced within one year following the end of Decommissioning; the combination of mitigation measures to control existing invasive plant populations and reduced vehicle and equipment traffic is predicted to return invasive plant propagule pressure to baseline levels. Similarly, the end of Decommissioning will result in reduced vehicle and equipment traffic and a subsequent reduction of dust generation and deposition. Any dust that has accumulated is predicted to be naturally washed from vegetation by natural weather events.

The context of the residual effect of change in areal extent of habitat types is predicted to be moderate. The majority of habitats anticipated to be disturbed by the Project are common within the Terrestrial RSA, which is expected to be adapted to the frequent fire disturbance characteristic of the Boreal Shield Ecozone. Vegetation and ecosystems within the Terrestrial RSA have also experienced historic anthropogenic fragmentation and disturbance resulting from exploration activities such as line cutting, drilling, and access development. As such, vegetation and ecosystems within the Terrestrial RSA are expected to have a moderate resilience to stress.

The residual effect of change in areal extent of habitat types is predicted to be likely. Habitats are expected to be disturbed both directly and indirectly during all phases of the Project.

Table 9.2-13: Summary of the Characteristics Ratings for Change in Areal Extent of Habitat Types

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project is expected to reduce the extent of some habitat types within the Terrestrial RSA.
Magnitude	Low	Up to 1,161.8 ha (2.9 %) of all habitats within the Terrestrial RSA are predicted to be affected by the Project. This includes up to 851.0 ha (3%) of terrestrial habitats and up to 97.7 ha (1.5%) of wetland habitats within the Terrestrial RSA.
Geographic Extent	Local	The direct loss of habitat types is expected to be limited to the Project Area during Construction, and indirect effects are expected to be restricted to the Vegetation LSA during all Project phases.
Duration	Long-term	Habitat types affected by the Project are expected to regenerate over time within reclaimed areas of the Project Area; those areas progressively reclaimed during Operation will regenerate throughout the remainder of Operation and beyond, and remaining reclaimed areas are expected to regenerate following Decommissioning. Edge effects are expected to lessen over time following the end of the Decommissioning phase as a result of natural encroachment of native species and are predicted to persist until revegetation and tree growth on the Project Area create a more gradual structural transition along forest edges (e.g., a tall shrub or pole/sapling structural stage, approximately 20 years following Decommissioning).
Frequency	Frequent	While direct disturbance to habitat types as a result of clearing during Construction is expected to occur once, alteration within the Vegetation LSA by indirect effects is anticipated to occur frequently throughout Construction, Operation, and Decommissioning, and infrequently during Post-Decommissioning.

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Reversibility	Partially Reversible	Habitats cleared within the Project Area are expected to regenerate on reclaimed areas of the Project Area over time following the end of Operation. Primary access roads will remain 'as-built' for the purpose of maintenance and aftercare, resulting in small areas that are not expected to be reclaimed.
Context	Moderate	The majority of habitats anticipated to be disturbed by the Project are common within the Terrestrial RSA, which is expected to be adapted to the frequent fire disturbance characteristic of the Boreal Shield Ecozone. Vegetation and ecosystems within the Terrestrial RSA have also experienced historic fragmentation and disturbance resulting from exploration activities such as line cutting, drilling, and access development. As such, vegetation and ecosystems within the Terrestrial RSA are expected to have a moderate resilience to stress.
Likelihood	Likely	Habitats are expected to be disturbed both directly and indirectly during all phases of the Project.

Significance and Confidence

The residual effect of change in areal extent of habitat types as a result of the Project is not expected to result in a change to the vegetation abundance KI that will alter its integrity within the Terrestrial RSA to the point where it is not sustainable or unavailable to contribute to ecological functions; therefore, the residual effect is predicted to be **not significant.**

The level of confidence of this prediction is moderate. While the direct effects of clearing are well known, uncertainty exists with respect to the extent and degree of alteration resulting from edge effects, dust deposition, invasive plants, the resiliency of habitats to withstand potential Project-related change, and the regeneration of reclaimed areas. As with all ecosystem mapping, some uncertainty also exists in relation to the accuracy of the mapping used to identify vegetation communities and ecosystems.

9.2.6.2.2 Change in Concentrations of Constituents of Potential Concern in Plant Tissue

A quantitative assessment modelling dispersion and uptake of COPCs in the environment was completed for the Project as part of the ERA, which is in Appendix 10-A in Section 10. This approach is aligned with the CSA N288.6 guidance. The ERA will be updated throughout the life of the Project and will provide a key tool for environmental performance reporting. In the ERA, COPCs in plant tissue was estimated for blueberry, lichen, browse, and Labrador tea. The uptake of these plants to various terrestrial receptors, including humans, was subsequently evaluated. The purpose of this section of the EIS was not to repeat the information from the ERA, but provide a separate evaluation of indirect effects of COPCs in vegetation, primarily through a potential change in areal extent of habitat types as a result of indirect effects from COPC uptake.

Considering the mitigation outlined in Section 9.2.5, a residual effect of deposition of COPC on plants and soil is expected, with the potential for uptake into plant tissues. This is further assessed within the ERA (Appendix 10-A). Uptake of COPC by vegetation is highly variable and dependent on vegetation species, soil conditions, and constituent identity and concentration (Shaw 1989). Thus, this assessment has conservatively assumed 1) equivalent probability of deposition of COPC onto vegetation as a result of dust, air emissions, and surface water runoff within the Vegetation LSA, and 2) equivalent uptake of COPC among all vegetation species. The assessment considered deposition of COPC on vegetation during all Project phases by dust deposition, air emissions, and surface water runoff.

As described in Section 9.2.6.2, vegetation and ecosystems within the Project Area are expected to be cleared during Construction. Thus, the majority of deposition and uptake of COPC on vegetation is expected to occur outside of the Project Area within the Vegetation LSA during all Project phases as a result of dust and air emissions primarily associated with roads and areas of active soil disturbance. Deposition and uptake of COPC resulting from surface water runoff is expected to be reduced with the use of mitigation outlined within the surface water programs to be developed as part of the EMS, including water collection and treatment (Section 9.2.5).

Given these assumptions, deposition and uptake of COPC is predicted to occur within up to 992.2 ha (2.5%) of vegetation within the Terrestrial RSA during all Project phases (Table 9.2-12).

Residual Effects Characteristics

The residual effects characterization for change in concentrations of COPC in plant tissue is provided in Table 9.2-14. Uptake of COPC is predicted to be an adverse effect, as it can affect plants by reducing plant health, changing plant abundance and community composition, and potentially changing their nutritional value and toxicity to wildlife (Shaw 1989).

The magnitude of the change in concentrations of COPC in plant tissue is predicted to be low. Up to 992.2 ha (2.5%) of vegetation within the Terrestrial RSA may be affected by change in concentrations of COPC in plant tissue during all Project phases. Vegetation currently located within the Project Area is expected to be cleared during the Construction Phase and is not anticipated to be affected by changes in concentrations of COPC in plant tissue.

The geographic extent of the residual effect is predicted to be local. Changes in concentrations of COPC in plant tissue are expected to be confined to the Vegetation LSA along the boundaries of roads and near areas of active soil disturbance during all Project phases.

The change in concentrations of COPC in plant tissue is predicted to be long-term (more than 38 years) because of the extended time periods often necessary for COPC to attenuate in the soil. For example, timelines for trace metals depletion from the soil vary widely depending on chemistry and climate, from 75 years to over 3,000 years in temperate climates (Kabata-Pendias and Pendias 2001).

The frequency of the change in concentrations of COPC in plant tissue is predicted to be frequent. Dust deposition and vehicle emissions are expected to occur frequently throughout Construction, Operation, and Decommissioning, and infrequently during Post-Decommissioning.

Change in concentrations of COPC in plant tissue is predicted to be fully reversible. Accumulated COPC deposited on above-ground plant tissues (e.g., stems, leaves, and twigs) and the attenuation of accumulated COPC within the soil is expected to be reversible over the long-term through natural attenuation processes such as degradation, dispersion, sorption, and radioactive decay (Dinis and Fiuza 2021).

The context of the change in concentrations of COPC in plant tissue is predicted to be moderate. Vegetation within the Terrestrial RSA is expected to be adapted to the frequent fire disturbance characteristic of the Boreal Shield Ecozone, and has experienced historic fragmentation and disturbance resulting from exploration activities such as line cutting, drilling, and access development. As such, vegetation within the Terrestrial RSA is expected to have a moderate resilience to stress. In addition, naturally elevated concentrations of aluminum, cadmium, and lead have been identified within surface water within the Terrestrial RSA (Ecometrix Incorporated 2020), and elevated baseline concentrations of COPC were identified within vegetation and soils at PSP (Appendix 9-B).

The residual effect of change in concentrations of COPC in plant tissue is predicted to be likely. Dust and air emissions are anticipated to occur during all Project phases, and COPC are expected to have a moderate probability of being transported to vegetation with variable degree of uptake into plant tissue, depending on local conditions and plant species.

Table 9.2-14: Summary of the Characteristics Ratings for Change in Concentrations of Constituents of Potential Concern in Plant Tissue

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Constituents of potential concern can affect plants by reducing plant health, changing plant abundance and community composition, and potentially changing their nutritional value and toxicity to wildlife and humans.
Magnitude	Low	Up to 992.2 ha (2.5%) of vegetation within the Terrestrial RSA may be affected by changes in concentrations of COPC in plant tissue during all Project phases.
Geographic Extent	Local	Changes in concentrations of COPC in plant tissue are expected to be confined to the Vegetation LSA along the boundaries of roads and near areas of active soil disturbance during all Project phases.
Duration	Long-term	Changes in concentrations of COPC in plant tissue is predicted to be Long-term (more than 38 years) because of the extended time periods often necessary for COPC to attenuate in the soil.
Frequency	Frequent	Deposition of COPC by means of dust and air emissions are expected to occur frequently throughout Construction, Operation, and Decommissioning, and infrequently during Post-Decommissioning.
Reversibility	Fully Reversible	Accumulated COPC deposited on above-ground plant tissues (e.g., stems, leaves, and twigs) and the attenuation of accumulated COPC within the soil is expected to be reversible over the Long-term through natural attenuation processes such as degradation, dispersion, sorption, and radioactive decay.
Context	Moderate	Vegetation within the Terrestrial RSA is expected to be adapted to the frequent fire disturbance characteristic of the Boreal Shield Ecozone and have experienced historic

Residual Effects Characteristic	Rating	Summary Rationale for Rating
		fragmentation and disturbance resulting from exploration activities such as line cutting, drilling, and access development. As such, vegetation within the Terrestrial RSA are expected to have a moderate resilience to stress.
Likelihood	Likely	Dust and air emissions are anticipated to occur during all Project phases, and COPC are expected to have a moderate probability of being transported to Vegetation and Ecosystems and taken up by plant tissue as a result.

Significance and Confidence

The residual effect of change in concentrations of COPC in plant tissue as a result of the Project is not expected to result in a change in the constituent concentrations in vegetation KI that will alter the integrity of vegetation within the Terrestrial RSA to the point where it is not sustainable or unavailable to contribute to ecological functions; therefore, the residual effect is predicted to be **not significant**.

The level of confidence of this prediction is moderate. Uncertainty exists with respect to the type and concentration of COPC that may be deposited, their bioavailability, and the responses of individual vegetation species and ecosystem structure and function.

9.2.6.3 Listed Plant Species Valued Component

9.2.6.3.1 Change in the Number of Listed Plants

As detailed in Section 9.2.3.2, nine occurrences of the listed plant species Alaskan clubmoss were recorded within the Terrestrial RSA to the northwest of the Vegetation LSA during baseline surveys.

No listed plant occurrences have been observed within the Vegetation LSA or Project Area to date; however, the Project Area has been revised since listed plant surveys were completed and field surveys cannot confirm the absence of listed plants. Thus, the potential remains for changes in the number of listed plants as a result of the Project.

Listed plants typically inhabit specialized habitats that occur infrequently on the landscape (Henderson 2009, Penny and Klinkenberg 2018). Wetland habitats are considered to have a moderate to high potential to support listed plant species and have been mapped within 0.5 ha (<0.1%) of the Project Area, and 98.2 ha (8%) of the Vegetation LSA. The remainder of habitats are dominated by sandy mesic to submesic ecosites commonly encountered on the Boreal Shield (i.e., jack pine / blueberry / lichen [BS3] and/or black spruce / blueberry / lichen [BS7]); given the frequency of these ecosites within the Vegetation LSA, these areas are consequently considered to have a low potential for supporting listed plants. In addition, the majority of and vegetation communities in the Terrestrial RSA have been, and continue to be, exposed to frequent fire disturbance characteristic of the Boreal Shield Ecozone, anthropogenic disturbance, and fragmentation predominantly resulting from exploration (e.g., line cutting, drilling, and access development).

Given the abundance of Alaskan clubmoss observed during the 2017 listed plant surveys in transitional habitats, the potential exists that this species may occur within similar habitats throughout the Terrestrial RSA.

Residual Effects Characteristics

The residual effects characterization for change in the number of listed plants is provided in Table 9.2-15. This residual effect is anticipated to be adverse, as the Project may reduce the extent or number of listed plants within the Terrestrial RSA.

The magnitude of the change in the number of listed plants is predicted to be low. No known listed plants within the Terrestrial RSA are anticipated to be affected, but potential exists for unobserved occurrences to be affected within the Vegetation LSA during all Project phases. The abundance of Alaskan clubmoss observed during baseline surveys suggests that additional occurrences of this species may be identified within transitional habitats within the Project Area during site-specific pre-construction surveys (Section 9.2.8). This species' local abundance within the Terrestrial RSA (Figure 9.2-7) and provincial ranking of Vulnerable (S3) is consistent with a prediction of low magnitude.

The residual effect is predicted to be local in geographic extent. Potential direct loss of listed plants is expected to be limited to the Project Area, while indirect effects may extend into the Vegetation LSA during all Project phases.

The change in the number of listed plants is predicted to be long-term (more than 38 years). Once lost, listed plants are unlikely to regenerate as they often have limited ability for dispersal, poor reproduction and/or recruitment (Schemske et al. 1994, Wamelink et al. 2014).

The frequency of the change in the number of listed plants is predicted to be frequent. While loss of listed plants caused by clearing during the Construction Phase may occur once, alteration of listed plants and their habitats due to indirect effects is anticipated to occur frequently throughout Construction, Operation, and Decommissioning, and infrequently during Post-Decommissioning.

The reversibility of the residual effect of change in the number of listed plants is predicted to be partially reversible. Listed plants typically have specific habitat requirements, are rarely successfully transplanted (Maslovat 2009, Government of Saskatchewan 2016), and are not likely to return once lost from a specific location within the Terrestrial RSA. However, listed plants affected indirectly by dust deposition, edges, and changes to water quantity and quality may naturally regenerate and re-establish over time following the end of Operation.

The context of the residual effect of change in the number of listed plants is predicted to be moderate. Listed plant species are often highly habitat-specific, with low resiliency to disturbance and habitat loss or degradation (Wamelink et al. 2014). However, no listed plants have been observed within the Vegetation LSA to date, and the listed plant species known to occur (Alaskan clubmoss) is listed as Vulnerable (S3) in Saskatchewan, indicating a lower conservation priority in the province.

Based on available baseline information, the residual effect of change in the number of listed plants is conservatively predicted to be unlikely. No historical observations of listed plants have been observed within the Vegetation LSA to date.

Table 9.2-15: Summary of the Characteristics Ratings for Change in the Number of Listed Plants

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project has the potential to reduce the number of listed plants within the Terrestrial RSA.
Magnitude	Low	No listed plants within the Terrestrial RSA are anticipated to be affected, but the potential exists that unobserved occurrences may be affected during all Project phases.
Geographic Extent	Local	Potential direct loss of listed plants is expected to be limited to the Project Area, indirect effects may extend into the Vegetation LSA during all Project phases
Duration	Long-term	Once lost, listed plants are unlikely to regenerate as they often have limited ability for dispersal and poor reproduction and/or recruitment.
Frequency	Frequent	While loss of potential listed plants as a result of clearing during Construction will occur once, alteration of listed plants and their habitats due to indirect effects is anticipated to occur frequently throughout Construction, Operation, and Decommissioning, and infrequently during Post-Decommissioning.
Reversibility	Partially Reversible	Listed plants typically have specific habitat requirements, are rarely successfully transplanted, and are not likely to return once lost from a specific location within the Terrestrial RSA. However, listed plants affected indirectly by effects such as dust deposition, edges, and changes to water quantity and quality may naturally regenerate over time following the end of Operation.
Context	Moderate	Listed plants are often highly habitat-specific with low resiliency to disturbance and habitat loss or degradation. However, no listed plants have been observed within the Vegetation LSA to date. Listed plants observed in the RSA are of relatively low conservation priority in the province (i.e., S3)
Likelihood	Unlikely	No historical observations of listed plants have been observed within the Vegetation LSA to date.

Significance and Confidence

The residual effect of change in the number of listed plants is not expected to result in a change in the listed plant species KI that will alter its integrity within the Terrestrial RSA to the point where it is not sustainable or are unavailable to contribute to ecological functions; therefore, the residual effect is predicted to be **not significant.**

The level of confidence of this prediction is moderate. No listed plants have been previously observed within the Vegetation LSA; however, uncertainty exists with respect to whether occurrences are present, and if so, where they are in relation to Project activities. Pre-construction surveys for listed plants within the Project Area have been designed to mitigate this uncertainty (Section 9.2.8). In addition, while the direct effects of clearing are well known, uncertainty exists with respect to the extent and degree of potential alteration to any potential listed plant occurrences that may result from edge effects, dust deposition, and invasive plants as this depends on the location of the occurrence in relation to the Project activities.

9.2.6.4 Wetlands Valued Component

9.2.6.4.1 Change in the Areal Extent of Wetlands

Predicted residual effects on the areal extent of wetlands include the direct effect of wetland disturbance (i.e., clearing during Construction), and the indirect effect of alteration of wetland form and function such as introduction and/or proliferation of invasive plants, edge effects, changes to water quantity and quality, and dust deposition during all Project phases.

Direct wetland disturbance has been mitigated by reducing the size of the Project Area to the extent practicable during Project design. However, up to 0.5 ha (less than 0.1%) of all wetlands within the Terrestrial RSA may be directly disturbed within the Project Area during Construction (Table 9.2-16). Direct wetland disturbance is expected to be restricted to wetlands located at access road stream crossings and the transmission line corridor. In both cases the approach to design will be one of avoidance and minimal disturbance with clear span bridges and minimal clearing required for transmission line installation where avoidance of open water areas can be met. Up to 1.5% of Wetlands within the Terrestrial RSA may be indirectly affected during all Project phases.

Bogs are predicted to be the wetland class most directly affected by the Project, with 0.4 ha (less than 0.1%) of mapped bog ecosystems within the Terrestrial RSA expected to be directly disturbed within the Project Area during Construction. Fens are the next most affected, with 0.1 ha (0.1%) anticipated to be directly affected during Construction (Table 9.2-16). Less than 0.1 ha (less than 0.1%) of shallow open water wetlands within the Terrestrial RSA are also anticipated to be directly affected by the Project.

Within these wetland classes, the wetland ecosite expected to be most affected is the willow shrubby rich fen (ecosite BS23) with direct disturbance to 0.1 ha predicted to occur within the Project Area (0.5% of the BS23 ecosite within the Terrestrial RSA). The remaining ecosites anticipated to be directly affected by the Project are locally abundant, with direct disturbance expected to affect <0.1% of these ecosites within the Terrestrial RSA (Table 9.2-16).

Indirect disturbance resulting from introduction and/or proliferation of invasive plants, edge effects, changes to water quantity and quality, and dust deposition during all Project phases is anticipated to occur within up to 97.7 ha (1.5%) of wetlands within the Terrestrial RSA. This includes 3.5 ha (2.6%) of fen ecosystems, 45.2 ha (1.9%) of bog ecosystems, and 49.0 ha (1.2%) of shallow open water wetlands (Table 9.2-16). No swamp wetland classes are anticipated to be directly or indirectly affected by the Project (Table 9.2-16).

Indirect disturbance associated with the potential to adversely affect BS19/24 includes the introduction and/or proliferation of invasive plants, edge effects, changes to water quantity and quality, and dust deposition during all Project phases (as described in Section 9.2.4.2.1). Wetland ecosites BS19/24 (graminoid bog/fen) and BS25 (open fen) are peatland ecosystems typically characterized by high water tables (i.e., a very moist or very wet moisture regime), while ecosite BS27 (sedge rocky shore) is a sparsely vegetated ecosystem predominated by rocky substrates, typically occurring adjacent to lakes and ponds (McLaughlan et al. 2010). Because these ecosystems rely on high water tables and existing waterbodies, alteration of water quantity would be expected to have the highest potential to cause an adverse effect. Therefore, maintenance of wetland hydrology is expected to be the most effective mitigation to sustain these wetland ecosites within the Terrestrial LSA throughout the Project lifespan.

Table 9.2-16: Wetland Disturbance Predicted to Result from the Project

Ecosite Code[1]	Ecosite Description[1]	Structure Code[2]	Area of Direct Disturbance within Project Area (ha)	Area of Indirect Disturbance within the Vegetation LSA (ha)	Total Area within Terrestrial RSA (ha)	Proportion Directly Disturbed within Terrestrial RSA (%)	Proportion Indirectly Disturbed within Terrestrial RSA (%)
Swamps							
BS16	Black spruce / balsam poplar / river alder swamp	6	-	-	8.8	-	-
Swamps Subtotal			**-**	**-**	**8.8**	**-**	**-**
Bogs							
BS17	Black spruce treed bog	5	0.4	17.8	1,157.1	<0.1	1.5
BS18	Labrador tea shrubby bog	3	<0.1	23.3	967.6	<0.1	2.4
		3a	-	-	20.3	-	-
		3b	-	-	2.0	-	-
		Total	<0.1	23.3	989.9	<0.1	2.4
BS19	Graminoid bog	2	-	2.8	160.5	-	1.8
BS19/24[3]	Graminoid bog or graminoid fen	2	-	0.8	1.2	-	64.2
BS20	Open bog	1	-	0.6	65.5	-	0.8
Bogs Subtotal			**0.4**	**45.2**	**2,374.2**	**<0.1**	**1.9**
Fens							
BS19/24[3]	Graminoid bog or graminoid fen	2	-	0.8	1.2	-	64.2
BS21	Tamarack treed fen	5	-	1.9	66.5	-	2.9
BS22	Leatherleaf shrubby poor fen	3a	-	-	28.5	-	-

Ecosite Code[1]	Ecosite Description[1]	Structure Code[2]	Area of Direct Disturbance within Project Area (ha)	Area of Indirect Disturbance within the Vegetation LSA (ha)	Total Area within Terrestrial RSA (ha)	Proportion Directly Disturbed within Terrestrial RSA (%)	Proportion Indirectly Disturbed within Terrestrial RSA (%)
BS23	Willow shrubby rich fen	3b	0.1	0.5	20.9	0.5	2.2
BS24	Graminoid fen	2	-	-	9.0	-	-
BS25	Open fen	1	-	0.4	5.7	-	6.2
Fens Subtotal			**0.1**	**3.5**	**131.8**	**0.1**	**2.6**
Shallow Open Water							
BS26	Rush sandy shore	2	-	-	15.1	-	-
BS27	Sedge sandy shore	2	-	4.2	29.3	-	14.2
Waterbody[4]	-	0	<0.1	44.9	4,101.9	<0.1	1.1
Shallow Open Water Subtotal			**<0.1**	**49.0**	**4,146.3**	**<0.1**	**1.2**
Total Wetlands[5]			**0.5**	**97.7**	**6,661.1**	**<0.1**	**1.5**

Notes:

1 Ecosystems are described in detail in the Guide to the Ecosites of Saskatchewan's Provincial Forests (McLaughlan et al. 2010).

2 Modified from the Field Manual for Describing Terrestrial Ecosystems (BC Ministry of Environment, Lands, and Parks and BC Ministry of Forests 1998). 0 = unvegetated; 1 = sparse / bryophyte / lichen; 2 = herb/graminoid; 3a = low shrub; 3b = tall shrub; 5 = young forest, 6 = mature forest.

3 The ecosite BS19/24 is not considered a unique ecosystem and is instead an artifact of mapping uncertainty, as it was not possible to distinguish between BS19 (graminoid bog) and BS24 (graminoid fen) ecosites within these areas during the wetland mapping process due to a lack of available information (e.g., soil information, vegetation field plots, water quality data). As such, this ecosite has conservatively been split between bog and fen classifications. If all BS19, BS24, and BS19/24 ecosites were combined into a single combined "graminoid peatland" category, only 2.1% (3.6 ha of 170.7 ha) would be expected to be indirectly disturbed. However, no direct disturbance on wetland ecosites BS19/24, BS25, or BS27 is anticipated.

4 Areas of open water <2 m deep are defined as shallow open water wetland ecosystems (National Wetlands Working Group 1997); as such, waterbodies have been conservatively included as Wetlands.

5 Some numbers are rounded for presentation purposes. Therefore, the totals may not equal the sum of the individual values.

Residual Effects Characteristics

The residual effects characterization for change in the areal extent of wetlands is provided in Table 9.2-17. This residual effect is anticipated to be adverse, as the Project is predicted to reduce the extent of wetlands within the Terrestrial RSA.

The magnitude of the change is predicted to be low. Up to 0.5 ha (<0.1%) of wetlands within the Terrestrial RSA are predicted to be directly disturbed as a result of Project Construction and up to 97.7 ha (1.5%) may be indirectly affected during all Project phases (Table 9.2-17).

The residual effect is predicted to be local in geographic extent. While direct disturbance of wetlands is expected to be limited to the Project Area during Construction, indirect effects are expected to extend into the Vegetation LSA during all Project phases.

The change in the areal extent of wetlands is expected to be long-term (more than 38 years). Once natural drainage patterns are re-established following Operation, the structure and function of wetlands altered as a result of indirect Project effects are expected to re-establish over time, reaching similar structure and function to pre-construction conditions following the end of Post-Decommissioning.

The frequency of the change in the areal extent of wetlands is predicted to be frequent. While direct disturbance to wetlands as a result of clearing will occur over a short time period during Construction, wetland alteration by indirect effects is anticipated to occur frequently throughout Construction, Operation, and Decommissioning, and infrequently during Post-Decommissioning.

Change in the areal extent of wetlands is predicted to be partially reversible. Direct disturbance to wetland area is predicted to be partially reversible during Decommissioning once natural hydrologic conditions are re-established. Alterations to wetland extent, structure and/or function as a result of indirect Project effects during all Project phases are predicted to be reversible over time once natural hydrologic conditions are re-established and edge effects, dust, water quality changes, and invasive plant propagule pressure are reduced at the end of Decommissioning.

The context of the residual effect of change in the areal extent of wetlands is predicted to be moderate. Wetlands can exhibit low resilience and high susceptibility to disturbance (MacKenzie and Shaw 2000); however, frequent fire disturbance is characteristic of the Boreal Shield Ecozone, and wetland vegetation is expected to be adapted to this natural disturbance regime.

The residual effect of change in the areal extent of wetlands is predicted to be likely. Wetlands are expected to be disturbed both directly and indirectly during all phases of the Project.

Table 9.2-17: Summary of the Characteristics Ratings for the Change in the Areal Extent of Wetlands

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project is predicted to reduce the extent of Wetlands within the Terrestrial RSA.
Magnitude	Low	Up to less than 0.1% of Wetlands within the Terrestrial RSA are predicted to be directly disturbed as a result of Project Construction. Direct wetland disturbance is expected to be restricted to wetlands located at access road stream crossings and the transmission line corridor. In both cases the approach to design will be one of avoidance and minimal disturbance with clear span bridges and minimal clearing required for transmission line installation where avoidance of open water areas can be met. Up to 1.5% of Wetlands within the Terrestrial RSA may be indirectly affected during all Project phases
Geographic Extent	Local	While direct disturbance to Wetlands is expected to be limited to the Project Area during Construction, indirect effects are expected to extend into the Vegetation LSA during all Project phases.
Duration	Long-term	Once natural drainage patterns are re-established following Operation, the structure and function of Wetlands altered as a result of indirect Project effects are expected to re-establish after Post-Decommissioning (more than 38 years).
Frequency	Frequent	While direct disturbance to Wetlands as a result of clearing will occur over a short time period during Construction, Wetland alteration by indirect effects is anticipated to

Residual Effects Characteristic	Rating	Summary Rationale for Rating
		occur frequently throughout Construction, Operation, and Decommissioning, and infrequently during Post-Decommissioning.
Reversibility	Partially Reversible	Direct disturbance to wetland area is predicted to be partially reversible during Decommissioning once natural hydrologic conditions are reinstated. Alterations to wetland extent, structure and/or function as a result of indirect Project effects during all Project phases are predicted to be reversible over time once natural hydrologic conditions are reinstated and edge effects, dust, water quality changes, and invasive plant propagule pressure are reduced at the end of Decommissioning.
Context	Moderate	Wetlands can exhibit low resilience and high susceptibility to disturbance; however, disturbance is common within the Terrestrial RSA, and existing Wetlands have been historically disturbed by access roads and exploration activities.
Likelihood	Likely	Change in the extent of Wetlands has a high potential for occurrence.

Significance and Confidence

The residual effect of change in the areal extent of the Wetlands VC as a result of the Project is not expected to result in a change to the wetlands KI that will alter its integrity within the Terrestrial RSA to the point where it is not sustainable or unavailable to contribute to ecological functions; therefore, the residual effect of change in the areal extent of wetlands is predicted to be **not significant.**

The level of confidence of this prediction is moderate. While the direct effects of clearing and grading on wetland structure and function are well known, uncertainty exists with respect to the extent and degree of alteration resulting from edge effects, dust deposition, changes in water quantity and quality, invasive plants, and the resiliency of wetlands within the Terrestrial RSA to withstand potential Project-related change. As with all ecosystem mapping, some uncertainty also exists in relation to the accuracy of the mapping products used to identify wetlands.

9.2.6.5 Summary of Project-related Residual Effects on Vegetation and Ecosystems, Listed Plant Species, and Wetlands

The following potential residual effects of the Project on the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs were identified through the assessment process:

Vegetation and Ecosystems VC

Vegetation abundance KI

- Change in areal extent of habitat types.

Concentrations of COPC in vegetation KI

- Change in level of COPC in plant tissue.

Listed Plant Species VC/KI

- Change in the number of listed plants.

Wetlands VC/KI

- Change in areal extent of wetlands.

The results of the characterizations for these residual effects are summarized in Table 9.2-18. The residual effects of the Project on the vegetation abundance and constituent concentrations in vegetation KIs were predicted to be **not significant**. Thus, the residual effects of the Project on the Vegetation and Ecosystems VC is predicted to be **not significant**.

Similarly, the residual effects of the Project on the listed plant species, and wetlands KIs, were predicted to be **not significant**. Thus, the residual effects of the Project on the Listed Plant Species and Wetlands VCs are predicted to be **not significant.**

All residual effects, significant or not significant, are carried forward into the CEA for assessment.

Table 9.2-18: Summary of Project-related Residual Effects

Valued Component	Key Indicator	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Vegetation and Ecosystems	Vegetation Abundance	Change in Areal Extent of Habitat Types	A	L	LSA	LT	FF	PR	M	L	NS	M
	Constituent Concentrations	Change in Concentrations of Constituents of Potential Concern in Plant Tissue	A	L	LSA	LT	FF	FR	M	L	NS	M
Listed Plant Species	Listed Plant Species	Change in the Number of Listed Plants	A	L	LSA	LT	FF	PR	M	U	NS	M
Wetlands	Wetlands	Change in the Areal Extent of Wetlands	A	L	LSA	LT	FF	PR	M	L	NS	M

[1] Direction: Adverse (A), Positive (P)
Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility: Fully Reversible (FR), Partially Reversible (PR), Irreversible (IR)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (U), Likely (L)
Significance: Not-Significant (NS), Significant (S)
Level of Confidence: High (H), Moderate (M), Low (L)

9.2.7 Cumulative Effects

The CEA considers whether residual adverse effects of the Project on a given VC will overlap spatially and/or temporally with the same residual adverse effects resulting from other past, present, and reasonably foreseeable projects or activities. The CEA follows standard methodology as per provincial (e.g., Guidelines for an Environmental Assessment under the [Saskatchewan] *Environmental Assessment Act* 1980) and federal (e.g., Assessing Cumulative Environmental Effects under the Canadian *Environmental Assessment Act* 2012) guidance, and is discussed in detail within Section 5.9.

For the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs, the environmental effects of past and existing projects and activities are captured in the baseline conditions (i.e., Existing Environment; Section 9.2.3). Thus, the likelihood of cumulative effects as a result of ongoing and reasonably foreseeable future projects is the focus of this CEA.

The spatial boundaries of the CEA for Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs are defined as the Terrestrial RSA. Projects/activities that are outside of the Terrestrial RSA but could have potential effects that extend into the Terrestrial RSA were also considered. The temporal boundaries within which cumulative effects were considered include past, present, and reasonably foreseeable future activities inclusive of the life of the Project including Construction, Operation, Decommissioning, and Post-Decommissioning (Section 9.2.1.3).

Baseline conditions represent past and present projects and activities, including all existing disturbance. All Projects and activities listed in the Project and Activity Inclusion List (Section 5) that are not listed in subsequent subsections are not considered in the CEA for Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs because the residual effects of these developments are not anticipated to overlap spatially with the residual effects of the Project and are not in proximity to the Terrestrial RSA.

9.2.7.1 Potential Cumulative Effects

Future projects and activities with likely overlapping residual effects on the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs are outlined below.

The following Project-related residual effects were considered for their potential to interact cumulatively with the residual effects of reasonably foreseeable projects and activities identified within, or extending into the Terrestrial RSA:

<u>**Vegetation and Ecosystems VC**</u>

Vegetation Abundance KI

- Change in areal extent of habitat types.

Concentrations of COPC in Vegetation KI

- Change in level of COPC in plant tissue.

Listed Plant Species VC/KI

- Change in the number of listed plants.

Wetlands VC/KI

- Change in areal extent of wetlands.

Spatial information is not available for some future projects and most activities. The following projects and activities are expected to have residual effects on Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs, within or extending into the Terrestrial RSA (Figure 9.2-9):

- **Infrastructure maintenance activities**

Existing infrastructure within the Terrestrial RSA such as the Cree Lake Winter Trail, Highway 914, and the SaskPower transmission line ROW are anticipated to require maintenance such as vegetation control for safety and line-of-sight, road grading and gravelling, improvement of surface water management infrastructure (e.g., culvert replacement and recontouring of ditches and drainages), and other repairs. Such activities have the potential to contribute to the cumulative effects on the Vegetation and Ecosystems, Listed Plant Species and Wetlands VCs directly through vegetation clearing/control, and indirectly through introduction and/or proliferation of invasive plants, dust deposition, and deposition of COPC onto plants and soil within the Terrestrial RSA.

- **Mineral exploration and other resource use**

Vegetation and ecosystems within the Terrestrial RSA have experienced historic anthropogenic fragmentation and disturbance during exploration activities such as line cutting, drilling, and access development, and future exploration activities within the Terrestrial RSA are likely. Such exploration activities are expected to contribute to the cumulative effects on the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs directly through vegetation clearing, and indirectly through increased edge effects, and increased vehicle and equipment traffic that can result in the introduction and/or proliferation of invasive plants, dust deposition, and deposition of COPC onto plants and soil within the Terrestrial RSA.

- **Indigenous land use activities**

Highway 914 is presently gated at the Key Lake Mine, which restricts further access to the northeast. Increased access to the area was identified as a concern (20-LK-LEASESUR-267.67; ERFN and SVS 2022). Increased access to the Terrestrial RSA may result in a small increase in the harvest of traditional plants (e.g., medicinal plants) and vegetation (e.g., berries)[25]. This may contribute

[25] 18-EN-VILX-3.80, 19-LK-ERFNTrap-134.124, 20-LK-LEASESUR-267.40.

cumulatively with the residual effects of the Project by increasing vehicle traffic, which could result in the introduction/proliferation of invasive plants and increase dust deposition, which can lead to deposition of COPC on plants and soil within the Terrestrial RSA.

- **Lodges/outfitters and known tourist/recreational activities**

Ongoing use of existing recreational trails within the Terrestrial RSA (e.g., Cree Lake Winter Trail) may contribute cumulatively with the residual effects of the Project by resulting in the introduction/proliferation of invasive plants. Improved access to the Terrestrial RSA due to the Project may also result in increased recreational activities such as off highway vehicle use[26] and/or additional trail development (19-LK-ERFNTrap-134.133). These activities have the potential to contribute to cumulative effects on Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs.

The above projects and activities have been carried forward in the CEA. In the absence of comprehensive activity details and spatial information, the assessment was primarily qualitative, based on available information and understanding of the scope of these projects and activities.

Climate Change Considerations

As described in Section 15.5.2 in Section 15, ensemble output data from 24 different global climate models was used to present a range of possible climate conditions for the Tomblin Lake Region under two emissions scenarios. The ensemble outputs forecast a range of potential futures relevant to the region where the Project is located and presents results over a long-term horizon over the life of the Project. In general, these outputs project warmer, snowier winters and longer, hotter summers over time (Section 15.5.2 in Section 15). While total precipitation is modeled to increase over the lifetime of the Project (i.e., an average predicted mean annual increase of 6 to 12%; Section 15.5.2 in Section 15), warmer temperatures (i.e., increasing approximately 2°C by mid-century, and 3°C to 5°C by 2080) may result in increased evaporation, potentially leading to somewhat drier growing seasons.

The effects of climate on vegetation are complex, encompassing many interrelated biotic and abiotic processes. In addition, modelled changes in climate are expected to affect vegetation species and communities differently, depending on their identity and resilience to anticipated change (Price et al. 2013). Although much uncertainty exists with climate change modeling and the

[26] 20-LK-LEASESUR-267.109, 20-LK-LEASESUR-267.110, 20-LK-LEASESUR-267.111, 20-LK-LEASESUR-267.44, 20-LK-LEASESUR-267.45, 20-LK-LEASESUR-267.46, 20-LK-LODGESUR-267.112, 20-LK-LODGESUR-267.47.

magnitude and extent of predicted effects, the following broad potential effects on Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs may occur:

- Warmer and drier conditions may increase the frequency, duration, and intensity of fire disturbance, resulting in a potential increase in regenerating seral stages on the landscape (Stewart et al. 1998);
- Longer, warmer summers and warmer winters may alter the distribution and degree of infestation of insect pests (Stewart et al. 1998);
- Warmer temperatures and longer growing seasons may increase vegetation growth rates (Price et al. 2013); and,
- Changes in precipitation and increased temperature and resultant increased evapotranspiration may reduce the availability of water, particularly for wetland ecosystems (Price et al. 2013).

Despite these potential effects, ecosystems within the Terrestrial RSA are common throughout the Boreal Shield Ecozone of Saskatchewan and across the Canada's boreal forest, and because of their adaptation to disturbance, vast distribution, and genetic diversity are expected to exhibit resilience to climate change (Price et al. 2013). Price et al. (2013) noted that ecosystems along the present-day southern margins of the boreal forest (i.e., the ecotone) are expected to be most affected by climate change. As such, it is likely that the location of the Terrestrial RSA (i.e., within the central portion of the Boreal Shield Ecozone) is expected to limit the potential for adverse effects from climate change.

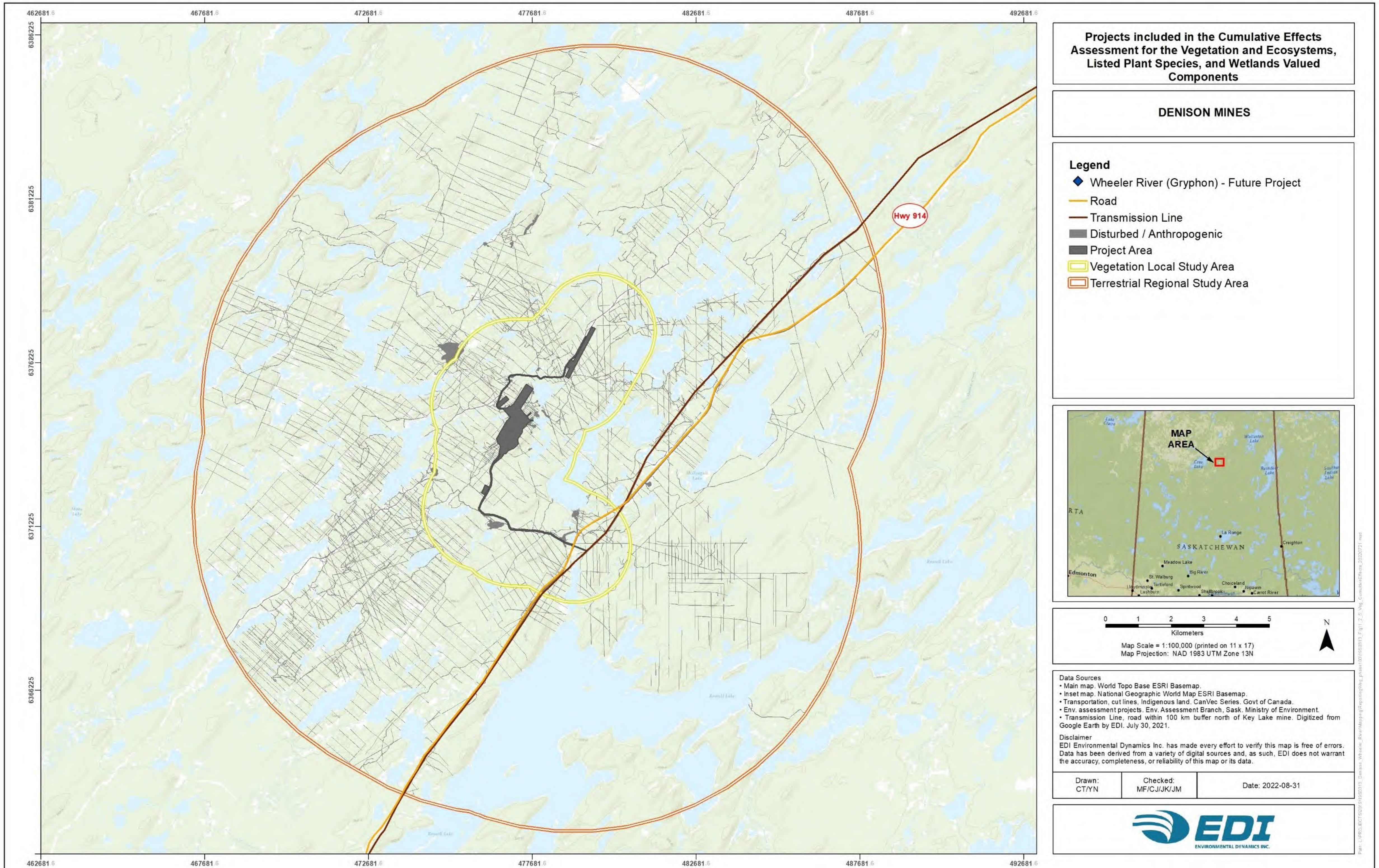

Figure 9.2-9: Projects included in the Cumulative Effects Assessment for the Vegetation and Ecosystems, Listed Plant Species, and Wetlands Valued Components

9.2.7.2 Additional Mitigation Measures

It is assumed that the projects and activities included in the CEA include approvals, mitigation measures and BMPs set by the applicable jurisdictional and regulatory agencies. Additional mitigation (i.e., in addition to the mitigation considered in the assessment of Project-related effects [Section 9.2.5]) is not considered necessary to avoid or minimize the predicted cumulative effects on the Vegetation and Ecosystems, Listed Plant Species, or Wetlands VCs.

9.2.7.3 Cumulative Effects Characterization and Determination of Significance

The interactions between the predicted Project residual effects and the residual effects of other projects and activities were reviewed to determine potential cumulative effects on the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs.

Cumulative effects on the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs have been characterized and assessed in terms of magnitude, geographical extent, duration, frequency, reversibility, context, and likelihood, significance, and level of confidence of effect. Characterization criteria and significance definitions for this CEA are consistent with those presented in Section 9.2.6.

Vegetation and Ecosystems Valued Component

Vegetation Abundance – Change in Areal Extent of Habitat Types

Residual effects on vegetation abundance resulting from the Project were identified and assessed as **not significant** in Section 9.2.6. The lands comprising the Terrestrial RSA are primarily native but have historically experienced 599.0 ha (1.5%) of anthropogenic disturbance from exploration activities such as line cutting, drilling, and access development, at varying levels of regeneration.

In addition, natural disturbances such as fires and forest pests have the potential to affect change in the extent of habitat types within the Terrestrial RSA. The Terrestrial RSA is located within the Boreal Shield Ecozone, known to experience a largely natural fire regime that results in the most area burned per unit area and the highest proportion of very large fires (more than 50,000 ha) in the province (Parisien et al. 2004). As a result, much of the vegetation within the Terrestrial RSA (70.6%) is comprised of post-fire regeneration (Appendix 9-B), and additional forest fire disturbance within the Terrestrial RSA is likely to occur in the future. Similarly, forest pests such as the spruce budworm (*Choristoneura fumiferana*) and the jack pine budworm (*Choristoneura pinus*) have the potential to affect coniferous-dominated habitats within the Terrestrial RSA (Government of Saskatchewan 2019a). These forest pest outbreaks are typically and predicably cyclic in nature: spruce budworm outbreaks are expected to occur roughly 35 years apart with the last outbreak peaking in 2002 and the next predicted to occur in 2037 (Government of Saskatchewan 2019a).

These historic and ongoing disturbances, in combination with the residual effects of the Project and reasonably foreseeable future projects and activities, are expected to act cumulatively to affect vegetation abundance in the Terrestrial RSA through change in the areal extent of habitat types.

Contributing projects and activities within the Terrestrial RSA are anticipated to have mitigation measures in place to reduce vegetation disturbance to the extent practicable. Habitats are expected to regenerate within disturbed lands that have been reclaimed or allowed to regenerate naturally (e.g., following mineral exploration). As such, the cumulative effect of change in areal extent of habitat types is expected to be limited and isolated.

The cumulative effects characterization for change in areal extent of habitat types is provided in Table 9.2-19.

The magnitude of the change in areal extent of habitat types is expected to be moderate. The majority of past, present, and reasonably foreseeable projects and activities are predicted to result in relatively low levels of direct and indirect vegetation disturbance; however, exploration activities are common on the landscape and are expected to continue to contribute to vegetation disturbance within the Terrestrial RSA throughout the foreseeable future as natural regeneration continues and reclamation efforts for the Project commence.

The cumulative effect is expected to be regional in geographic extent. Change in areal extent of habitat types is expected to occur throughout the Terrestrial RSA.

The duration of change in areal extent of habitat types is expected to occur over the long-term (more than 38 years) because of the extended time periods required for some ecosystems to regenerate following disturbance and reclamation.

The frequency of the change in areal extent of habitat types is expected to be frequent. While vegetation loss due to of vegetation clearing are anticipated to occur infrequently, alteration of Vegetation and Ecosystems within the Terrestrial RSA by indirect effects such as introduction/proliferation of invasive plants, edge effects, and dust deposition is expected to occur frequently.

The change in areal extent of habitat types is expected to be partially reversible. Most of the vegetation lost or altered within the Terrestrial RSA has the potential to regenerate over time after the source of the disturbance has ceased. This is particularly true for exploration activities; once cutlines have been created, vegetation is expected to regenerate over time. However, permanent features on the landscape (e.g., Highway 914) are not expected to revert back to native vegetation and will continue to result in indirect effects on adjacent vegetation (e.g., edge effects, dust deposition, introduction/proliferation of invasive plants).

The context of the cumulative effect of change in areal extent of habitat types is expected to be moderate. Ecosystems within the Terrestrial RSA are adapted to the frequent fire disturbance characteristic of the Boreal Shield Ecozone, which confers a moderate resilience to stress; however, existing areas of native vegetation within the Terrestrial RSA have experienced historic fragmentation and indirect disturbance resulting from roads and exploration activities such as line cutting, drilling, and access development.

The cumulative effect of change in areal extent of habitat types is likely. Native vegetation is common within the Terrestrial RSA, and this is expected to be affected by the Project and other projects and activities.

The cumulative change in areal extent of habitat types is not expected to result in a change in the vegetation abundance KI that will alter its integrity within the Terrestrial RSA to the point where it is not sustainable or is unavailable to contribute to ecological functions; therefore, the cumulative effect of change in areal extent of habitat types is expected to be **not significant.**

The level of confidence of this prediction is moderate. While the direct effects of clearing are well known, uncertainty exists with respect to the extent and degree of alteration resulting from edge effects, dust deposition, invasive plants, the resiliency of vegetation to withstand change, and the regeneration of reclaimed and naturally regenerating areas into native vegetation communities.

Constituent Concentrations in Vegetation – Change in Concentrations of Constituents of Potential Concern in Plant Tissue

Residual effects on constituent concentrations in vegetation resulting from the Project were identified and assessed as **not significant** in Section 9.2.6. Change in concentrations of COPC in plant tissue due to air emissions and dust deposition on vegetation caused by vehicle traffic is ongoing on roads and trails within the Terrestrial RSA. Additional deposition of COPC (and subsequent uptake) is predicted to occur during all phases of the Project due to air emissions and dust deposition caused by Construction and Operation of the Project, as well as vehicle and equipment traffic.

The reasonably foreseeable future projects and activities are expected to result in increased air emissions and dust deposition caused by increased vehicle and equipment traffic during all Project phases, as well as vegetation clearing required during infrastructure maintenance of the Cree Lake Winter Trail, Highway 914, and the SaskPower transmission line ROW. Mineral exploration and other activities are expected to add cumulatively to deposition and uptake of COPC within the Terrestrial RSA through dust deposition and increased vehicle and equipment traffic.

The cumulative effects characterization for change in concentrations of COPC in plant tissue is provided in Table 9.2-19.

The magnitude of the cumulative change in concentrations of COPC in plant tissue is expected to be low because it is expected be confined to the boundaries of roads, near areas of active soil disturbance (e.g., the Project Area), and areas downgradient of the Project.

The geographic extent of this cumulative effect is expected to be regional. Although change in concentrations of COPC in plant tissue is expected to be confined to disturbance edges, past, present, and future projects and activities are scattered throughout the Terrestrial RSA.

The frequency of the cumulative change in concentrations of COPC in plant tissue is expected to be frequent. Dust deposition, vehicle emissions, and surface water movement resulting from the Project are expected to occur frequently during Construction, Operation, and Decommissioning, and infrequently during Post-Decommissioning.

The duration of cumulative change in concentrations of COPC in plant tissue is expected to be long-term (more than 38 years) because of the time periods necessary for COPC to attenuate in the soil. Timelines for trace metals depletion from the soil vary widely depending on chemistry, from 75 years to over 3,000 years in temperate climates (Kabata-Pendias and Pendias 2001).

Change in concentrations of COPC in plant tissue is expected to be fully reversible. Accumulated COPC deposited on above-ground plant tissue (e.g., stems, leaves, and twigs) and the attenuation of accumulated trace metals within the soil is expected to be fully reversible over the long-term (more than 38 years) through natural attenuation processes such as degradation, dispersion, sorption, and radioactive decay (Dinis and Fiuza 2021).

The context of the cumulative effect of change in concentrations of COPC in plant tissue is expected to be moderate. Vegetation communities and ecosystems within the Terrestrial RSA have experienced frequent fire disturbance characteristic of the Boreal Shield Ecozone and existing areas of native vegetation within the Terrestrial RSA have experienced historic fragmentation and indirect disturbance resulting from roads and exploration activities such as line cutting, drilling, and access development. In addition, existing elevated levels of elevated baseline concentrations of COPC including aluminum, beryllium, boron, cadmium, chromium, cobalt, iron, lead, nickel, titanium, uranium, and zinc, and elevated radionuclides lead-210 and polonium-210 have been identified within vegetation and soils at PSP located closest to Highway 914 (Appendix 9-B).

The cumulative effect of change in concentrations of COPC in plant tissue is expected to be likely. Dust, air emissions, and surface water runoff resulting in deposition of COPC on vegetation (and subsequent uptake) is expected to occur within the Terrestrial RSA.

The cumulative effect of change in concentrations of COPC in plant tissue is not expected to result in a change in the constituent concentrations in vegetation KI that will alter the integrity of vegetation within the Terrestrial RSA to the point where it is not sustainable or is unavailable to contribute to ecological functions; therefore, the cumulative effect of change in areal extent of habitat types is expected to be **not significant.**

The level of confidence of this prediction is moderate. Uncertainty exists with respect to the type and concentration of COPC that may be deposited, their bioavailability, and the responses of vegetation species and communities.

Table 9.2-19: Summary of Cumulative Effects for Vegetation and Ecosystems

Cumulative Effects	Project Phases	Cumulative Effects Characterisation[1]								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Vegetation Abundance – Change in Areal Extent of Habitat Types	Construction Operation Decommissioning Post-Decommissioning	M	RSA	LT	FF	PR	M	L	NS	M
Constituent Concentrations in Vegetation – Change in Concentrations of Constituents of Potential Concern in Plant Tissue	Construction Operation Decommissioning Post-Decommissioning	L	RSA	LT	FF	FR	M	L	NS	M

[1] Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility: Fully Reversible (FR), Partially Reversible (PR), Irreversible (IR)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (U), Likely (L)
Significance: Not-Significant (NS), Significant (S)
Level of Confidence: High (H), Moderate (M), Low (L)

Listed Plant Species Valued Component

Change in the Number of Listed Plants

Residual effects on the Listed Plant Species VC resulting from the Project were identified and assessed as **not significant** in Section 9.2.6. One listed plant species (Alaskan clubmoss) has been recorded within the Terrestrial RSA, and the potential exists for other occurrences of listed plant species to be present (Section 9.2.6). It is expected that future foreseeable Projects will follow published Activity Restriction Guidelines for Sensitive Species (SK MOE 2017b), and employ avoidance and/or mitigation as recommended by the SK CDC for listed plant species occurrences (SK CDC 2020). As such, the cumulative effect on listed plant species is expected to be limited and isolated.

The cumulative effects characterization for change in the number of listed plants is provided in Table 9.2-20.

The magnitude of the change in the number of listed plants is expected to be low. The majority of past, present, and reasonably foreseeable projects and activities are predicted to result in relatively low levels of direct and indirect vegetation disturbance. Wetland habitats are considered to have a moderate to high potential to support listed plant species in the Terrestrial RSA, and have been mapped within 10,940.6 ha (27.2%) of the Terrestrial RSA, and 98.2 ha (8%) of the Vegetation LSA. The remainder of habitats are dominated by sandy mesic to submesic ecosites commonly encountered on the Boreal Shield (i.e., jack pine / blueberry / lichen [BS3] and/or black spruce / blueberry / lichen [BS7]); given the frequency of these ecosites within the Terrestrial RSA, these areas are consequently considered to have a low potential for supporting listed plants. In addition, the majority of and vegetation communities in the Terrestrial RSA have been, and continue to be, exposed to frequent fire disturbance characteristic of the Boreal Shield Ecozone. Exploration activities are common on the landscape and are expected to continue to contribute to vegetation disturbance within the Terrestrial RSA throughout the foreseeable future. The local abundance of Alaskan clubmoss within the Terrestrial RSA (Figure 9.2-7) and provincial ranking of Vulnerable (S3) is consistent with a prediction of low magnitude.

The cumulative effect is expected to be regional in geographic extent. Change in the number of listed plants has the potential to occur throughout the Terrestrial RSA.

The duration of change in the number of listed plants is expected to occur over the long-term (more than 38 years). Once lost, listed plants are unlikely to regenerate as they often have limited ability for dispersal, poor reproduction and/or recruitment (Schemske et al. 1994, Wamelink et al. 2014).

The frequency of the change in the number of listed plants is expected to be frequent. While loss of listed plants due to of vegetation clearing is anticipated to occur infrequently, alteration of listed plants and their habitats within the Terrestrial RSA by indirect effects such as introduction/proliferation of invasive plants, edge effects, and dust deposition is expected to occur frequently.

The change in the number of listed plants is expected to be partially reversible. Listed plant species typically have specific habitat requirements, are rarely successfully transplanted (Maslovat 2009, Government of Saskatchewan 2016), and are not likely to return once lost from a specific location within the Terrestrial RSA. However, listed plants affected indirectly by dust deposition, edges, and changes to water quantity and quality may naturally regenerate and re-establish over time following the end of the disturbance.

The context of the cumulative effect of change in the number of listed plants is predicted to be moderate. Listed plant species are often highly habitat-specific, with low resiliency to disturbance and habitat loss or degradation (Wamelink et al. 2014). However, the only listed plant species known to occur within the Terrestrial RSA (Alaskan clubmoss) is listed as Vulnerable (S3) in Saskatchewan, indicating a lower conservation priority in the province.

Based on available baseline information, the cumulative effect of change in the number of listed plants is predicted to be likely. Although no listed plant species have been identified within the

Vegetation LSA, the known occurrences of Alaskan clubmoss within the Terrestrial RSA are located adjacent to existing exploration disturbance and may be subject to ongoing indirect effects (e.g., introduction/proliferation of invasive plants, edge effects, and dust deposition).

The cumulative effect of change in the number of listed plants is not expected to result in a change in the listed plant species KI that will alter its integrity within the Terrestrial RSA to the point where it is not sustainable or are unavailable to contribute to ecological functions; therefore, the cumulative effect is predicted to be **not significant.**

The level of confidence of this prediction is moderate. No listed plants have been previously observed within the Vegetation LSA, and only one listed plant species has been identified within the Terrestrial RSA; however, uncertainty exists with respect to whether occurrences are present, and if so, where they are located in relation to the Project and other future foreseeable projects and activities. While the direct effects of clearing are well known, uncertainty exists with respect to the extent and degree of potential alteration that may result from edge effects, dust deposition, and invasive plants. Pre-construction listed plant surveys planned within the Project Area are expected to minimize the Project's contribution to this cumulative effect.

Table 9.2-20: Summary of Cumulative Effects for Listed Plant Species

Cumulative Effects	Project Phases	Cumulative Effects Characterisation[1]								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Change in the Number Listed Plants	Construction Operation Decommissioning Post-Decommissioning	L	RSA	LT	FF	PR	M	L	NS	M

[1] Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility: Fully Reversible (FR), Partially Reversible (PR), Irreversible (IR)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (U), Likely (L)
Significance: Not-Significant (NS), Significant (S)
Level of Confidence: High (H), Moderate (M), Low (L)

Wetlands Valued Component

Change in the Areal Extent of Wetlands

Residual effects on the Wetlands VC resulting from the Project were identified and assessed as **not significant** in Section 9.2.6. Existing provincial legislation (*Environmental Management and Protection Act* [Government of Saskatchewan 2010[and the *Water Security Agency Act* [Government of Saskatchewan 2019b]) requires written approval (i.e., Aquatic Habitat Protection Permits) prior to any works within a wetland. It is expected that other future projects and activities will comply with this requirement; however, potential cumulative effects on wetlands may occur as a result of overlapping edge effects, changes to water quantity/quality, dust deposition, and/or the introduction/proliferation of invasive plants. This cumulative effect on wetlands is expected to be limited and isolated.

The cumulative effects characterization for change in the areal extent of wetlands is provided in Table 9.2-21.

The magnitude of the change in the areal extent of wetlands is predicted to be low because it is expected be confined to the boundaries of roads and trails, near areas of active soil disturbance (e.g., the Project, exploration activities), and areas downgradient of the Project.

The cumulative effect is predicted to be regional in geographic extent. Change in the areal extent of wetlands has the potential to occur throughout the Terrestrial RSA.

The change in the areal extent of wetlands is expected to be long-term, i.e., more than 38 years because of the extended time periods required for some wetland ecosystems to regenerate following disturbance and reclamation (e.g., peatlands).

The frequency of the change in the areal extent of wetlands is predicted to be frequent. While direct disturbance to wetlands due to clearing are anticipated to occur infrequently, alteration of wetlands within the Terrestrial RSA by indirect effects such as introduction/proliferation of invasive plants, edge effects, and dust deposition is expected to occur frequently.

Change in the areal extent of wetlands is predicted to be partially reversible. Most of the cumulative change in wetland extent is predicted to be reversible over time once natural topographic and hydrologic conditions are re-established and edge effects, dust, water quality changes, and invasive plant propagule pressure are reduced. However, permanent features on the landscape (e.g., existing roads) are not expected to revert back to native vegetation and will continue to result in indirect effects on adjacent vegetation (e.g., edge effects, dust deposition, introduction/proliferation of invasive plants).

The context of the cumulative effect of change in the areal extent of wetlands is predicted to be moderate. Wetlands can exhibit low resilience and high susceptibility to disturbance (MacKenzie and Shaw 2000); however, frequent fire disturbance is characteristic of the Boreal Shield Ecozone, and wetland vegetation is expected to be adapted to this natural disturbance regime.

The cumulative effect of change in the areal extent of wetlands is predicted to be likely. Wetlands are expected to be disturbed both directly and indirectly as a result of Project construction and other projects and activities.

The change in the areal extent of wetlands is not expected to result in a change will alter the integrity of wetlands within the Terrestrial RSA to the point where they are not sustainable or str unavailable to contribute to ecological functions; therefore, the cumulative effect is expected to be **not significant.**

The level of confidence of this prediction is moderate. While the direct effects of clearing are well known, uncertainty exists with respect to the extent and degree of alteration resulting from edge effects, dust deposition, invasive plants, the resiliency of wetlands to withstand change, and the regeneration of reclaimed areas into native vegetation communities.

Table 9.2-21: Summary of Cumulative Effects for Wetlands

Cumulative Effects	Project Phases	Cumulative Effects Characterisation[1]								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Change in the Areal Extent of Wetlands	Construction Operation Decommissioning Post-Decommissioning	L	RSA	LT	FF	PR	M	L	NS	M

[1] Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility: Fully Reversible (FR), Partially Reversible (PR), Irreversible (IR)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (U), Likely (L)
Significance: Not-Significant (NS), Significant (S)
Level of Confidence: High (H), Moderate (M), Low (L)

9.2.7.4 Cumulative Effects Assessment Summary

The following residual effects of the Project were carried forward to the CEA:

Vegetation and Ecosystems VC

Vegetation abundance KI

- Change in areal extent of habitat types.

Constituent concentrations in vegetation KI

- Change in level of COPC in plant tissue.

Listed Plant Species VC/KI

- Change in the number of listed plants.

Wetlands VC/KI

- Change in areal extent of wetlands.

As detailed above, the residual effects of the Project, in conjunction with the comparable residual effects from past, present, and reasonably foreseeable future projects on the vegetation abundance and constituent concentrations in vegetation KIs were predicted to be **not significant**. Thus, the cumulative effects are not expected to alter the integrity of the Vegetation and Ecosystems VC (i.e., it remains sustainable and available to contribute to ecological functions) and is predicted to be **not significant**.

Similarly, the residual effects of the Project, in conjunction with the comparable residual effects from past, present, and reasonably foreseeable future projects on the listed plant species and wetlands KIs were predicted to be **not significant**. Thus, the cumulative effects are not expected to alter the integrity of the Listed Plant Species VC and Wetlands VC (i.e., they remain sustainable and available to contribute to ecological functions) and are predicted to be **not significant.**

9.2.8 Monitoring and Follow-up

Follow-up refers to a range of activities used to:

- further quantify and qualify Project-related effects against predictions (if/where necessary);
- assess the effectiveness of mitigation measures;
- provide a mechanism for modification and/or adaptation;
- identify new problems (should they arise); and
- implement additional mitigation (if/where applicable) including triggers and corrective actions.

Denison is committed: (1) to reduce disturbance to Vegetation and Ecosystems, Listed Plant Species, and Wetlands throughout all Project Phases, and (2) to reclaim the Project Area to an ecological trajectory that aligns with the desired end-land use(s) and regulatory requirements at the completion of the mining tenure. A key step will be to appropriately implement all applicable environmental management plans during the given Project phases. A follow-up strategy is proposed to support existing mitigation and thereby minimize uncertainty in support of these commitments.

Project monitoring and adaptive management plans specific to Vegetation include:

- Pre-construction listed plant surveys will be targeted on ecosites encountered in the Project Area but not previously surveyed, as well as ecosites within the Project Area with high potential to support listed plants (e.g., Alaskan clubmoss).
- Vegetation and invasive plants will be routinely monitored throughout the life of the Project.
- Soil monitoring during salvaging and stockpiling activities will be undertaken.
- Progressive reclamation and revegetation of disturbed areas will be monitored in accordance with the Decommissioning Plan.
- Monitoring will be employed to understand uptake of COPC in plants.

Where mitigation measures are not deemed to be successful, adaptive management techniques will be employed. Findings during monitoring, as well as revised BMPs, improved scientific methods, and regulatory changes will be incorporated into the environmental management plans, to reduce effects during the lifetime of the Project. Interested Parties, Indigenous communities and organizations, and regulatory agencies will be involved in developing mitigation and adaptive management measures where applicable.

9.2.8.1 Pre-construction Listed Plant Surveys

Pre-construction listed plant surveys will be undertaken within the Project Area within ecosites that were not encountered during the 2017 surveys, as well as within selected areas of the Project Area with the potential to support listed plants (e.g., transitional habitats favoured by Alaskan clubmoss). Surveys will be undertaken to verify EA predictions and identify mitigation measures to protect Listed Plant Species, as appropriate.

Should Listed Plant Species be identified within the Project Area, site- and species-specific mitigation measures will be developed by a qualified vegetation ecologist to avoid and/or minimize potential Project effects.

9.2.8.2 Construction Monitoring

Targeted monitoring and inspection will be undertaken during Construction to verify that mitigation measures to reduce effects on Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs have been appropriately applied, maintained, and removed, where necessary. Environmental inspectors (on-site monitors) will be present during Construction to verify compliance and evaluate the success of mitigation measures outlined in Section 9.2.5, mitigation and management plans specific to Vegetation including the plans for erosion and sediment control management and monitoring of vegetation, and the Decommissioning Plan, and applicable approval conditions. Construction monitoring procedures will clearly define and delineate indicators and descriptors to identify potential deficiencies, triggers, and corrective actions. These procedures will identify the key personnel (e.g., Managers, Superintendents and Technical Leads) responsible for document review, approval, and implementation.

9.2.8.3 Vegetation Monitoring

Vegetation monitoring will be conducted periodically throughout all Project phases to reduce the potential for effects on vegetation associated with routine vegetation clearing and maintenance within the Project Area and to avoid the introduction and spread of invasive plant species. Vegetation monitoring will verify compliance and evaluate the success of mitigation measures outlined in Section 9.2.5, mitigation and management plans specific to Vegetation including plans for erosion and sediment control, environmental protection of vegetation and soil, and the Decommissioning Plan, and applicable approval conditions. These procedures will identify the key personnel (e.g., Managers, Superintendents and Technical Leads) responsible for document review, approval and implementation.

9.2.8.4 Constituents of Potential Concern in Vegetation

Vegetation and soil sampling and laboratory analyses for COPC commenced in 2017 at 10 PSPs for radon (further described in Section 9.2.3.1.2), and will continue to be conducted periodically throughout all Project phases to identify if plants within the Vegetation LSA are accumulating COPC within their tissues. Monitoring for COPC in vegetation will be completed in accordance with the methodologies outlined in the EMS, and as outlined in the ERA (Appendix 10-A in Section 10).

9.2.9 Vegetation and Ecosystems, Listed Plant Species, and Wetlands Summary

The terrestrial VCs (and KIs) considered in this EIS are Vegetation and Ecosystems (vegetation abundance and constituent concentrations in vegetation), Listed Plant Species (listed plant species), and Wetlands (wetlands). The main activities considered in the effects assessment include site preparation (i.e., clearing, grading and construction of roads, airstrip, and surface infrastructure), water management (i.e., withdrawal/use of surface and/or groundwater and release of effluent), and reclamation (i.e., progressive and final reclamation of disturbed areas).

Based on the timing and nature of the interactions between the Project activities and the KI's, the following adverse effects on the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs have the potential to occur during the lifetime of the Project: change in areal extent of habitat types, change in the level of COPC in plant tissue, change in the number of listed plants, and change in the areal extent of wetlands.

Mitigation measures were designed to avoid or minimize potential effects, including the following:

- The Project footprint has been reduced and is primarily within previously disturbed areas, thereby minimizing direct and indirect habitat loss and/or alteration.
- Disturbance to vegetation and soils will be avoided by clearly delineating Project Area boundaries (e.g., with the use of fencing, staking, or flagging), adhering to construction plans and schedules, and by restricting off-site machine use.
- Pre-construction listed plant surveys will be completed within the Project Area.
- Should Listed Plants be identified within the Vegetation LSA prior to Construction, site- and species-specific mitigation measures to avoid and/or limit Project effects will be determined by a Qualified Vegetation Ecologist. Specific mitigation measures will depend on the species, its life history characteristics, time of year, and the location of the occurrence in relation to Project activities.
- Snow melt and runoff will be controlled within the Project Area to prevent the potential release of contaminated runoff from affecting vegetation in adjacent areas.
- Sediment and erosion control measures will be implemented in accordance with the plans within the EMS and the soil and vegetation monitoring plan.
- Surface water management features (e.g., culverts and ditches) will constructed and maintained (as per Project design specification) along access roads and facility sites to facilitate surface drainage continuity and hydrologic connectivity—especially in proximity to wetlands, water crossings, and waterbodies.
- Equipment and vehicles will arrive at the Project Area clean, and will be inspected for soil, plant material, and seeds, and cleaned as appropriate, to limit the potential for the introduction of invasive plants and noxious weeds.
- Areas with a high risk for the potential spread of invasive plants and noxious weeds (i.e., within or adjacent to existing infestations) will be avoided to the extent practicable; if work must occur in these areas, invasive plant management will be implemented before starting work.
- During Operation, progressive reclamation will be completed where possible, and the progress and success of these activities will be assessed annually[27].
- During all phases, open-source dust and process-source dust will be carefully monitored and reduced by controlling access and travel (i.e., traffic management) during peak construction and (if/where necessary) applying dust suppression measures.
- A vegetation and soil sampling program—comprising scheduled collection of soil and plant tissues from permanent sampling locations for analysis of COPC—will be conducted periodically

[27] KML and NVP 2022.

during all Project phases to identify if plants within the Vegetation LSA are accumulating COPC within their tissues.

With the implementation of the above (and additional) mitigation measures, the residual effects on the Vegetation and Ecosystems, Listed Plant Species, and Wetlands VCs were assessed as follows:

- Effects on Vegetation and Ecosystems, related to change in areal extent of habitat types, are anticipated to be:
  - Low magnitude: Up to 1,161.8 ha (2.9 %) of all habitats within the Terrestrial RSA are predicted to be affected by the Project (0.4% directly disturbed, and up to 2.5% indirectly disturbed), including up to 851.0 ha (3%) of terrestrial habitats within the Terrestrial RSA, and up to 97.7 ha (1.5%) of wetland habitats within the Terrestrial RSA.
  - Local extent: The direct loss of habitat types is expected to be limited to the Project Area during Construction, and indirect effects are expected to be restricted to the Vegetation LSA during all Project phases.
  - Long-term duration: Habitat types affected by the Project are expected to regenerate over time within reclaimed areas of the Project Area; those areas progressively reclaimed during Operation will regenerate throughout the remainder of Operation, and beyond, and remaining reclaimed areas will regenerate following Decommissioning.
  - Partially reversible: Forested habitats cleared within the Project Area are expected to regenerate on reclaimed areas of the Project Area over time following the end of Operation. Primary access roads will remain 'as-built' for the purpose of maintenance and aftercare, resulting in small areas that are not expected to be reclaimed.
  - Not significant: change in areal extent of habitat types as a result of the Project is not expected to result in a change to the vegetation abundance KI that will alter its integrity within the Terrestrial RSA to the point where it is not sustainable or unavailable to contribute to ecological functions.
- Effects on Vegetation and Ecosystems, related to changes in COPC in plant tissue, are anticipated to be:
  - Low magnitude: Up to 992.2 ha (2.5%) of vegetation within the Terrestrial RSA may be affected by changes in concentrations of COPC in plant tissue during all Project phases.
  - Local extent: Changes in concentrations of COPC in plant tissue are expected to be confined to the Vegetation LSA along the boundaries of roads and near areas of active soil disturbance during all Project phases.
  - Long-term duration: Changes in concentrations of COPC in plant tissue is predicted to be Long-term (more than 38 years) because of the extended time periods often necessary for COPC to attenuate in the soil.

- Fully reversible: Accumulated COPC deposited on above-ground plant tissues (e.g., stems, leaves, and twigs) and the attenuation of accumulated COPC within the soil is expected to be reversible over the Long-term through natural attenuation processes such as degradation, dispersion, sorption, and radioactive decay.
- Not significant: change in concentrations of COPC in plant tissue as a result of the Project is not expected to result in a change in the constituent concentrations in vegetation KI that will alter the integrity of vegetation within the Terrestrial RSA to the point where it is not sustainable or unavailable to contribute to ecological functions.

- Effects on Listed Plant Species, related to change in the number of listed plants, are anticipated to be:
  - Low magnitude: No listed plants within the Terrestrial RSA are anticipated to be affected, but the potential exists that unobserved occurrences may be affected during all Project phases.
  - Local extent of habitat effects: Potential direct loss of listed plants is expected to be limited to the Project Area, indirect effects may extend into the Vegetation LSA during all Project phases
  - Long-term duration: Once lost, listed plants are unlikely to regenerate as they often have limited ability for dispersal and poor reproduction and/or recruitment.
  - Partially reversible: Listed plants typically have specific habitat requirements, are rarely successfully transplanted, and are not likely to return once lost from a specific location within the Terrestrial RSA. However, listed plants affected indirectly by effects such as dust deposition, edges, and changes to water quantity and quality may naturally regenerate over time following the end of Operation.
  - Not significant: The residual effect of change in the number of listed plants is not expected to result in a change in the listed plant species KI that will alter its integrity within the Terrestrial RSA to the point where it is not sustainable or are unavailable to contribute to ecological functions.
- Effects on Wetlands, related to change in the areal extent of wetlands, are anticipated to be:
  - Low magnitude: Less than 0.1% of Wetlands within the Terrestrial RSA are predicted to be directly disturbed as a result of Project Construction. Direct wetland disturbance is expected to be restricted to wetlands located at stream crossings for access roads and the transmission line corridor. In both cases the approach to design will be one of avoidance and minimal disturbance with clear span bridges and minimal clearing required for transmission line installation where avoidance of open water areas can be met. Up to 1.5% of Wetlands within the Terrestrial RSA may be indirectly affected during all Project phases.

- Local extent of habitat effects: While direct disturbance to Wetlands is expected to be limited to the Project Area during Construction, indirect effects are expected to extend into the Vegetation LSA during all Project phases.
- Long-term duration: Once natural drainage patterns are re-established following Operation, the structure and function of Wetlands altered as a result of indirect Project effects are expected to re-establish after Post-Decommissioning (more than 38 years).
- Partially reversible: Direct disturbance to wetland area is predicted to be partially reversible during Decommissioning once natural hydrologic conditions are reinstated. Alterations to wetland extent, structure and/or function as a result of indirect Project effects during all Project phases are predicted to be reversible over time once natural hydrologic conditions are reinstated and edge effects, dust, water quality changes, and invasive plant propagule pressure are reduced at the end of Decommissioning.
- Not significant: The residual effect of change in the areal extent of the Wetlands VC as a result of the Project is not expected to result in a change to the wetlands KI that will alter its integrity within the Terrestrial RSA to the point where it is not sustainable or unavailable to contribute to ecological functions.

These Project residual effects were carried forward to the CEA and assessed in relation to their overlap in space and time with the residual effects of other projects and activities. The residual effects of the Project, in conjunction with the comparable residual effects from all past, present, and reasonably foreseeable future projects are not expected to alter the integrity of the Vegetation and Ecosystems, Listed Plant Species, or Wetlands VCs within the Terrestrial RSA beyond an acceptable level (i.e., they remain sustainable and available to contribute to ecological function). As such, the cumulative effects on the Vegetation and Ecosystems, Listed Plant Species, or Wetlands VCs are expected to be **not significant**.

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9.3 Ungulates, Furbearers, and Woodland Caribou

This subsection addresses potential Project-related effects on the Ungulates, Furbearers, and Woodland Caribou VCs and their associated KIs. In support of the assessment, this section covers the following aspects:

- scope of the assessment;
- influence of IK, LK, and engagement on the assessment;
- description of the existing environment for the VCs and associated KIs;
- identification of potential interactions between the Project and the VCs and associated KIs;
- identification and description of potential Project-related effects on the VCs and associated KIs;
- identification and description of mitigation measures to avoid or minimize the potential adverse Project-related effects on VCs,
- description and characterization of potential Project residual effects on VCs and associated KIs, including determination of significance and level of confidence in the predictions;
- identification and characterization of cumulative effects; and
- identification and description of monitoring and follow-up programs and activities.

Figure 9.3-1 is a graphic representation of the assessment process used in this EIS.

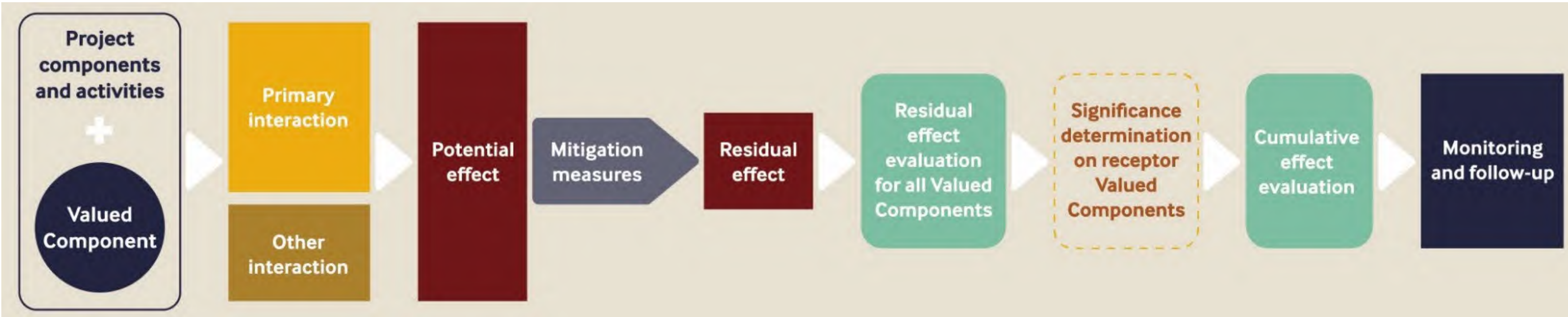

Figure 9.3-1: Environmental Assessment Process for the Wheeler River Project

9.3.1 Scope of the Assessment

9.3.1.1 Valued Component Selection

The process and rationale for selection of VCs, and establishment of KIs and associated MPs, is described in Section 5.3 in Section 5**.** Ungulates, Furbearers, and Woodland Caribou VCs were selected based on their likelihood of interaction with the Project, and their contributing roles to biodiversity and ecosystem function. These VCs also contribute to environmental, socio-economic, and cultural values of Indigenous groups, regulators, and the public. The Ungulates, Furbearers, and Woodland Caribou VCs are interrelated, to varying extents, and are linked to other VCs, including:

Atmospheric and Acoustic

- Air Quality – dust deposition and air emissions have the potential to disperse trace metals and radionuclides into the ambient air, which can subsequently be deposited into surface water and onto vegetation and soil, taken up into the food chain, and affect Ungulates, Furbearer, and Woodland Caribou VCs. This will be captured through the ERA (Appendix 10-A in Section 10).
- Noise – increased noise levels above ambient conditions may cause temporary disturbance to wildlife, which could result in temporary avoidance of the area and other behavioural responses.

Geology and Groundwater

- Geology – alteration of geological material through terrain destabilization and accelerated erosion may affect wildlife and wildlife habitat in proximity to the Project.
- Groundwater Quality – changes in groundwater quality may affect the availability and quality of wildlife habitat.
- Groundwater Quantity – changes in groundwater quantity may affect the availability and quality of wildlife habitat.

Aquatic Environment

- Surface Water Quality – changes in surface water quality may affect the availability and quality of wildlife habitat and affect the health of wildlife species.
- Surface Water Quantity – changes in surface water quantity may affect the availability and quality of wildlife habitat.
- Aquatic Habitat – changes in aquatic habitats associated with the Wheeler River watershed and its sub-basins may affect wildlife habitat.
- Sediment Quality – changes in sediment quality may affect biological functions in proximity to aquatic habitats and influence wildlife habitat (i.e., muskrat and mink).
- Fish Habitat – muskrat (and to a lesser extent mink) may influence fish habitat through houses, lodges and borrows.

- Fish Health – changes to fish health (through chemical/radiological exposure) and increase in fish mortality may affect wildlife (i.e., wolverine, muskrat, and mink).

Terrestrial Environment

- Terrain – changes to terrain, which interacts with vegetation communities, may affect wildlife habitat.
- Organic Matter/Peat – changes to organic matter/peat may affect wildlife habitat.
- Soil Quantity – changes to soil quantity may affect wildlife habitat.
- Soil Quality – changes to soil quality may affect wildlife habitat and the health of wildlife species.
- Vegetation and Ecosystems – changes to vegetation and ecosystems, which provide habitat for feeding, reproduction, rearing, and/or cover for wildlife, may affect wildlife and wildlife habitat.
- Listed Plant Species – changes to listed plant species may affect wildlife and wildlife habitat.
- Wetlands – changes to wetlands, which provide habitat for feeding, reproduction, rearing, and/or cover for wildlife, may affect wildlife and wildlife habitat.
- Raptors – raptors may prey on furbearer species and changes in raptor populations may affect these species.
- Migratory Breeding Birds – furbearers may prey on migratory breeding birds and their eggs and changes in migratory breeding bird populations may affect wildlife species.
- Bird Species at Risk – furbearers may prey on bird species at risk and their eggs and changes in bird species at risk populations may affect wildlife species.

Human Health

- Human Health and Safety – moose, muskrat, and woodland caribou are important food sources for local residents, and, as such, are part of the exposure pathway for humans.

Land and Resource Use

- Indigenous Land and Resource Use – KIs of the Ungulates, Furbearers, and Woodland Caribou VCs contribute to Indigenous land and resource use, including harvest (hunting and trapping) for food and fur. Changes in their populations may affect Indigenous land and resource uses.
- Other Land and Resource Use – KIs of the Ungulates, Furbearers, and Woodland Caribou VCs provide resource values such as resident hunting and trapping, tourism, guided outfitting, and the sale of fur and fur products. Changes in their populations may affect other land and resource uses.

Economics

- Economy – the harvest of KIs of the Ungulates, Furbearers, and Woodland Caribou VCs contributes to the local economy through supplying meat and fur as well as supporting tourism, guided outfitting, and the sale of fur and fur products. Changes in their populations may affect the local economy.

Figure 9.3-2 to Figure 9.3-4 are graphic representations of the main linkages among the Ungulates, Furbearers, and Woodland Caribou VCs and other VCs, illustrating the flow of assessment information into and from the Ungulates, Furbearers, and Woodland Caribou VCs.

Figure 9.3-2: Integrated Assessment Approach - Key Connections between Ungulates and Other Valued Components

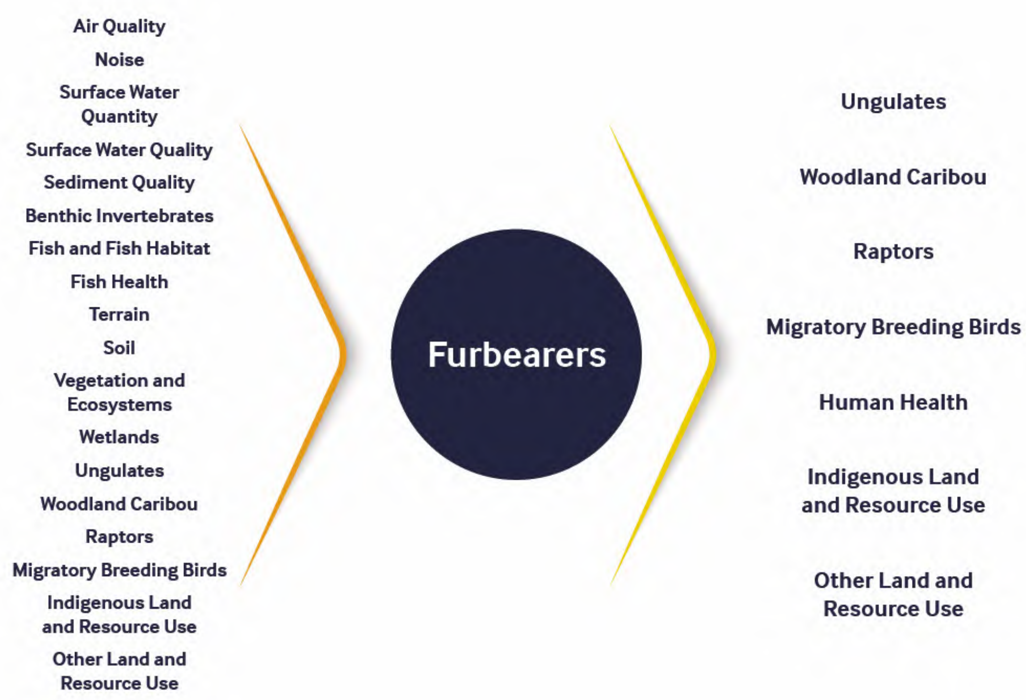

Figure 9.3-3: Integrated Assessment Approach - Key Connections between Furbearers and Other Valued Components

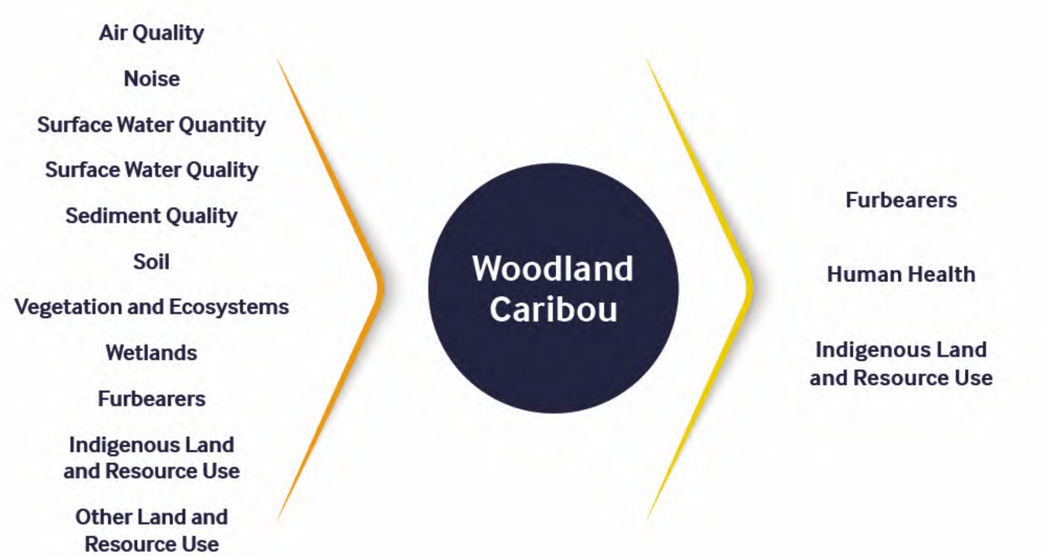

Figure 9.3-4: Integrated Assessment Approach - Key Connections between Woodland Caribou and Other Valued Components

9.3.1.2 Key Indicators and Measurable Parameters

The KIs and associated MPs for the Ungulates, Furbearer, and Woodland Caribou VCs are summarized in Table 9.3-1.

Table 9.3-1: Key Indicators and Measurable Parameters for the Ungulates, Furbearers, and Woodland Caribou Valued Components

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Ungulates		
Moose (*Alces alces*)	Project activities and infrastructure may affect moose populations. Moose are an important subsistence and cultural species and a primary prey species for large carnivores.	Amount of habitat that may be altered or lost relative to its availability in the Terrestrial RSA. Moose mortalities directly or indirectly attributable to the Project.
Furbearers		
Wolverine (*Gulo gulo*)	Project activities and infrastructure may affect wolverine populations, resulting in non-compliance with permit conditions requirements (e.g., *Species at Risk Act*). Wolverine are locally trapped furbearers and considered apex predators; they occupy large home ranges consisting of undisturbed habitat.	Amount of habitat that may be altered or lost relative to its availability in the Terrestrial RSA. Wolverine mortalities directly or indirectly attributable to the Project.
Pine marten (*Martes americana*)	Project activities and infrastructure may affect pine marten populations. Pine marten are important furbearers and contribute to the local economy. They require mature forests but can sustain viable populations in forests with a managed level of disturbance.	Amount of habitat that may be altered or lost relative to its availability in the Terrestrial RSA. Pine marten mortalities directly or indirectly attributable to the Project.
Mink (*Neovison vison*)	Project activities and infrastructure may affect mink populations. Mink are important furbearers and contribute to the local economy. They are a prey species for many carnivores.	Amount of habitat that may be altered or lost relative to its availability in the Terrestrial RSA. Mink mortalities directly or indirectly attributable to the Project.
Muskrat (*Ondatra zibethicus*)	Project activities and infrastructure may affect muskrat populations. Muskrats are important furbearers and a prey species for many carnivores. They contribute to the local economy and may also be trapped for food.	Amount of habitat that may be altered or lost relative to its availability in the Terrestrial RSA. Muskrat mortalities directly or indirectly attributable to the Project.
Woodland Caribou		
Woodland caribou (*Rangifer tarandus caribou*)	Project activities and infrastructure may affect woodland caribou populations, resulting in non-compliance with permit conditions requirements (e.g., SARA). Woodland caribou are an important cultural and subsistence species and a federal and provincial species at risk.	Amount of habitat that may be altered or lost relative to its availability in the Terrestrial RSA. Woodland caribou mortalities directly or indirectly attributable to the Project.

In response to information requests received from federal and provincial regulatory agencies, additional wildlife species at risk have been included in the assessment. Details related to life history requirements, expected Project effects, proposed mitigation measures, and anticipated residual effects on these species at risk are provided in Appendix 9-D.

9.3.1.3 Spatial and Temporal Boundaries

9.3.1.3.1 Spatial Boundaries

The spatial boundaries for the EA of Ungulates, Furbearers, and Woodland Caribou are depicted in Figure 9.3-5 and were defined as follows:

- **Project Area**: the area within which the Project and all components/activities are located (i.e., the area of maximum physical disturbance). The Project Area covers 169.6 ha and is not VC-specific, but consistent throughout the EA.
- **Wildlife LSA**: the area established to assess the potential, direct and indirect effects of the Project on the Ungulates, Furbearers, and Woodland Caribou VCs. It was delineated based on the area over which direct and indirect effects on VCs are most likely to occur. It is defined as the Project Area plus a 1.7 km buffer (i.e., 4,842.7 ha). The Wildlife LSA is intended to address provincially and federally mandated activity setback distances required for species at risk that may be found within or have home ranges that extend into the Wildlife LSA (Omnia 2020 in Appendix 9-B).
- **Terrestrial RSA:** the area established to assess the potential, largely indirect, effects of the Project on the terrestrial VCs (including the Ungulates, Furbearers, and Woodland Caribou VCs) in the broader, regional context. It also provides the regional context in which cumulative effects on terrestrial VCs may occur. The Terrestrial RSA (i.e., 40,173.6 ha) is defined as a minimum of a 6.6 km buffer around the Wildlife LSA and has been delineated to capture regional effects on wildlife species with large home ranges (see Appendix 9-B).

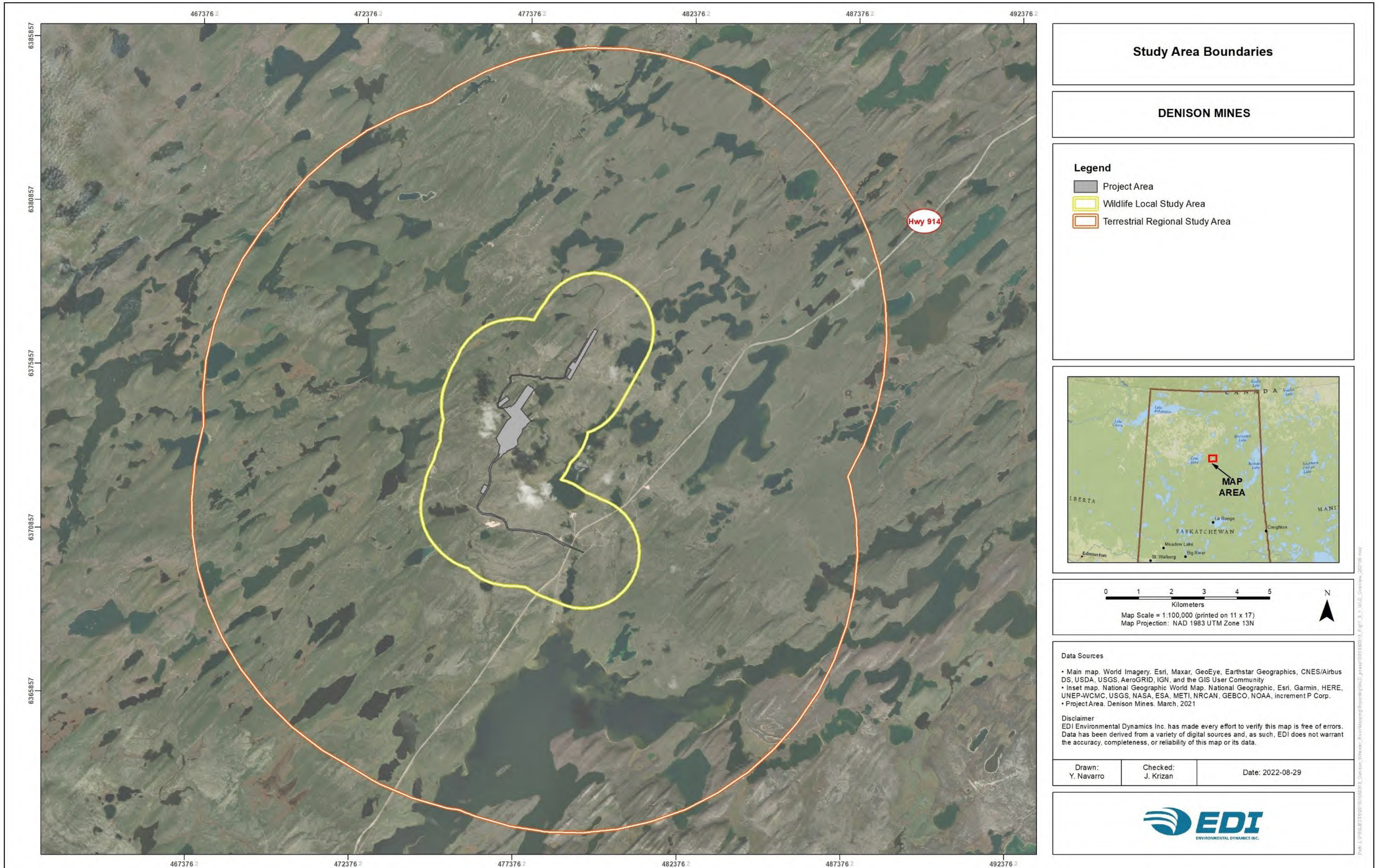

Figure 9.3-5: Study Area Boundaries for Wildlife Valued Components

9.3.1.3.2 Temporal Boundaries

The temporal boundaries for the EA of the Ungulates, Furbearers, and Woodland Caribou VCs represent the timeframes that the Project is expected to interact with and potentially affect these VCs. Temporal boundaries are based on the different phases of the Project, as described in in Table 9.3-2.

Table 9.3-2: Phases of the Project

Phase and Year	Description of Activities	
Construction Year 1 to 3	• Development of access roads and air strip • Site preparation and earthworks; clearing, leveling and grading of the project area • Power generation – generators • Installation of main substation and distribution of power around site • Wellfield and freeze hole drilling; ground freezing • Batch plant operation (concrete); crusher at borrow area • Development of surface infrastructure (camp, operations centre, plants, ponds, pads and support facilities)	• Waste management (composting, domestic and industrial landfill operation, recycling) • Water management (including treatment and site run-off) • Groundwater supply • Surface water withdrawal • Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel) • On-site and off-site operation of vehicles and transport of materials • Air transportation for workers • Regulatory site inspections • Engagement - site visit from Interested Parties
Operation Year 3 to 18	• Operation of the ISR wellfield • Wellfield and freeze wall drilling • Operation and expansion of freeze wall • Batch plant operation (grout and cement) crusher at borrow area • Expansion of pond and pads • Operation of the processing plant and production of uranium concentrate • Water withdrawal from groundwater or surface water body • Management of surface water (including seepage and site run-off) • Water treatment, both domestic and industrial • Water release to surface water body • Waste management (composting, domestic and industrial landfill operation, recycling) • Hazardous waste management (temporary storage, handling, and off-site transportation)	• Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates • On-site and off-site operation of vehicles and transport of materials • Power supply – primarily power from the grid, also generators and back-up generators • Package and transport of nuclear substances • Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel) • Air transportation for workers • Progressive decommissioning and reclamation • Regulatory site inspections • Engagement - site visit from Interested Parties
Decommissioning Year 18 to 23	• Site water management, treatment and release • Mining horizon remediation and thawing of freeze wall	• Generators • Waste management (composting and landfill operation)

Phase and Year	Description of Activities	
	• Process water treatment and release • Closure of ISR and freeze wells and related infrastructure • Decontamination of surface facilities and injection, recovery and monitoring wells • Asset removal (including site power transmission lines and electrical infrastructure) • Demolition and disposal of non-salvageable surface infrastructure and materials • Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	• Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal) • On-site and off-site operation of vehicles and transport of materials • Reclamation of disturbed areas • Regulatory site inspections • Engagement - site visit from Interested Parties
Post-Decommissioning Year 23 to 38	• Environmental monitoring	• Regulatory site inspections • Engagement - site visit from Interested Parties

9.3.2 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

Indigenous Knowledge can be understood as the unique and collective knowledge of Indigenous peoples and typically includes knowledge of the environmental, cultural, economic, political, and spiritual conditions of a community or region. Indigenous Knowledge (in combination with information from LK and engagement) was collected, compiled, and made available for inclusion into all VC sections. Within this EIS, information obtained through IK, LK, and engagement are viewed as complementary and influential alongside information obtained through the review of western science. All sources of information are used in the following sections to gain and describe a well-rounded understanding of the existing environment of the Ungulates, Furbearer, and Woodland Caribou VCs and the potential effects of the Project. In accordance with the methodologies provided in Sections 3, 4, and 5 of the EIS, IK, LK, and engagement have been incorporated and referenced within the assessment of the Ungulates, Furbearers, and Woodland Caribou VCs as available and appropriate.

Denison has recorded and stored information regarding IK, LK, and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 20-LK-LEASESUR-267.20). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment. Appendix 9-A provides a summary of unique identification numbers referenced within Section 9.3.

9.3.3 Existing Environment

9.3.3.1 Ungulates

The Ungulates VC is represented by one KI: moose. Therefore, this section describes the existing environment for moose in the Wildlife LSA, Terrestrial RSA, and the province for context.

9.3.3.1.1 Scientific Literature Review

Overview

Moose are not listed under the federal SARA or by COSEWIC (ECCC 2021). The SK CDC assigned them a status of S5 (Secure/Common: demonstrably secure under present conditions; widespread and abundant; low threat level) (SK CDC 2021).

Moose Range

Moose occur in suitable habitat across Saskatchewan with the requirement for cover and the availability of suitable forage being determining factors in moose habitat selection. In the Saskatchewan boreal forest, cover is provided by a mixture of closed, mature coniferous stands and forage by young regenerating deciduous stands, as well as aquatic vegetation during the summer (SK MOE 2019a). While anthropogenic disturbances may adversely affect moose, they generally benefit from an abundance of young forage stands associated with forest regeneration after disturbances caused by fires and some anthropogenic activities, such as logging. Stenhouse et al. (1995) studied 30 radio-collared female moose for 3 years in a low-density population in the southern Northwest Territories. They reported that individual moose home ranges varied from 40 km^2 to 942 km^2 between animals and seasons, with the mean home range size estimated at 174 (± 31) km^2. Their study also concluded that fall home ranges were twice the size of winter and summer home ranges and that seasonal ranges overlapped widely (Stenhouse et al. 1995).

In recent years, moose populations were observed to be declining in the southern portions of Saskatchewan's commercial forest (150 to 200 km south of the Terrestrial RSA). Between 2011 and 2017, six Wildlife Management Zones (WMZ; out of a total of 16 WMZs) were assessed and three zones (WMZ 56, 57 and 67) were found to have moose populations declining by up to 30% (SK MOE 2019a). Evidence also exists for similar trends across the remaining southern boreal forest WMZs. A combination of factors may be responsible for the observed declines, including habitat alteration and loss, disease, and parasites, as well as increased predation and hunting pressure due to increased density of linear developments (SK MOE 2019a).

These surveys did not cover the northern parts of the province, which include the Terrestrial RSA. However, Neufeld et al. (2021) studied an 87,193 km^2 area in the Saskatchewan Western Boreal Shield (encompassing the Terrestrial RSA in the north and extending to the west, east and south; extending roughly from 55.0° to 61.0°N and −96.9° to −108.6°W). This area comprises the Athabasca Plain and Churchill River Upland ecoregions, a region with low anthropogenic disturbances (0.18% of land cover was classified as an anthropogenic feature) and with a historically high fire-return interval (47% of stands were aged less than 40 years). They found that, despite the high levels of fire-related disturbance in the region, overall moose density was relatively low with 47 moose/1,000 km^2 and suggested that this low density might be reflective of the observed low abundance of deciduous or mixed-wood stands and lack of deciduous browse in the young conifer stands dominating the region (Neufeld et al. 2021).

Population Trends

Neufeld et al. (2021) summarized results from 16 aerial ungulate surveys over a period of eight years between 2008 and 2015. Thirteen of these surveys were designed to observe moose (in addition to caribou) in their study area and an average density of 45.7 moose/1,000 km^2 (37.8 to 53.6 moose/1,000 km^2) was estimated based on these surveys (Neufeld et al. 2021). These density estimates for moose are similar to the lowest reported moose populations in North America and are comparable to other northern boreal shield regions in Ontario (24 to 46 moose/1,000 km^2) (Neufeld et al. 2021). Two studies in 1988 and 1994 near Key Lake (approximately 30 km south of the Terrestrial RSA) reported similar low moose densities with 30 moose/1,000 km^2 and 20 moose/1,000 km^2, respectively (Neufeld et al. 2021). A potential reason for the low moose density could be the poorly productive shield ecosystem and successional dynamics both of which favour conifers at all seral stages with limited production of deciduous browse post-disturbance. Neufeld et al. (2021) observed that frequent fires did not improve available browse of willows and the best stand type for moose browse was mixed-wood stands (of any age), which were represented at 7.0% of the landscape of the study area.

Harvest

Moose are highly valued by subsistence and sport hunters, and they are an important cultural species for Indigenous people (SK MOE 2019a). Non-Saskatchewan residents are authorized to hunt for moose through outfitters, with the province making approximately 300 guided moose licenses available each year. Indigenous subsistence harvest numbers for moose are not available because this harvest information is collected (and reported) through communities and Indigenous groups.

Table 9.3-3 provides an overview of the estimated annual resident moose harvest through regular and draw licences between 2016 and 2020 for the entire province (SK MOE 2021). Reporting of harvest estimates through resident draw licences was changed in 2017; prior to 2017, no summary results were provided. Prior to 2016, no regular moose licences were issued, and the total moose harvest was estimated based on draw licences (SK MOE 2021).

Table 9.3-3: 2016 to 2020 Annual Resident Moose Harvest through Regular and Draw Licences (SK MOE 2021)

Year	Licence Type	Licences Sold	Hunter Surveys Completed	Harvest Success	Estimated Total Harvest	Estimated Adult Males	Estimated Adult Females	Estimated Young of the Year	Total Estimated Resident Harvest[1]
2016	Resident Regular	7,221	1,635	14%	954	950	0	0	5,233
	Resident Draw	N/A	N/A	N/A	4,279	N/A	N/A	N/A	
2017	Resident Regular	6,594	1,720	14%	882	882	0	0	4,961
	Resident Draw	5,319	1,935	78%	4,079	1,886	1,747	451	
2018	Resident Regular	4,968	1,155	17%	783	783	0	0	2,682
	Resident Draw	4,842	1,662	79%	3,742	1,899	1,427	417	
2019	Resident Regular	4,941	1,065	23%	1,067	1,058	9	0	4,865
	Veteran Regular[2]	114	39	14%	9	9	0	0	
	Resident Draw	4,731	1,388	81%	3,798	1,971	1,458	369	
2020	Resident Regular	6,287	3,240	21%	1,201	1,188	8	6	4,883
	Veteran Regular[2]	140	80	16%	12	12	0	0	
	Resident Draw	4,499	2,882	83%	3,670	1,928	1,372	370	

1 The total estimated resident harvest numbers did not add up in the harvest report (SK MOE 2021).

2 Veteran regular harvest was only reported for 2019. Veterans are defined as Saskatchewan residents or Canadian residents who are former members of the Canadian Armed Forces, have successfully underwent basic training, and have been honourably discharged. Veteran licences are free of charge (SK MOE 2020).

Based on 2016 to 2020 harvest reports (SK MOE 2021), the average annual moose harvest by resident hunters for the entire province of Saskatchewan was 4,525 moose. Bulls comprised the highest percentage of the reported harvest, followed by females, and calves represented the smallest percentage (and were only harvested through the draw licences; Table 9.3-3). Draw licence sales and associated moose harvest estimates are further refined in the annual reports by WMZ. The Project is located in WMZ 75, while WMZ 73, 74, and 76 are adjoining WMZ 75 (Figure 9.3-6). Between 2014 and 2020 (the years for which data are available), no draw licences were sold for any of these WMZ and, therefore, no associated harvest was reported to have occurred in the area (SK MOE 2021). While this breakdown to WMZ harvest numbers is not available for resident regular licences, it is assumed that most of the annual harvest through resident regular licences occurred in the southern part of the province.

Starting in 2020, the province made it mandatory to complete and submit a hunter harvest survey to better and more accurately calculate harvest success from the number of moose (or other species) harvested per hunter (SK MOE 2021). The province uses hunter harvest success in combination with other information sources, including aerial surveys, to assess population trends. In the boreal forest, hunter success is based on the availability of moose, road access (existing and new developments) and changes in moose behaviour in response to areas with high hunting pressure (avoidance behaviour). Results from the 2020 hunting season were not available for inclusion in this EIS.

Chronic Wasting Disease

Chronic wasting disease (CWD) is an infectious, fatal disease in farmed and wild cervids, such as deer, elk, reindeer (and possibly caribou), and moose, affecting the central nervous system. It has not been shown to affect humans, but the possibility of infection cannot be excluded (SK Ministry of Agriculture 2021a). The disease has been confirmed in Saskatchewan and is monitored through tissue sample collections (i.e., the hunter surveillance program). It was first detected in the province in a farmed cervid in 1996 and in wild cervids in 2000. Since then, CWD has been detected in wild cervids throughout most of the western and central portions of the province (SK Ministry of Agriculture 2021a). Testing is limited and CWD may also be present in other areas. No positive cases have been reported for the Terrestrial RSA. In the 2020 / 2021 CWD survey, out of 3,000 hunter submissions, 466 positive cases were detected, including 335 mule deer (*Odocoileus hemionus*), 121 white-tailed deer (*Odocoileus virginianus*), 5 elk (*Cervus canadensis*), and 5 moose. Based on the results since monitoring started in 1997, CWD is currently considered endemic across southern Saskatchewan, south of the boreal forest.

The five infected moose in 2020 / 2021 were collected through samples submitted by the hunter surveillance program. One additional positive case (not counted in the survey) was a moose seized by conservation officers and another sample (not included in the survey results) was from a moose carcass (SK Ministry of Agriculture 2021a). To date, most infected moose were from areas south of the boreal forest, where the disease is prevalent in mule deer populations and are described as spillover cases from infected deer. Therefore, CWD is not considered to be established in Saskatchewan moose populations (SK Ministry of Agriculture 2021a).

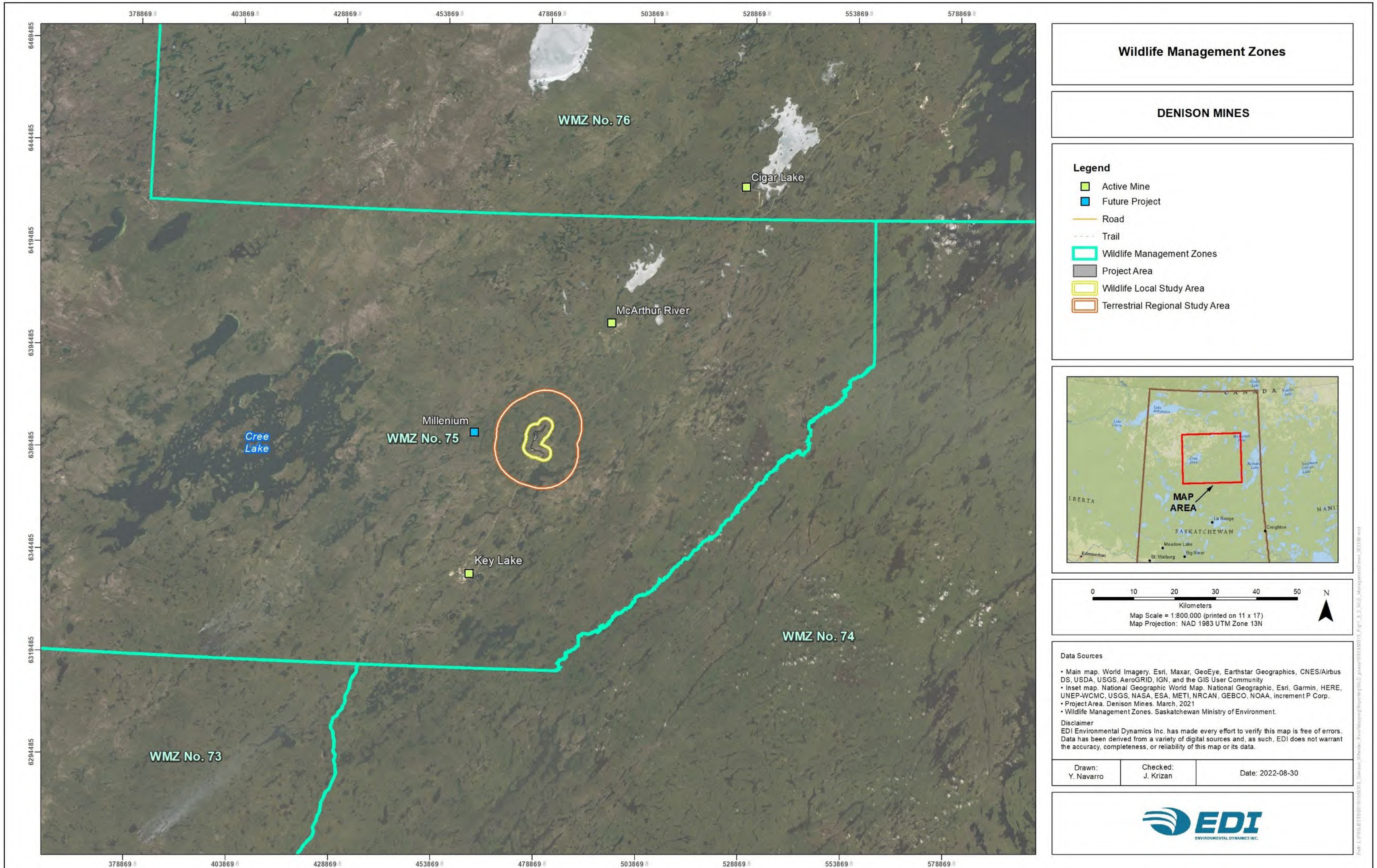

Figure 9.3-6: Wildlife Management Zones

9.3.3.1.2 Information from Indigenous Knowledge, Local Knowledge, and Engagement

Indigenous Knowledge on moose in the region is provided in the following text. This information also includes LK and information from engagement.

Engagement Database

Knowledge holders confirmed that moose occupy the English River Traditional Territory and may occur in the Terrestrial RSA; however, it was noted that less moose occur now than in prior years (19-LK-ERFNTrap-134.149; 19-LK-ERFNTrap-134.237) and moose are now less abundant than caribou in the area (19-LK-ERFNTrap-134.149). The area to the north of the Terrestrial RSA provides generally better habitat for moose than the Wildlife LSA or the Project Area (19-LK-ERFNTrap-134.149). The area east and north of Three Mile Lake (in the northern portion of the Terrestrial RSA) was pointed out as having moose (19-LK-ERFNTrap-134.149) (Appendix 9-B - Omnia winter tracking transects #11 and 4 – Omnia Terrestrial Baseline Report, Figure 2.5-1).

Moose are reported to calve close to the Wheeler River, with lots of muskeg in the area (16-EN-ERFN-100.15). Moose have been observed to feed on lichen and lowbush cranberries (18-EN-ERFN-5.76) and they also eat the tips of fresh growth off the younger pine trees, particularly in years with deep snow and/or crusts on the snow (19-LK-ERFNTrap-134.155). The observation that there are less moose in the area than before might be caused by moose moving south, which could possibly be a result of a natural change (19-LK-ERFNTrap-134.149): "… *He sees more caribou and less moose. He believes this is a natural change and moose are moving further south."*

English River First Nation members stated that they have seen wolf tracks when on hunting trips, and they assume that the wolves are there because they hunt caribou in the green (i.e., unburned) areas. They are not concerned about the wolves because they mostly rely on moose for their harvest (21-EN-ERFN-473.12). For the ERFN, moose are important, and they are worried how their population might be affected by the Project (21-EN-ERFN-473.13), especially since they have been observing that moose are slowly returning to the previously burnt areas (21-EN-ERFN-473.24).

Concerns were voiced over possible increased fishing and hunting pressure stemming from more people accessing the area due to the mine being developed (20-LK-LEASESUR-267.67). Concerns also include that traditional land users and wildlife will be disturbed by the development (21-EN-SUR-446.68). Challenges brought on by the Project may include *"… the impact of mining on the natural habitat and the displacement of the animals that currently inhabit the proposed site*" (21-EN-SUR-446.69).

English River First Nation and Shared Valued Solutions: Wheeler River Project – Summary of Traditional Knowledge Study Results

English River First Nation and Shared Value Solutions (2022) compiled an IK study documenting current and past land use, knowledge of the land, and participants' perspectives on potential Project effects, as well as cumulative effects from past mining and other developments.

The ERFN IK study identified a wildlife corridor used by several species, including moose. The corridor runs between Cree Lake (outside and to the west of the Terrestrial RSA and Russel Lake (in the southern portion of the Terrestrial RSA (Feature 1001-09; ERFN and SVS 2022). The report also identified a moose calving area in the Terrestrial RSA, southwest of the Project Area (Feature 1001-08; ERFN and SVS 2022).

The study also indicated that a variety of changes have occurred along the Key Lake Road where mining activity is concentrated (i.e., along the northern portion of the road, south of the RSA) and that there is concern about potential future development continuing this trend. Features of concern were identified, including the following (ERFN and SVS 2022):

- 1001-22 (changes to access through roads) – more people are accessing Cree Lake via existing winter roads and quad trails. There is a concern that more people may find out about this access and will start using it to access Cree Lake.
- 1001-23 (changes to access through roads) – concern about declining moose population from an influx of hunters; more people may be accessing the area year after year.
- 1014-26 (changes to animal/plant health or population through roads) - increased presence of human population has led to decline in moose population.
- 1004-17 (changes to access through roads) – more people are being given access (e.g., through recreational leases) to the land to harvest and fish, leading to more offroad vehicle and boat use in the area.
- 1006-15 (changes to access through roads) – since Key Lake Road was built in the late 1970s more people have been observed accessing the land.

9.3.3.1.3 Baseline Studies

Moose were documented in the Wildlife LSA and Terrestrial RSA during terrestrial baseline surveys conducted in 2017 through 2019 (Appendix 9-B). Moose presence was recorded by either moose sign (i.e., tracks, pellets, and evidence of feeding activity based on browse activity) or photographs, collected through a wildlife camera study.

Winter Track Count Surveys / Spring Ungulate Pellet Group Survey

During the 2017 and 2018 winter track surveys, moose trails were observed in both years on transects located in 4 of 20 surveyed ecosites, including transects with existing anthropogenic disturbances. Moose trails were observed in BS17 (black spruce treed bog), BS18 (Labrador tea shrubby bog), road/anthropogenic (polygonal and linear disturbance) and RF2 (regenerating forest – tall shrub dominated)[28] ecosites. Trail densities were highest in RF2 (regenerating forest – tall

[28] Note that for this EIS, Omnia's novel regenerating forest types RF1, RF2, and RF3 were reclassified consistent with the provincial ecosite classification of BS3 (jack pine - blueberry/lichen) and BS7 (black spruce - blueberry/lichen) when assessing residual effects of the Project (explained in Section 9.3.6).

shrub dominated) ecosites during 2017 surveys and in BS17 (black spruce treed bog) ecosites during 2018 surveys (Appendix 9-B).

In 2017 and 2018, moose winter pellet groups were detected in four ecosites and summer pellet groups were detected in three ecosites. Moose winter and summer pellet groups were detected most frequently along creeks in the survey areas with different creeks represented in the winter and summer surveys. Independent of the season, no moose pellet groups were observed along transects with existing anthropogenic disturbances (Appendix 9-B). Winter pellet groups were observed in BS7 (black spruce/blueberry/lichen), RF2 (regenerating forest – tall shrub dominated), RF3 (regenerating forest - low shrub dominated), and RF1 (regenerating forest – tree dominated) ecosites. The highest mean winter pellet group density was detected in the BS7 (black spruce/blueberry/lichen) ecosite.

In 2017 and 2018, summer pellet groups were detected in BS16 (black spruce/balsam poplar/river alder swamp), RF2 (regenerating forest – tall shrub dominated), and RF1 (regenerating forest – tree dominated) ecosites. The highest mean summer pellet group density was detected in the BS16 (black spruce/balsam poplar/river alder swamp) ecosite (Appendix 9-B).

Wildlife Camera Study

Wildlife camera locations were spread across three categories of linear features in mature and regenerating forest types: road (a maintained or seasonally accessible road supporting traffic), trail/rough road (a cleared disturbance over two m in width), and hand-cut line (a cleared disturbance under 2 m in width) (Appendix 9-B). Trails/rough roads and roads had the highest frequency of wildlife detection rates during that program. Moose were less frequently observed than other species (e.g., snowshoe hare [*Lepus americanus*] and woodland caribou) and they were only observed on two categories of linear features: trails and hand-cut lines.

Browse Availability Survey

The availability and use of nine species or species groups of woody browse were studied in the Wildlife LSA and Terrestrial RSA (Appendix 9-B). The most encountered species were alder (*Alnus spp*.), willow (*Salix spp*.), and sweet gale (*Myrica gale*). Alder was observed in 45% of the ecosites surveyed, sweet gale in 65%, and willow in 80%. Alder, sweet gale, and willow were also the only woody species observed to be browsed, with willow having the highest frequency of browse at 2% (of available willows), and both alder and sweet gale browsed less than 1% each. Browse was observed in the BS3 (jack pine/blueberry/lichen), BS16 (black spruce/balsam poplar/river alder swamp), BS22 (leatherleaf shrubby poor fen), RF3 (regenerating forest - low shrub dominated), and RF2 (regenerating forest – tall shrub dominated) ecosites (Appendix 9-B).

In summary, while the baseline studies were not designed to establish habitat selection or relative abundance estimates, they confirmed the presence of moose and, with that, the availability of suitable habitat in the Wildlife LSA and Terrestrial RSA. The surveys showed that moose occurred across the Terrestrial RSA, but more sign was observed in regenerating forest—tall shrub dominated and black spruce treed bog ecosites as well as along transects in riparian habitats.

9.3.3.2 Furbearers

To represent terrestrial, semi-aquatic, and aquatic species, as well as species at risk, the Furbearers VC consists of four KIs: wolverine, pine marten, mink, and muskrat. Therefore, this section describes the existing environment for these four species in the Wildlife LSA and Terrestrial RSA. Table 9.3-4 provides a summary of the federal and provincial species status for the four KI species.

Table 9.3-4: Status of Key Indicator Species of the Furbearers Valued Component

Species	SARA[1]	COSEWIC[2,3]	Saskatchewan[4]
Wolverine	Special Concern	Special Concern	S2 – Imperiled/Very Rare: at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats, or other factors.
Pine marten	Not listed	Not listed	S4 - Apparently Secure: uncommon but not rare; some cause for long-term concern due to declines or other factors.
Mink	Not listed	Not listed	S5 – Secure/Common: demonstrably secure under present conditions; widespread and abundant; low threat level.
Muskrat	Not listed	Not listed	S5– Secure/Common: demonstrably secure under present conditions; widespread and abundant; low threat level.

1 *Species at Risk Act* (SARA; ECCC 2021).

2 Committee on the Status of Endangered Wildlife in Canada (COSEWIC) 2014.

3 In May 2014, the Eastern and Western wolverine populations were considered as a single unit across the Canadian range (instead of the previous split int Eastern and Western populations).

4 Saskatchewan Conservation Data Centre (SK CDC) 2021.

9.3.3.2.1 Scientific Literature Review

Wolverine

Overview

Wolverine are the largest terrestrial members of the mustelid family and occur circumpolar in tundra, taiga, and forest zones. They are non-migratory and are active throughout the year during day and night. They frequently travel long distances, can climb trees, are good swimmers, and are adapted to hunting in deep snow (Siemens Worsely 2011). In Saskatchewan, wolverines are distributed across the northern ecoregions of the province, including the Athabasca Plain Ecoregion (Siemens Worsely 2011). The Wildlife LSA and Terrestrial RSA fall entirely within the Athabasca Plain Ecoregion of the Boreal Shield Ecozone.

Wolverine are listed on Schedule 1 of the federal SARA and by COSEWIC as Special Concern (ECCC 2021) and the SK CDC assigned the species a status of S2 (Imperiled/Very Rare: at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats, or other factors) (SK CDC 2021).

Habitat Requirements

Wolverine occupy large home ranges and, therefore, need vast tracts of undisturbed land to maintain viable populations. Suitable wolverine habitat is commonly defined trough a stable food supply rather than particular ecosites or vegetation communities (Siemens Worsely 2011). Habitat use was found to be dependent on prey availability, particularly carrion in winter, which is likely a factor limiting their populations. Wolverines are predators and scavengers, often caching food for future use. Therefore, their requirement for suitable habitat is based on a stable, year-round supply of food, mainly consisting of smaller prey species, such as rodents and hares, and carrion of large ungulates, such as moose and caribou (Siemens Worsely 2011, COSEWIC 2014).

Wolverine have specific habitat requirements for maternal den sites and successful dens may be reoccupied for several consecutive years (Siemens Worsely 2011). Females den under snow-covered rocks, logs or within snow tunnels. Dens require adequate insulating snow cover that persists throughout the denning natal period (between February and April) and adequate protection from predators such as golden eagles (*Aquila chrysaetos*), bears (*Ursus spp.*) and wolves (*Canis lupus*). In addition to natal dens, multiple dens may be used for rendezvous between female and kits later in the summer or as resting sites (Siemens Worsely 2011).

No wolverine habitat or population models were available for Saskatchewan. However, the Alberta Biodiversity Monitoring Institute modelled predicted wolverine abundance in a variety of vegetation and human footprint types in the forested region of Alberta (ABMI 2020a). The study resulted in the following predictions (for forested regions in Alberta):

- Relative abundance is generally low, and similar across forest stand and vegetation types.
- In young stands, relative abundance is affected more by forest harvest than natural disturbance.
- Wolverines are absent from most human footprint types (i.e., areas of human development and activities) with agriculture and urban/industrial footprints showing the largest reduction in abundance.
- Wolverines are negatively associated with (i.e., avoid) linear features.

Population Trends

Most females reach sexual maturity at two or three years of age, may reproduce annually, and produce, on average, two kits per litter (COSEWIC 2014). Wolverine home ranges extend over 50 to 400 km^2 for females and 230 to 1,580 km^2 for males. Wolverine densities are low across their range between 5 and 10 animals / 1,000 km^2 (COSEWIC 2014). In Saskatchewan, wolverine populations are not monitored. Based on incidental observations, harvest records, and available undisturbed habitat, it is believed that densities are lowest in the southern boreal forest zone of their range and increase further north in the province. In 2008, the total provincial population was roughly estimated at less than 1,000 animals (Siemens Worsely 2011).

Population Threats

Wolverine face mortality risks from predation and starvation as well as from anthropogenic sources, including harvest and vehicle collisions (Siemens Worsely 2011, COSEWIC 2014). Studies have identified forest fragmentation, habitat loss, trapping (even at low levels), and winter food availability as potential threats to their population (ABMI 2020a). Wolverines are believed to be vulnerable to climate change because females are dependent on a deep snowpack to build their dens.

Observed fluctuations in harvest effort and associated uncertainties of long-term harvest levels, as well as increased access and efficiency of hunting, could result in a reduction of accuracy in documenting population size and trends and in subsequent local overharvest (COSEWIC 2014). Transportation corridors, forestry, oil and gas and mineral exploration and development, and hydroelectric developments have the potential to increase access for harvest and contribute to additional mortalities and loss of functional habitat (COSEWIC 2014).

Similar to other Canadian jurisdictions, in Saskatchewan, the potential threats to wolverines include new and existing road corridors, overharvesting, and recreational activities. However, none of these threats are currently considered to affect the population (Siemens Worsely 2011). Due to the low human density of northern regions, roads and harvest are considered minor threats. Denning females are sensitive to disturbance during denning season in February to April and may abandon their dens and, in some cases, their litter, which may decrease their reproductive success. Recreational activities, such as snowmobiling and back-country skiing, may therefore affect the reproductive success of wolverine through den disturbance. Recreation activities are more widespread in the southern extent of the Saskatchewan wolverine range, and it is believed that they play a minor role in the northern portion of the province (e.g., in the Athabasca Plain Ecoregion) with the overall threat stemming from recreation considered to be low (Siemens Worsely 2011).

Harvest and Protection

In Saskatchewan, no specific habitat is designated or protected as critical or important for wolverine. Continued protection comes through the vast areas of undeveloped land, which offer the population refuge from most harvesting and development activities (Siemens Worsely 2011). Wolverine harvest is regulated in Saskatchewan with the possibility to set quotas or close trapping seasons if conservation concerns should arise (Siemens Worsely 2011). To trap wolverines on unoccupied Crown land in central and northern Saskatchewan, Northern Fur Conservation Area members need to purchase an annual licence (SK MOE 2021).

Pine Marten

Overview

Pine marten are members of the mustelid family and are associated with mature, coniferous, and mixed wood forests throughout the northern boreal forest in Saskatchewan (SK MOE 2019b). They are not considered a Species at Risk and are, therefore, not listed federally or provincially (Table 9.3-4).

Except during the mating season (between June and August), marten are solitary. Age of maturity is reached at one year, but marten typically do not reproduce until they are two or three years old. Males may breed with more than one female and an average of three kits are born in late March to early April in maternity dens where they are protected against predators, such as carnivores and raptors (Environment Canada 2013).

Marten territories are known to be variable in size, determined by several factors (Buskirk and McDonald 1989). In North America, studies have shown that male territories average between 2 and 10 km^2 and males defend their territories against other males but tolerate multiple female territories in or intersecting with their territories. Female territories are typically smaller, averaging 2 to 5 km^2 (Buskirk and McDonald 1989).

As opportunistic feeders, the pine marten diet includes small mammals, birds, fruit, nuts, insects, and carrion, with their main food source across North America being red-backed voles (*Clethrionomys gapperi*). In 2016, red-backed voles were found to be the most frequently captured small mammal species in the Wildlife LSA and Terrestrial RSA (Appendix 9-B).

Population Trends

Saskatchewan assesses pine marten status using harvest reports (associated with the permitted export of fur) as a measure of population trends (SK MOE 2019b). With this method, a healthy marten population is indicated when harvest numbers track the market price, which is typically established after the annual trapping effort. In a healthy marten population, the following year harvest will typically trail market trends, such that high market values in one year result in higher harvest numbers the following year (SK MOE 2019b). This harvest trend assessment indicated that the marten population has remained consistent over the last decade with a suitable amount of mature forest in the Saskatchewan marten range (SK MOE 2019b).

Habitat Requirements and Population Threats

Pine marten are a forest-dependent species because most of their required resources are distributed within forested environments. They achieve maximum population densities when their prey, such as rodents, squirrels, and birds, are abundant and they may abandon reproduction when food resources are scarce (Environment Canada 2013). Their low reproductive rate combined with their dependence on forest habitats likely limit their ability to respond to improved habitat conditions with increased reproduction rates (Environment Canada 2013).

Marten populations are more stable in mature forests away from road access; however, their populations can be maintained in harvested forests that maintain the amount of coarse woody debris, standing dead wood, and living trees required by the species (SK MOE 2019, Natural Resources Canada 2020). If marten habitat requirements are not considered, timber harvesting activities can cause marten populations to collapse. Currently, there is no indication that timber harvesting activities in Saskatchewan are adversely affecting provincial marten population levels (SK MOE 2019b).

Several studies in Ontario found that mature forests provide the most favourable habitat for marten survival within the boreal forest range. Populations were found to also persist at lower levels in mature, regenerating forests, but only if trapping was controlled. Marten seemed to be more susceptible to trapping in managed forests compared to mature, unmanaged forests, which might be partially explained by different densities of road networks that provide increased access to trappers. The authors concluded that viable populations of pine marten will exist when both fur harvesting and timber harvesting are managed together (Natural Resources Canada 2020).

No pine marten habitat or population models were available for Saskatchewan. However, the Alberta Biodiversity Monitoring Institute modelled predicted pine marten abundance in a variety of vegetation and human footprint types in the forested region of Alberta (ABMI 2020b). The study resulted in the following predictions (for forested regions in Alberta):

- Pine marten relative abundance is similar across all forest stand types and treed fen and treed swamp vegetation types.
- Pine marten relative abundance is lower in harvested stands than in naturally disturbed stands of similar age.
- Pine marten relative abundance is predicted to be lower in all human footprint categories compared to vegetated habitat types.
- The largest predicted negative effects occur in agriculture and urban/industrial footprints.

The Saskatchewan Ministry of Environment (SK MOE) recently included a survey requesting trappers to assess populations of marten (and all other furbearers) in their area in the online hunter harvest survey, which will provide wildlife managers with a second metric of marten population trends in the future (SK MOE 2021). Based on regional fur harvest returns, pine marten are the most harvested furbearer species for which records are kept, indicating that this species contributes to the economy in Fur Conservation Area (FCA) N-18 (Cree Lake), which includes the Terrestrial RSA (Figure 9.3-7).

Mink

Overview

Mink are semi-aquatic predators occurring in vegetated habitat near water, such as along streams, ponds and lakes, and marsh edges throughout Canada. They are not considered a Species at Risk and are not listed federally or provincially (Table 9.3-4). Mink are excellent swimmers and can hunt in water and on land (Searing 1979). While they are primarily nocturnal, they have been observed to be active during the day.

Their primary habitat requirements are the presence of an abundant food supply and adequate denning sites (Searing 1979). Mink are opportunistic predators whose food habits vary widely within their geographic range. Seasonal and geographic differences are known to be caused by differences in prey availability. Fluctuations in prey density may be a factor in large population fluctuations observed in mink populations (Searing 1979). Studies in North America found that seasonal or annual diets are typically composed of small mammals, waterfowl, fish, amphibians, and aquatic invertebrates. In some areas, muskrats are the primary prey species; muskrats are particularly vulnerable to mink predation under conditions of drought or over-population (Searing 1979). Mink den close to water bodies with gently sloped banks and often use existing beaver or muskrat burrows as dens.

Habitat Requirements

In Canada, mink select for riparian areas in coniferous and deciduous forests and are found occasionally in grassland habitats in proximity to aquatic habitat such as streams and wetlands (ABMI 2020c). Habitat studies from Saskatchewan were not available, but studies from Alberta presented more information on preferred mink habitat.

A habitat model based on actual observations in Alberta provided a coarse index of mink habitat use comparing the proportion of detections in each habitat type (i.e., native vegetation and human footprint habitat types) relative to the proportional availability of the habitat types (ABMI 2020c). The results of the model showed a strong positive association of mink detections with three habitat types: swamp, non-treed bog fen, and marsh (i.e., mink were consistently observed). Deciduous and black spruce habitat types were somewhat avoided, and all other habitat types were strongly avoided. They included mixed wood, pine, white spruce, grass, and shrub habitat types as well as forestry, crop, tame pasture, rough pasture, urban / industrial, and linear infrastructure human footprint types (ABMI 2020c). The results of the study suggest that, based on the included habitat types, mink select for wet habitat types and may be found on occasion in forested habitat types associated with wet environments but strongly avoid dryer forests, grasslands, and any type of human activity or development (ABMI 2020c).

Population Trends

Population fluctuations have been observed in mink populations across their range, which are likely based on fluctuations in density of their prey and supported by their relatively high reproductive rate (Searing 1979). Mink do not form pair bonds but are promiscuous and are among the only mammals mating in spring allowing pregnant females to adjust to existing environmental conditions closer to the time of giving birth (Feldhamer et al. 2003). After a gestation period of 40 to 75 days, the kits are born from April to June, in litters consisting of four kits on average. Sexual maturity is attained during the next spring, when the kits are about 10 months old (Feldhamer et al. 2003). Mink density or abundance numbers are unknown for most of their range (including in Saskatchewan), but fur harvest returns provided in the Terrestrial Baseline Report (Appendix 9-B) indicated a stable population in and around the Terrestrial RSA for the past 30 years (described in Section 9.3.3.2.3).

Population Threats

Mink have few natural predators, but are hunted by great horned owls (*Bubo virginianus*), red foxes (*Vulpes vulpes*), coyotes (*Canis latrans*), wolves, and black bears (*Ursus americanus*).

Based on regional fur harvest returns, mink are among the most harvested furbearers in Saskatchewan, indicating that this species contributes to the economy in FCA N-18 (Appendix 9-B).

Mink are one of several furbearers allowed to be farmed in Saskatchewan for pelts, fur products, and breeding stock for other farms. Fur farming is a licenced industry in Saskatchewan (SK Ministry of Agriculture 2021b). Annual licences are required from the Ministry of Agriculture to establish or operate strictly regulated fur farms or trade in fur farmed animals or fur products. Other furbearers are allowed to be farmed as well, but it is unlikely that farms for those species exist.

<u>**Muskrat**</u>

Overview

Muskrat, the largest members of the vole family, are aquatic specialists occupying ponds and wetlands across North America. They are fully functional on land and in water and are efficient swimmers and divers, capable of remaining submerged up to 15 minutes (Feldhamer et al. 2003). Because they spend most of their life in an aquatic environment, the animals possess a poor sense of sight, hearing, and smell. Muskrats are not considered a Species at Risk and are not listed federally or provincially (Table 9.3-4).

Habitat Requirements

Muskrat are associated with aquatic habitats, typically occupying freshwater marshes, marshy areas of lakes, and slow-moving streams with water depths between 1 and 2 m. With these depth requirements, muskrats will select for water bodies that do not freeze to the bottom during the winter but are shallow enough to support growth of aquatic vegetation.

Muskrat prefer areas with bulrushes (*Scirpus spp*.), cattails (*Typha spp*.), pondweeds (*Potamageton spp*.), sedges (*Carex spp*.), or horsetails (*Equiesetum spp*.) (Feldhamer et al. 2003). They feed on these vegetation species and use them as building material for construction of lodges and feeding stations. If vegetation is unavailable, they may consume fish, frogs, clams, crayfish, or cultivated crops. During winter, muskrat build push-ups (smaller lodges) through the ice, providing the animals with a place to eat and rest (Feldhamer et al. 2003)

When the right vegetation is sparse or absent, muskrats dig burrows in firm banks of lakes, ponds, or slow-moving streams. Extended burrow systems in banks and lodges surrounded by water serve as escape routes from predators (e.g., minks) and provide shelter from the weather and waves (Feldhamer et al. 2003).

Muskrat habitat studies from Saskatchewan were not available, but studies from Alberta presented information on preferred muskrat habitat. A habitat model based on actual observations in Alberta provided a coarse index of muskrat habitat use comparing the proportion of detections in each habitat type (i.e., native vegetation and human footprint habitat types) relative to the proportional availability of the habitat types (ABMI 2020d). The results of the model showed a strong positive association with the following habitat and human footprint types: pine, white spruce, swamp, grass, shrub, non-treed bog fen, and marsh (ABMI 2020d). Muskrats showed a moderately negative association with urban/industrial habitat and avoided deciduous, mixed wood, black spruce, forestry, crop, tame pasture, rough pasture, and linear infrastructure habitat and human footprint types (ABMI 2020d). However, no open water habitats (e.g., ponds, lakes, and streams) were included in the surveyed habitat types.

Population Trends

Muskrat start breeding as soon as the ice breaks up; they breed multiple times each year and may have three litters during the summer months with 5 to 10 kits per litter (Canadian Wildlife Federation 1986). They build their nests on tree stumps above the water surface.

Muskrat populations exhibit fluctuations in numbers with drastic decreases every 7 to 10 years. While these population crashes are often blamed on predators or on over-trapping, researchers believe that the health of individuals deteriorates with increasing population density, causing widespread mortality and reproductive failure (Canadian Wildlife Federation 1986). After a population decline, reproductive and mortality rates typically stabilize, leading to a renewed increase in muskrat densities.

Population Threats

Harvest

Muskrat, trapped for their fur, are the third most harvested species in the FCA N-18 (Cree Lake), which includes the Terrestrial RSA (Appendix 9-B). In addition to regular harvest activities, muskrats may be hunted for food (Section 9.3.3.2.2).

Predation

Mink often use the muskrat burrow systems and dig into muskrat lodges, where they can cause heavy mortality among juvenile muskrats (Canadian Wildlife Federation 1986). Northern pike (*Esox lucius*) also inhabit marshes and shallow water bodies and prey on muskrats.

Muskrat live in territorial family groups and older offspring must leave if the lodges or burrows are overcrowded. When leaving their family group in search of new habitat, and while moving on dry land, muskrats are subject to predation by raptors, wolves, coyotes, foxes, wolverines, fishers (*Pekania pennanti*), and lynx (*Lynx canadensis*) (Canadian Wildlife Federation 1986).

Environmental Conditions

Researchers documented that cold winters, heat and drought conditions, and floods can cause population declines in mink (Canadian Wildlife Federation 1986). Recent research suggests that the loss of a large wetland habitat in the Peace-Athabasca Delta is the primary cause for an observed decline in muskrat abundance at that location, and that this correlation can be applied across the muskrat's North American range (Ward and Gorelick 2018). The authors compared 46 years of data (from 1970 to 2016) on record of inundation and compared changes in the extent of wetland habitat with the survey records for muskrat abundance. Results showed that the declines in wetland habitat (driven by climate change and river regulation) and muskrat abundance were synchronous: temporarily inundated regions that provide muskrat habitat have diminished gradually over the past 46 years, while the muskrat population density (measured as houses/km^2) has also declined at the same rate (Ward and Gorelick 2018).

9.3.3.2.2 Information from Indigenous Knowledge, Local Knowledge, and Engagement

Indigenous Knowledge on furbearers in the region is provided in the following text. This information also includes LK and information from engagement.

Engagement Database

Knowledge holders confirmed that wolverines have been observed in the English River Traditional Territory occasionally. While they are not encountered regularly, no change in frequency of wolverine observations has occurred over the years (19-LK-ERFNTrap-134.162).

In recent years, pine marten have been more common compared to fisher. It was estimated that 90% or more of all observations of these two species are now marten, which is also reflected in the trapping results: "*In fact, last year Mr. John caught 90 marten and no fisher*" (19-LK-ERFNTrap-134.160). Marten are typically caught between November and April (19-LK-ERFNTrap-134.161).

In addition to wolverine and marten, lynx, beaver, and muskrat are trapped in the area. These three species are noted as not being as common now as they were in the past. In addition, they are not only harvested for their fur: "*Mr. John will consume small lynx, beaver and muskrat from his trapline…*" (19-LK-ERFNTrap-134.64).

Prey species for furbearers were described as well. In recent years, fewer snowshoe hare, grouse species, and ptarmigan were noted, while the number of squirrels seems higher now than in the past[29].

English River First Nation and Shared Valued Solutions: Wheeler River Project – Summary of Traditional Knowledge Study Results

English River First Nation and SVS (2022) compiled an IK study documenting current and past land use, knowledge of the land, and participants' perspectives on potential Project effects, as well as cumulative effects from past mining and other developments.

The ERFN IK study identified a wildlife corridor used by several species, including furbearer species, such as marten. The corridor runs between Cree Lake (outside and to the west of the Terrestrial RSA and Russel Lake (in the southern portion of the Terrestrial RSA (Feature 1001-09; ERFN and SVS 2022).

9.3.3.2.3 Baseline Studies

Winter Track Count Surveys

The 2017/2018 winter track count surveys were conducted to determine the presence/not-absence of winter-active animals, determine their relative abundance, and contribute to knowledge of habitat use of the species in the study areas (Appendix 9-B). Sampling intensity was 440 km-days in 2017 and 179 km-days in 2018 for the Terrestrial RSA. The trails of 13 different species/species group were detected during winter track count surveys across 15 ecosites, including those of pine marten and mink.

Pine marten trails were observed on all transect types over both years. The trails were detected in 58% of the ecosites surveyed and were most often observed in the BS3 (jack pine/blueberry/lichen), BS4 (jack pine – black spruce/feathermoss), and BS16 (0.58) (black spruce/balsam poplar/river alder swamp) ecosites during 2017 surveys (Appendix 9-B). In 2018, pine marten trails were detected most commonly in the BS4 (jack pine – black spruce/feathermoss), BS7 (black spruce/blueberry/feathermoss)[30], and RF2 (regenerating forest – tall shrub dominated) ecosites. The highest mean density of marten trails during both survey years was observed in the BS4 (0.83) (jack pine – black spruce/feathermoss) ecosite.

Mink trails were observed on all transect types over both years but most commonly on creek transects. Mink trails were detected in 65% of the ecosites surveyed but showed a marked

[29] 19-LK-ERFNTrap-134.165, 19-LK-ERFNTrap-134.166, 19-LK-ERFNTrap-134.167.

[30] Note that for this EIS, Omnia's novel regenerating forest types RF1, RF2, and RF3 were reclassified consistent with the provincial ecosite classification of BS3 (jack pine - blueberry/lichen) and BS7 (black spruce - blueberry/lichen) when assessing residual effects of the Project (explained in Section 9.3.6).

preference for BS17 (black spruce treed bog), BS21 (tamarack treed fen), and BS18 (Labrador tea shrubby bog) (Appendix 9-B).

Pine marten and mink scat were detected during ungulate pellet group surveys. Pine marten scat was detected in the BS3 (jack pine/blueberry/lichen) and mink scat was detected in the BS17 (black spruce treed bog) ecosites. No scat of these species was detected along the proposed access or existing anthropogenic transects (Appendix 9-B).

No wolverine sign was observed during the 2017 and 2018 surveys.

Semi-aquatic Furbearer Shoreline Surveys

Semi-aquatic furbearer shoreline surveys were completed in 2016 to study the occurrence and relative abundance of semi-aquatic furbearing mammals (including muskrat) and to provide spatial data on the distribution of semi-aquatic furbearer sign within the study areas (Appendix 9-B).

The surveys were completed along the shorelines of 6 creeks and 17 lakes/ponds in the Wildlife LSA and Terrestrial RSA and the locations of all observations along predetermined transects as well as incidental sightings were recorded. Muskrat sign was frequently observed in both the Wildlife LSA and Terrestrial RSA with 70% of the surveyed water bodies having muskrat sign. Observed signs of presence (in order of most to least common) included scat, territorial scent stations, and foraging platforms and/or sign of foraging (Appendix 9-B).

Fur Harvest Return

Fur harvest return information for 30 years was obtained and summarized for all species for FCA N-18 (Cree Lake), which includes the Terrestrial RSA (Figure 9.3-7; Appendix 9-B).

In FCA N-18, for the period 1985/1986 through 2017/2018, fur returns for the four representative Furbearer KIs were reported as follows: marten (4, 167), mink (2,761), muskrat (702), and wolverine (5). Pine marten, mink, and muskrat were the most harvested species of 16 species for which records were kept, indicating that these species contribute to the economy in FCA N-18.

While the dataset officially covered a period of 33 years, no harvest records were available for the years 2003/2004, 2006/2007, and 2007/2008. Therefore, Table 9.3-5 provides a summary of the 30-year harvest totals, averages (expressed as the mean) and minimum/maximum numbers reported. Annual harvest numbers for furbearers may not solely reflect species abundance in the area because they are also dependent on trapper effort and annual fur prices, which may fluctuate over time.

Table 9.3-5: Harvest Summary for Key Indicators of the Furbearer Valued Component (1985 / 1986 through 2017 / 2018) (Omnia 2020)

Species	Total Harvest	Mean Harvest[1]	Minimum/Maximum[1]	Years with > 0 Harvest
Wolverine	5	1.25 / year	1 / 2	5 / 30
Pine marten	4,167	138.90 / year	22 / 366	30 / 30
Mink	2,761	95.21 / year	7 / 454	29 / 30
Muskrat	702	63.82 / year	3 / 274	12 / 30

1 The values are for years that reported harvest numbers greater than 0.

In summary, while Omnia's (2020, included as Appendix 9-B) baseline studies were not designed to establish habitat selection or relative abundance estimates for species of the Furbearer VC, they confirmed the presence of pine marten, mink, and muskrat and, with that, the availability of suitable habitat in the Wildlife LSA and Terrestrial RSA. No indication of wolverine presence was detected during the baseline surveys (Appendix 9-B).

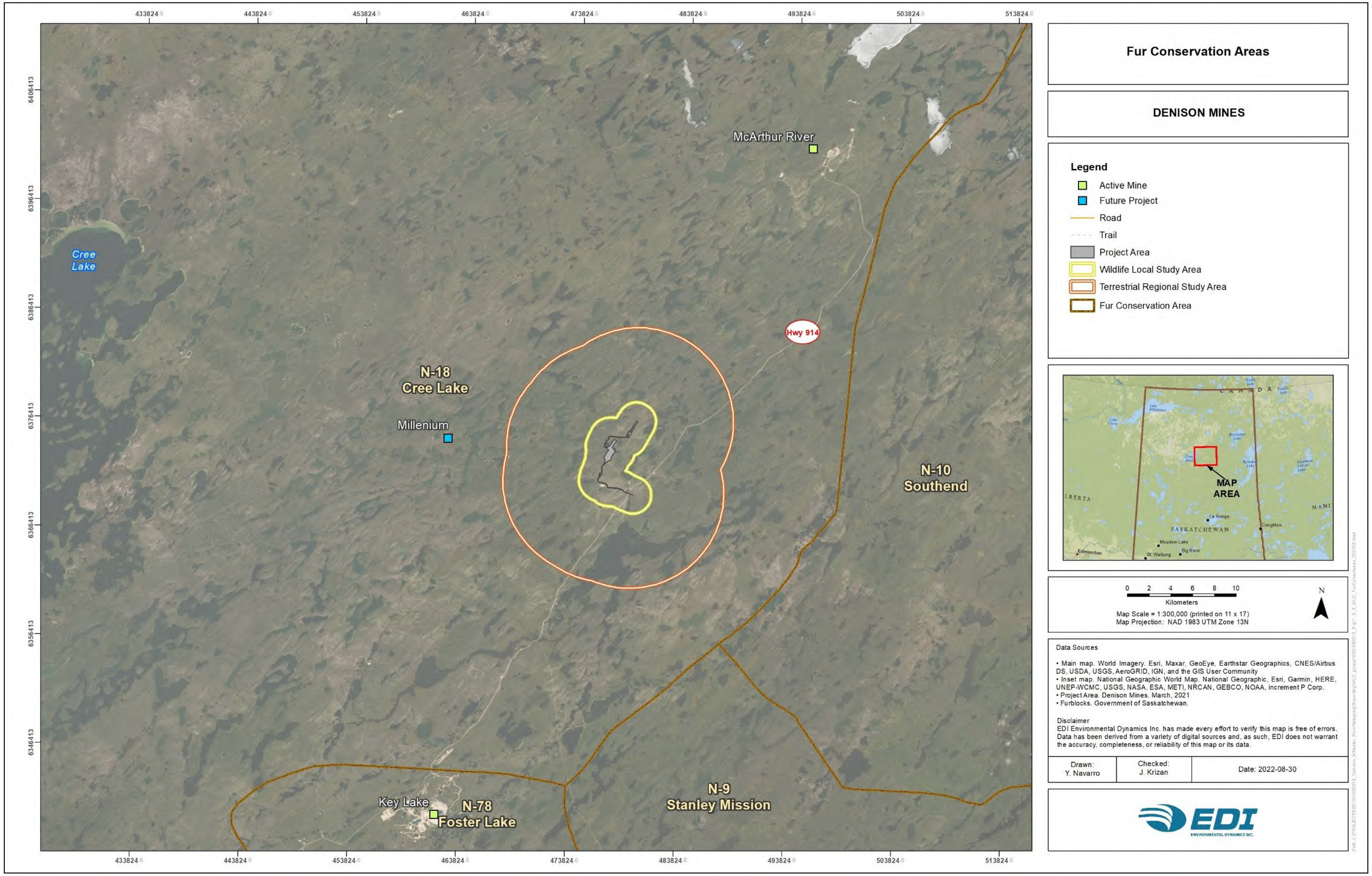

Figure 9.3-7: Fur Conservation Areas

9.3.3.3 Woodland Caribou

The Woodland Caribou VC is represented by one KI: woodland caribou. Therefore, this section describes the existing environment for woodland caribou in the Wildlife LSA and Terrestrial RSA.

9.3.3.3.1 Scientific Literature Review

Woodland caribou are listed under Schedule 1 of the federal SARA and by COSEWIC as Threatened (ECCC 2021) and the SK CDC assigned the species a status of S3 (Vulnerable/Rare to Uncommon: at moderate risk of extinction or extirpation due to a restricted range, relatively few populations, recent and widespread declines, threats, or other factors) in Saskatchewan (SK CDC 2021).

SK1 Boreal Shield Woodland Caribou Management Unit

The Project is located in the SK1 Boreal Shield Woodland Caribou Management Unit, which has low levels of anthropogenic disturbance and was exposed to large fire disturbances in the past 40 years (ECCC 2020) as described in Section 15 Effects of the Environment on the Project. Environment and Climate Change Canada (2020) identified the caribou population in the SK1 Boreal Shield range as the only population assessed as being self-sustaining at a threshold of 40% undisturbed habitat (in a range with predominantly fire disturbance). Based on this finding, it was recommended that total anthropogenic disturbance in the SK1 Boreal Shield range should not exceed 5% with the remainder being attributed to natural disturbance (while maintaining a minimum of 40% undisturbed habitat in the range). Woodland caribou populations in other Canadian jurisdictions are believed to be self-sustaining at a minimum of 65% of undisturbed habitat (ECCC 2020). The 40% undisturbed habitat across the SK1 Boreal Shield range was determined as the minimum threshold at which the local woodland caribou population has a probability of 71% of being self-sustaining. For these calculations, the disturbance footprints were measured as the combined effects of fires (having occurred in the past 40 years) and buffered (500 m) anthropogenic disturbances. Environment and Climate Change Canada (2020) suggested that this approach best represents the combined negative effects of increased predation and avoidance on caribou population trends.

Because of the uniqueness of the disturbance regime in the SK1 Boreal Shield range, a lower undisturbed habitat threshold has been identified by ECCC for this woodland caribou range.

The SK MOE (2019c) has developed a range plan for the SK2 Central Caribou Administration Unit (i.e., an area more than 200 km south of the Project) to facilitate effective landscape management in support of a self-sustaining woodland caribou population. No range information is currently available for the SK1 Boreal Shield range, and critical habitat has not yet been identified. Consultations for a range plan for the SK1 range are currently underway (SK MOE 2019c).

The SK1 Boreal Shield management unit contains high-quality conifer-dominated caribou habitat with greater than 40-year-old stands of jack pine and black spruce forests suitable for lichen colonization, black spruce swamps, and open muskegs supporting relatively high densities of caribou, at 36.9 caribou/1,000 km^2 or approximately 4,000 caribou across the SK1 Boreal Shield Woodland Caribou Management Unit (McLoughlin et al. 2019).

Research has shown that up to 70% of the year-round diet of caribou may consist of ground and arboreal lichens. If the quantity of available lichen forage is low, caribou can exist without relying entirely on lichens (McLoughlin et al. 2019). Due to their physiology, lichens are resilient to periods of drought and cold temperatures, but because of their slow growth rate, exhibit a slow recovery time after depletion and fire events. In the SK1 range, McLoughlin et al. (2019) found that stand types with the highest potential for adequate lichen biomass for caribou are jack pine and poorly drained black spruce sites.

McLoughlin et al. (2019) observed that, from 2014 to 2018, the caribou population exhibited a high average adult female survival rate and moderate recruitment (0.192 calves per cow in March), ranging from a low of 0.134 calves/cow in March 2016 to 0.244 calves/cow in March 2018. These demographic parameters led the authors to assess the SK1 Boreal Shield caribou population as being stable at the time of their study (McLoughlin et al. 2019).

While calving areas have not been documented within the SK1 range, it is recognized that caribou may use open fen and treed bog habitat types for calving during the spring/summer period. In Saskatchewan, caribou habitat used during the calving season in the SK2 range demonstrated a strong selection for treed muskegs, but avoidance of jack pine, mixed hardwood stands, and roads (Dyke 2008).

The location of woodland caribou observations from the baseline field program in relation to calving, foraging, and refuge habitat, based on information received from the SK MOE, is provided in Appendix 9-F.

Population Trends

Based on discussions with SK MOE and University of Saskatchewan, no recent caribou population data are publicly available for the RSA. However, it is understood that data have been collected and it has been confirmed that woodland caribou are present and use the habitat within the RSA (Pittoello 2021; McLoughlin 2021).

Neufeld et al. (2021) summarized results from aerial surveys over a period of eight years in an 87,193 km^2 study area in the Athabasca Plain and Churchill River Upland ecoregions including the Terrestrial RSA in the north (described in Section 9.3.3.1.1). During 11 of 16 aerial caribou surveys conducted between 2008 and 2015, woodland caribou were detected in the surveyed areas. The average density of the 16 surveys was estimated at 36.9 caribou/1,000 km^2) (95% CI = 26.7 to 47.2 caribou/1,000 km^2). Across the Neufeld et al. (2021) study area and all years, estimated caribou densities were higher in comparison to averages reported for most other boreal woodland caribou ranges in Canada (i.e., caribou density reported in other areas ranged 4.3 to 18.7/1,000 km^2) indicating that caribou can tolerate natural disturbance. One exception to the relatively high caribou densities in northern Saskatchewan was noted: the 2,285 km aerial survey for the Millennium Project in March 2014, 10 km west of the Terrestrial RSA, resulted in lower woodland caribou densities at 5 caribou/1,000 km^2 (Neufeld et al. 2021).

Eight of the sixteen caribou surveys reported the ratios of male to female and calf to female in their results with the average male:female ratio calculated at 0.571 (95% CI = 0.444 to 0.699) and calf:female at 0.195 (0.158 to 0.232). Again, the 2014 Millennium survey reported a different male:female ratio, outside the reported range (1.6), concurring with the reported low caribou densities.

Predation

In addition to relatively low predator densities in their study area, McLoughlin et al. (2019) found some spatial separation between caribou and wolves. Caribou did not seem to avoid existing linear features (such as roads, trails, and transmission lines) in the area, while wolves established their territories away from linear features. Unlike caribou, who preferred mature conifer stands, wolves selected for wetlands and patches of deciduous-mixed forest, avoiding stands of mature conifers. Other prey species, such as moose, also occurred at relatively low densities (i.e., 45.7 moose/1,000 km^2) (McLoughlin et al. 2019).

McLoughlin et al. (2019) observed that mortality of adult caribou occurred mostly during the snow-free season; however, mortality could not be confirmed for most of the caribou, with only the fate of 1 of 94 collared caribou confirmed in the four years of the study (which had been harvested by a hunter). Relatively low predator (e.g., wolf and black bear) densities in their study area were documented by McLoughlin et al. (2019), with other prey species (e.g., moose) also occurring at relatively low densities (i.e., 45.7 moose/1,000 km^2). While the effect on adult caribou survival by black bear is anticipated to be marginal compared to that by wolves, black bear may still be a predator of caribou calves and potentially a limiting factor to recruitment (McLoughlin et al. 2019).

McLoughlin et al. (2019) noted that there was spatial separation between caribou and wolves as well as black bear, although this was found to be variable amongst individuals. Caribou did not seem to avoid existing linear features (e.g., roads, trails, and transmission lines) in the area, while wolves established their territories away from linear features. Unlike caribou, who preferred mature conifer stands, wolves selected for wetlands and patches of deciduous-mixed-wood forest, avoiding stands of mature conifers. Black bears also used mixed-wood forests, particularly in the summer and fall, where they selected for jack pine stands <40 years old (McLoughlin et al. 2019). While predation is believed to be the limiting factor for woodland caribou, Neufeld et al. (2021) suggested that habitat- or disturbance-mediated apparent competition only plays a minor role in the Saskatchewan SK1 woodland caribou population. Habitat- or disturbance-mediated apparent competition occurs when natural (e.g., forest fires) and anthropogenic (e.g., human development or activities) disturbances increase the abundance of other ungulates, which in turn may increase predator densities, which then increases predation risk to caribou. Neufeld et al. (2021) concluded that Northern Shield and Taiga ecoregions are of low productivity where caribou may compete with only one ungulate species (i.e., moose); therefore, caribou and wolf dynamics do not follow general habitat- or disturbance-mediated apparent competition models.

Harvest

Indigenous peoples in Saskatchewan have an inherent right to harvest woodland caribou for subsistence purposes (SK MOE 2013). No other harvest of woodland caribou is currently permitted. Under provincial and federal recovery planning and effective species management, self-sustaining caribou populations will support long-term subsistence use of the species and protect treaty rights. Subsistence harvest levels are assumed to be low but actual numbers are not available because most communities or Indigenous groups are not collecting and/or publishing this information.

9.3.3.3.2 Information from Indigenous Knowledge, Local Knowledge, and Engagement

This section provides IK information from two sources: Denison's Engagement Database and Environment Canada's 2011 *Aboriginal Traditional Knowledge Study*.

Engagement Database

Indigenous Knowledge on caribou in the region is provided in the following text. This information also includes LK and information from engagement.

Knowledge holders confirmed that woodland caribou occupy the area and might be encountered in the Terrestrial RSA; more caribou than moose occur in the area (19-LK-ERFNTrap-134.149; 19-LK-ERFNTrap-134.151). Local trappers encounter caribou regularly at their traplines in winter and see them during summer (19-LK-ERFNTrap-134.151). They have not observed any changes in densities and suggest that the same number of caribou have been found in the area over the years (19 -LK-ERFNTrap-134.156).

Knowledge holders stated that the only type of caribou in the region are woodland caribou and barren-ground caribou (*Rangifer tarandus groenlandicus*) have not used the Terrestrial RSA for decades. "*Barren ground caribou were last seen in the north Cree Lake area around 1983. Mr. John believes they no longer come as far south because of the large fires that have burned across the north. He felt these fires may have created a barrier in search of food*" (19-LK-ERFNTrap-134.158).

Caribou are known to calve near the Wheeler River, which has lots of heavy muskeg in the area (16-EN-ERFN-100.15). Knowledge holders identified the area east of Highway 914 and northeast of Russell Lake, between Russell Lake and McDougall Lake (corresponding with Omnia winter tracking transects #5 and #9 [see Omnia Terrestrial Baseline Report, Figure 2.5-1]) as an area where caribou are commonly seen in the winter. "*There are tall trees here, some small hills with protected valley areas, and it seems sheltered. There is caribou moss in this area"* (19-LK-ERFNTrap-134.154).

Caribou are known to travel through areas of younger forest and burns to get to more preferred habitat types (19-LK-ERFNTrap-134.152), such as more mature forests and areas with abundant lichen growth. "*Caribou […] eat low bush cranberries and lichen; lichen takes many years to grow and recover*" (18-EN-ERFN-5.76). Caribou have been observed to use areas of younger forest stands with regenerating pine. In years with deep snow or when there is a hard crust on the snow, they may eat the tips of fresh growth off the younger pine trees (19-LK-ERFNTrap-134.155).

While woodland caribou densities may not have changed over the years (19-LK-ERFNTrap-134.156), the use of the area has changed since Highway 914 was built (19-LK-ERFNTrap-134.150). "*Caribou don't seem to be bothered by visual sightings of vehicles (smaller trucks) but seem to react to regular traffic of larger bigger vehicles and are sensitive to the vibrations*" (19-LK-ERFNTrap-134.150).

More cabins now occur in the area, which translates into more boat traffic on lakes due to anglers accessing the area for fishing (19-LK-ERFNTrap-134.24). More boat traffic on the lakes is associated with anglers cutting access trails to these lakes and access trails affect caribou through increased use of the trails by wolves who are now accessing these areas in search of prey (19-LK-ERFNTrap-134.24). "*Wolves travel on bush roads. Saw a pack of about 18 wolves recently*" (19-LK-ERFNTrap-134.159). In addition to the new access created for wolves, caribou also travel on bush roads. Local trappers often see caribou tracks on roads, trails, and hand-cut lines (19-LK-ERFNTrap-134.153). Caribou will also travel on lake ice in late winter when the snow is shallow and compacted (19-LK-ERFNTrap-134.157).

English River First Nation members stated that they have seen wolf tracks on hunting trips, and they assume that the wolves are there because they prey on caribou in the green (i.e., unburned) areas (21-EN-ERFN-473.12). One ERFN trapper did observe that wolves are using existing cutlines to access the area and hunt caribou. The number of cutlines in the area was described as being extensive and they would like to see more cutlines being reclaimed (21-LK-ERFNTrap-506.5). They feel that wolf populations are increasing, and they would like to see the wolf numbers reduced (21-LK-ERFNTrap-506.2; 21-LK-ERFNTrap-506.3). In terms of treatment types to reclaim cutlines, roads, or trails, it was pointed out that if trails are blocked to obstruct wildlife and human access, barriers should be high because animals may be able to jump over them (21-LK-ERFNTrap-506.4). It was suggested to construct one or two big mounds at the entrances of a linear feature and plant trees as well (21-LK-ERFNTrap-516.1).

It was pointed out that there are small pockets of caribou calving habitat that need to be considered in terms of Project disturbance (21-EN-ERFN-473.10; 21-EN-ERFN-473.11)[31]. It was mentioned that based on the Elders' experience it could take 35 years after natural disasters for the

[31] The referenced calving habitat is along Fox Lake Road, well outside the Terrestrial RSA and mitigation measures for the Project (Section 9.3.5) consider the elimination and reduction of the direct and indirect disturbance of caribou in sensitive habitat and during sensitive time periods (such as calving).

habitat to grow back. "*This land that Denison is on is pretty burnt except for some patches that are areas for caribou"* (*21-EN-ERFN-473.24)*.

Concerns were voiced over possible increased fishing and hunting pressure stemming from more people accessing the area due to the mine being developed (20-LK-LEASESUR-267.67). Concerns also include that traditional land users and wildlife will be disturbed by the development (21-EN-SUR-446.68). Challenges brought on by the Project may include "… *the impact of mining on the natural habitat and the displacement of the animals that currently inhabit the proposed site*" (21-EN-SUR-446.69).

English River First Nation and Shared Valued Solutions: Wheeler River Project – Summary of Traditional Knowledge Study Results

English River First Nation and SVS (2022) compiled an IK study documenting current and past land use, knowledge of the land, and participants' perspectives on potential Project effects, as well as cumulative effects from past mining and other developments.

The ERFN IK study identified a wildlife corridor used by several species, including woodland caribou. The corridor runs between Cree Lake (outside and to the west of the Terrestrial RSA and Russel Lake (in the southern portion of the Terrestrial RSA (Feature 1001-09; ERFN and SVS 2022). The reported also identified a caribou calving area: Feature 1009-07 covering large portions of the Terrestrial RSA with the exception of the most western, northern, and eastern extents. This area is also described as offering good caribou habitat year-round (ERFN and SVS 2022). Woodland caribou habitat that could possibly be exposed to noise disturbance and direct effects on lichen was described as Feature 1016-08 and covers most of the Terrestrial RSA with the exception to the most northern and western extents (ERFN and SVS 2022).

The study also indicated that a variety of changes have occurred along the Key Lake Road where mining activity is concentrated (i.e., along the northern portion of the road, south of the RSA) and that there is concern about potential future development continuing this trend. Features of concern were identified, including the following (ERFN and SVS 2022):

- 1001-22 (changes to access through roads) - more people are accessing Cree Lake via existing winter roads and quad trails. There is a concern that more people may find out about this access and will start using it to access Cree Lake.
- 1001-23 (changes to access through roads) - concern about declining caribou population from an influx of hunters; more people may be accessing the area year after year.
- 1004-17 (changes to access through roads) - more people are being given access (e.g., through recreational leases) to the land to harvest and fish, leading to more offroad vehicle and boat use in the area.
- 1006-15 (changes to access through roads) - since Key Lake Road was built in the late 1970s more people have been observed accessing the land.

Ya'thi Néné Lands and Resources Office - An Exploration of Recorded Athabasca Denesųłine Traditional Knowledge, Land Use, and Occupancy Study in the Vicinity of Denison Mines Wheeler River Project

The Ya'thi Néné Lands and Resources Office compiled a study of Athabasca Denesųłine IK in the vicinity of the Project. Knowledge providers stated that, based on observed tracks and caribou sightings, woodland caribou are known to be in area (including the Project Area, Wildlife LSA, and Terrestrial RSA). Athabasca Denesųłine provided information on barren-ground caribou in northeast Saskatchewan, well outside the Terrestrial RSA. Barren-ground caribou have historically been reported in the area, possibly close to the Terrestrial RSA.

English River First Nation's 2011 *Aboriginal Traditional Knowledge Study*

In September 2011, Environment Canada gathered Aboriginal Traditional Knowledge from Indigenous groups across Canada to support their recovery efforts of boreal woodland caribou (ERFN 2011). Each Indigenous group holds the copyright to their respective summary report compiled in Environment Canada's reports. Denison received approval from the ERFN to use the information compiled in the Environment Canada report for inclusion into this EIS (Participation and Funding Agreement between ERFN and Denison, dated March 30, 2021). The following text provides a summary of the report.

For the 2011 study compiled by Environment Canada, ten people were selected for interviews by ERFN, seven of them were elders and three lived off the land. Each interviewee agreed that low woodland caribou densities in the English River Traditional Territory were due to forest fires.

Habitat Use

Interviewees expressed their concerns about the Saskatchewan Government's "let it burn policy", which destroys valuable caribou habitat (ERFN 2011). It was stated that almost all of the northern part of the English River Traditional Territory is burnt, and the destroyed caribou habitat will take many years to regenerate.

Population Trends

Most interviewees stated that caribou lost their calving areas to fires and they moved elsewhere to have their calves. It is more difficult to find the caribou now (ERFN 2011).

Population Threats

Forest fires are considered the main threat to woodland caribou in the English River Traditional Territory. Predators pose a threat as well, but their presence never seemed to have affected the caribou population in the past. In addition, it was pointed out that industry (such as mining and exploration), tourism (in the summer), and hunting by other Indigenous groups may pose additional threats to the caribou population (ERFN 2011).

Traditional Practices

Interviewees explained that Dene from ERFN respect the land and all animals. The tradition to take only what is needed has been passed on through generations. English River First Nation use woodland caribou for food (along with fish, moose, and waterfowl) and the hides for clothing (ERFN 2011).

9.3.3.3.3 Baseline Studies

Woodland caribou were documented in the Wildlife LSA and Terrestrial RSA during the 2017 through 2019 terrestrial baseline surveys (Appendix 9-B). A total of 200 observations were made between 2017 and 2019 and recorded as either caribou sign (i.e., tracks, pellets, and evidence of feeding activity based on ground feeding craters and arboreal feeding evidence) or photographs (collected through the wildlife camera study) to document caribou presence in the LSA and RSA. Most observations occurred in the Terrestrial RSA, with observations concentrated in the north and southeast portions. Three observations occurred in the southeast portion of the Wildlife LSA, and no caribou sign was observed in the Project Area. Figure 9.3-8 provides an overview of caribou sign observed during the baseline studies, including incidental observations and telemetry point data within the terrestrial study areas. Of the 397 caribou observations that were documented, 221 caribou observations included seasonal information that was recorded. Of these, most were observed in the winter (n=194), with two observations in the spring, 11 observations in the summer, and 14 observations in the fall.

Winter Track Count Surveys / Spring Ungulate Pellet Group Survey

During the 2017 and 2018 winter track count surveys, woodland caribou trails were observed in six ecosites) in 2017 and no trails were detected in 2018. Of the observed trails in 2017, no woodland caribou trails occurred along road/anthropogenic, or creek transects, and all trails were recorded on transects in the BS3 (jack pine/blueberry/lichen), BS7 (black spruce/blueberry/lichen), BS9 (black spruce-jack pine/feathermoss), BS17 (black spruce treed bog), RF2 (regenerating forest – tall shrub dominated)[32] ecosites and on Water/Lake Ice. The highest mean density of caribou trails was observed in the BS9 (black spruce - jack pine/feathermoss) ecosite followed by BS7 (black spruce/blueberry/lichen) and BS17 (black spruce treed bog) (Appendix 9-B).

Woodland caribou pellet groups were observed in 2017 and 2018 in 25% (5 of 20) of the ecosites sampled. However, no woodland caribou pellet groups were observed along the proposed access or on transects with existing anthropogenic developments (Appendix 9-B). Winter pellet groups

[32] Note that for this EIS, Omnia's novel regenerating forest types RF1, RF2, and RF3 were reclassified consistent with the provincial ecosite classification of BS3 (jack pine - blueberry/lichen) and BS7 (black spruce - blueberry/lichen) when assessing residual effects of the Project (explained in Section 9.3.6).

were only detected in the BS3 (jack pine/blueberry/lichen) ecosite during the 2017 survey. In 2018, winter pellet groups were detected most frequently in the BS7 (black spruce/blueberry/lichen), BS3 (jack pine/blueberry/lichen), and BS17 (black spruce treed bog) ecosite. The highest mean density of winter pellet groups was detected in the BS7 (black spruce/blueberry/lichen) ecosite. Summer pellet groups were detected in the BS18 (Labrador tea shrubby bog) ecosite and no summer pellet groups were detected in 2018 (Appendix 9-B).

In 2017, woodland caribou feeding activity was recorded at five different locations. Four were ground feeding craters and one was evidence of arboreal feeding. All observations were within the BS3 (jack pine/blueberry/lichen) ecosite. The 2018 surveys detected 13 ground feeding craters/crater complexes and no evidence of arboreal feeding. Eight observations occurred in the BS3 (jack pine/blueberry/lichen) ecosite and five observations in the RF2 (regenerating forest – tall shrub dominated) ecosite (Appendix 9-B).

Wildlife Camera Study

Wildlife camera locations were spread across three categories of linear features in mature and regenerating forest types: road (a maintained or seasonally accessible road supporting traffic), trail/rough road (a cleared disturbance over 2 m in width), and hand-cut line (a cleared disturbance under 2 m in width) (Appendix 9-B). Trails/rough roads and roads had the highest frequency of wildlife detection, with woodland caribou being the second most commonly photographed species (after snowshoe hare). Of the 34 caribou observation events (for a total of 94 individuals) that were recorded, most were documented in the winter, with one observation event in the spring and one observation event in the summer. Seven data points had no date associated with the observations. Of the winter observation events that were documented, seven were located in the northern portion of the RSA and the remainder were located in the eastern portion of the RSA (Figure 9.3-8).

Browse Availability Survey

As an important resource for caribou populations, the abundance of terrestrial and arboreal lichen in the Wildlife LSA and Terrestrial RSA was surveyed in 2017 and 2018. Terrestrial lichen was observed in most of the vegetation cover types that were surveyed (except for BS23 [willow shrubby rich fens] and recent burns) and arboreal lichen occurred in 16 of 20 vegetation cover types surveyed during the baseline studies (Appendix 9-B). Terrestrial lichen was most abundant in ecosites BS3 (jack pine/blueberry/lichen), BS7 (black spruce/blueberry/lichen), and RF2 (regenerating forest – tall shrub dominated) ecosites. Terrestrial lichen was recorded in 96% of the Terrestrial RSA that was surveyed and occurred with a mean cover of 52%.

Arboreal lichen occurred in 80% (16 of 20) of the ecosites surveyed and were observed most frequently in the BS3 (jack pine/blueberry/lichen), BS7 (black spruce/blueberry/lichen), BS16 (black spruce/balsam poplar/river alder swamp), BS21 (tamarack treed fen), and BS23 (willow shrubby rich fen) ecosites. However, surveys were not distributed evenly across the ecosites, and results may not be accurate. Arboreal lichen was present at 55% of the Terrestrial RSA sample sites (Appendix 9-B).

In summary, while the baseline studies were not designed to establish habitat selection or relative abundance estimates, they confirmed the presence of caribou, and, with that, the availability of suitable habitat in the Wildlife LSA and Terrestrial RSA. Baseline studies also confirmed the presence of terrestrial and arboreal lichen across the study areas.

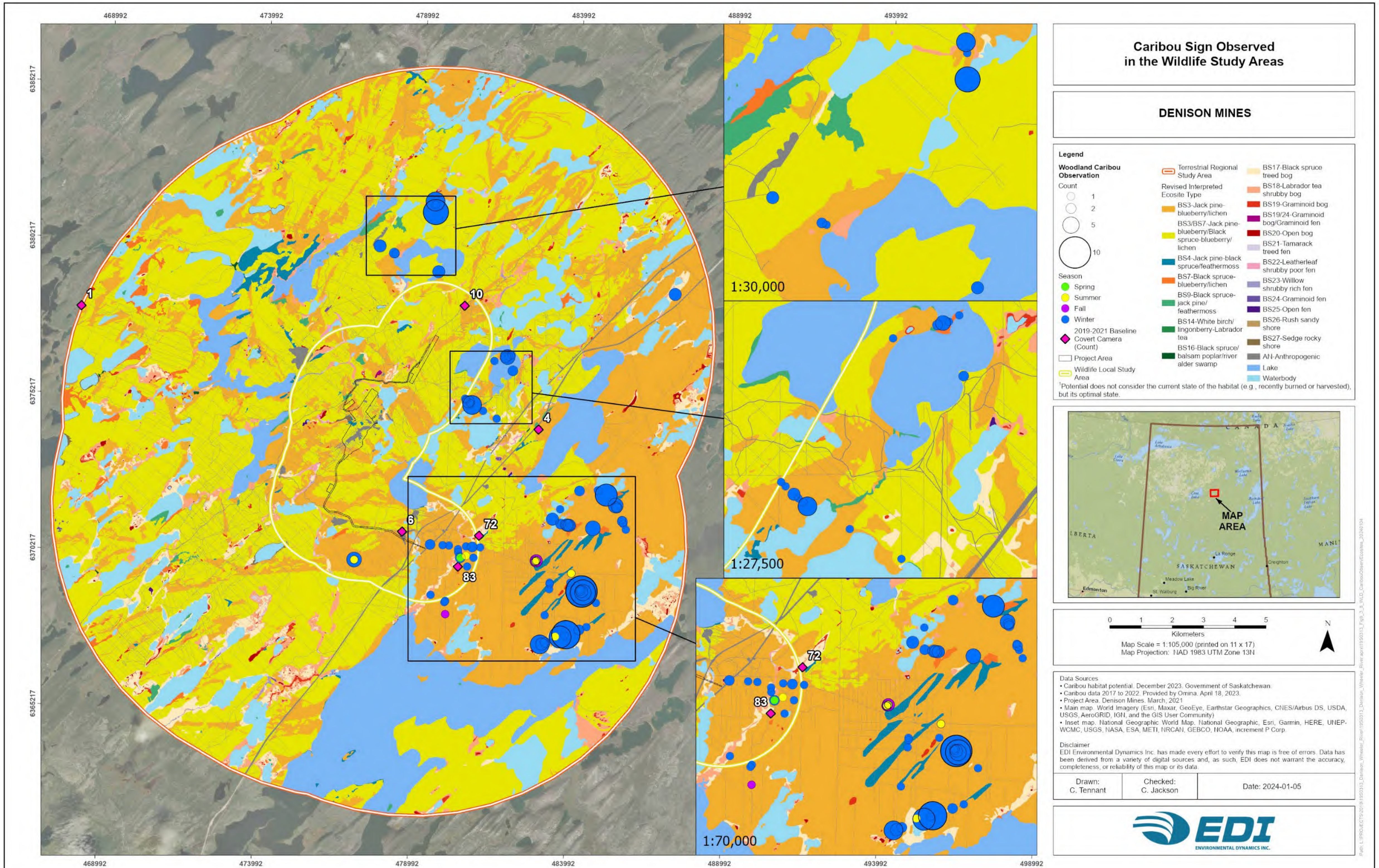

Figure 9.3-8: Caribou Sign Observations in the Wildlife Study Areas

9.3.4 Assessment of Project-related Effects

9.3.4.1 Potential Interactions Between the Project and Valued Components / Key Indicators

The Project will require the Construction, Operation, and Decommissioning of several components (as described in Section 2). Potential interactions between these Project components and activities and the VCs of Ungulates, Furbearers, and Woodland Caribou and their associated KIs are summarized by Project phase and activity in Table 9.3-6.

Potential interactions in Table 9.3-6 are ranked as:

- **Primary Interaction** (✓): Project activity is expected to interact with the VC / KI which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- **Other Interaction** (✓): Project activity is expected to interact with the VC / KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- **No Interaction:** Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

Table 9.3-6: Potential Project Interactions for Ungulates, Furbearers, and Woodland Caribou

Project Phase/Activity	Ungulates	Furbearers				Woodland Caribou
	Moose	Wolverine	Pine Marten	Mink	Muskrat	Woodland Caribou
Construction Activities						
Development of access roads and air strip	✓	✓	✓	✓	✓	✓
Site preparation and earthworks; clearing, leveling and grading of the Project Area	✓	✓	✓	✓	✓	✓
Power generation - generators	✓	✓	✓	✓	✓	✓
Installation of main substation and distribution of power around site	✓	✓	✓	✓		✓
Wellfield and freeze hole drilling; ground freezing	✓	✓	✓	✓	✓	✓
Batch plant operation (concrete); crusher at borrow area	✓	✓	✓	✓		✓
Development of surface infrastructure (camp, operations centre, plants, ponds, pads and support facilities)	✓	✓	✓	✓	✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)		✓	✓	✓		
Water management (including treatment and site runoff)				✓	✓	

Project Phase/Activity	Ungulates	Furbearers				Woodland Caribou
	Moose	Wolverine	Pine Marten	Mink	Muskrat	Woodland Caribou
Groundwater supply						
Surface water supply				✓	✓	
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)				✓	✓	
On-site and off-site operation of vehicles and transport of materials	✓	✓	✓	✓	✓	✓
Air transportation for workers	✓	✓	✓	✓	✓	✓
Regulatory site inspection	✓	✓	✓	✓	✓	✓
Engagement – site visit from Interested Parties	✓	✓	✓	✓	✓	✓
***Operation Activities*[1]**						
Operation of the ISR wellfield	✓	✓	✓	✓	✓	✓
Wellfield and freeze wall drilling	✓	✓	✓	✓	✓	✓
Operation and expansion of freeze wall						
Batch plant operation (grout and cement); crusher in borrow area	✓	✓	✓	✓		✓
Expansion of ponds and pads	✓	✓	✓	✓	✓	✓
Operation of the processing plant and production of uranium concentrate	✓	✓	✓	✓	✓	✓
Water withdrawal from groundwater or surface water body	✓	✓	✓	✓	✓	✓
Management of surface water (including seepage and site run-off)	✓	✓	✓	✓	✓	✓
Water treatment, both domestic and industrial	✓	✓	✓	✓	✓	✓
Water release to surface water body	✓	✓	✓	✓	✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)		✓	✓	✓		
Hazardous waste management (temporary storage, handling, and off-site transportation)	✓	✓	✓	✓	✓	✓
Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates	✓	✓	✓	✓	✓	✓
On-site and off-site operation of vehicles and transport of materials	✓	✓	✓	✓	✓	✓
Power supply – primarily power from the grid, also generators and back-up generators	✓	✓	✓	✓	✓	✓
Package and transport of nuclear substances	✓	✓	✓	✓	✓	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)				✓	✓	

Project Phase/Activity	Ungulates	Furbearers				Woodland Caribou
	Moose	Wolverine	Pine Marten	Mink	Muskrat	Woodland Caribou
Air transportation for workers	✓	✓	✓	✓	✓	✓
Progressive decommissioning and reclamation	✓	✓	✓	✓	✓	✓
Regulatory site inspection	✓	✓	✓	✓	✓	✓
Engagement – site visit from Interested Parties	✓	✓	✓	✓	✓	✓
Decommissioning Activities						
Site water management, treatment and release	✓	✓	✓	✓	✓	✓
Mining horizon remediation and thawing of freeze wall				✓	✓	
Process water treatment and release	✓	✓	✓	✓	✓	✓
Closure of ISR and freeze wells and related infrastructure	✓	✓	✓	✓	✓	✓
Decontamination of surface facilities and injection, recovery, and monitoring wells	✓	✓	✓	✓	✓	✓
Asset removal (including site power transmission lines and electrical infrastructure)	✓	✓	✓	✓	✓	✓
Demolition and disposal of non-salvageable surface infrastructure and materials	✓	✓	✓	✓	✓	✓
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	✓	✓	✓	✓	✓	✓
Generators	✓	✓	✓	✓	✓	✓
Waste management (composting and landfill operation)		✓	✓	✓		
Decommissioning of landfills; hazardous waste management (temporary storage and off-site disposal)	✓	✓	✓	✓	✓	✓
On-site and off-site operation of vehicles and transport of materials	✓	✓	✓	✓	✓	✓
Reclamation of disturbed areas	✓	✓	✓	✓	✓	✓
Regulatory site inspection	✓	✓	✓	✓	✓	✓
Engagement – site visit from Interested Parties	✓	✓	✓	✓	✓	✓
Post-Decommissioning Activities						
Environmental monitoring	✓	✓	✓	✓	✓	✓
Regulatory site inspections	✓	✓	✓	✓	✓	✓
Engagement - Site visit from Interested Parties	✓	✓	✓	✓	✓	✓

1 Operational activities include maintenance.

Not all activities are expected to interact with each of the three VCs, and the interaction is based on consideration of the VC- and KI-specific habitat requirements and behaviour. The activities of groundwater supply and operation and expansion of the freeze wall were deemed to have no interaction and were not carried forward in the effects assessment as they are not expected to result in detectable changes in the MPs associated with the KIs of the Ungulates, Furbearers, and Woodland Caribou. It is recognized that some interactions are the primary contributors to potential adverse effects on VCs and KIs. While all interactions are considered in the effects assessment, the primary contributors (i.e., the grey shaded cells in Table 9.3-6) will be the focus of the effects assessment for each VC.

9.3.4.2 Potential Project-related Effects

Based on the timing and nature of the interactions identified in Table 9.3-6, the following adverse effects on Ungulates, Furbearers, and Woodland Caribou, VCs have the potential to occur during the lifetime of the Project:

- alteration and/or loss of habitat; and
- change in mortality.

The potential effects are described below for each Project phase as they are expected to affect the VCs and associated KIs. Mitigation measures for each potential effect are described in Section 9.3.5.

In support of this EIS, an ERA was prepared with the objective to predict and assess the risk to representative human and ecological receptors resulting from exposure to radiological and non-radiological COPC expected to be released throughout all Project phases (Appendix 10-A in Section 10). The ERA used the expected sources of atmospheric and liquid releases to predict the transport of these constituents through the environment and resulting exposure and effects on ecological receptors (including representative wildlife species). Since the ERA assessed the effects of radiological and non-radiological emissions on representative wildlife species, these potential Project-related effects are not assessed in Section 9.3, and, where applicable, a reference is provided to the ERA.

9.3.4.2.1 Alteration and/or Loss of Habitat

<u>Overview</u>

Project-related alteration and/or loss of habitat may affect the distribution and/or abundance of Ungulates, Furbearers, and Woodland Caribou VCs. Alteration and/or loss of habitat, as indicated by a change in habitat availability, includes both direct and indirect changes. Direct habitat loss occurs where suitable habitat is physically disturbed or removed to the extent that the area is rendered functionally unsuitable for wildlife use, e.g., when vegetation or other features (such as dens, lodges, or wildlife trees) are cleared, removed, or affected during the lifetime of a project. Alteration of habitat is indirect habitat disturbance where suitable habitat remains physically intact, but its suitability is reduced or a minimum habitat size threshold is not met any longer (Muhly et al.

2015, Crooks et al. 2017). Indirect effects that alter habitat can include edge effects, fragmentation, patch size alterations, and sensory disturbances (e.g., noise, dust deposition, or human presence).

As habitat is lost, a minimum patch size is often required for an individual to occupy or use an isolated patch on a landscape (Robbins et al. 1989, Askins 1994). When available suitable habitat is below a minimum patch threshold, a reduction in occupancy or use may occur despite the continued presence of suitable habitat. As a result, patch size, both on an individual and population level, may have a species-specific effect on use of suitable habitat (Reunanen et al. 2002, Homan et al. 2004). Habitat fragmentation occurs when a large expanse of habitat is transformed into several smaller patches, isolated from each other and, therefore, frequently not providing required habitat functions to wildlife species inhabiting the original area.

Edge habitat is an area on either side of a border between vegetation communities. Edges between vegetation communities often result in altered microclimatic conditions that can influence quality in habitat further away from the edge (BC Ministry of Forests Research Program 1998). Edge habitat can adversely affect wildlife that require interior forest conditions. Differences in vegetative communities and structure at forest edges often result in altered microclimatic conditions relative to interior forest habitat (BC Ministry of Forests Research Program 1998). If changes to microclimatic conditions or vegetative structure at an edge exceed a species habitat preference or physiological tolerance, then edge habitat may result in lower occupancy or use, reduced survival, or lowered reproductive success.

Sensory disturbances are anticipated to alter habitat; however, the extent of the alteration is expected to vary by species, age, and sex. Some species may reduce use of areas along roads with greater traffic but do not avoid roads with less traffic. Moose may avoid areas with high road densities, but some may select areas around camps, and caribou avoidance of areas with aircraft traffic varies with different levels of human activity (Stephens and Peterson 1984, Mace et al. 1996, Polfus et al. 2011, Beyer et al. 2013). Anthropogenic noise can cause short-term habitat avoidance when the noise sources are present and wildlife may return when noise levels decrease; however, loud noises (e.g., starting and landing aircraft) can cause longer-term habitat avoidance (Bowles 1995). Vehicle and aircraft traffic, which can cause both visual and auditory disturbances, can result in some wildlife avoiding areas with increasing traffic and disturbance intensity (Northrup et al. 2012, Leblond et al. 2013). Dust deposition from Project activities and components may contribute to habitat alteration for some KIs as they may affect palatability of vegetation (Chen et al. 2017).

Project Phases

Construction

Alteration and/or loss of habitat is expected to occur during all Project phases; however, most Project effects are expected to occur during Construction. Site preparation and construction activities during the Construction Phase will involve vegetation clearing and ground disturbance for all Project components. Some of the areas to be cleared have already been disturbed and/or cleared as a result of past exploration activities, which is expected to reduce new disturbances.

The loss of habitat is anticipated to occur during Construction but will continue during the remaining Project phases and until Project activities decrease, Project components are removed, and disturbed habitat is revegetated and starts to provide suitable habitat for some KIs. Vegetation clearing, soil movement, and surface water management may result in a loss of habitat or a reduction in habitat quality. Site clearing, soil salvaging, stockpiling, and grading will occur within the Project Area, resulting in the direct loss of vegetation and potential wildlife habitat.

The alteration of habitat, including sensory disturbances, is anticipated to begin during Construction and continue through Post-Decommissioning; however, it is expected that the alteration of habitat due to sensory disturbances will decrease after Operation when Project-related activities decrease.

The activities expected to have the highest potential for alteration and/or loss of habitat during Construction are related to the development of site and access roads and the air strip; clearing, leveling and grading of the site; wellfield and freeze hole drilling; batch plant operation; development of surface infrastructure; waste management; water management; power generation; fuel management; operation of vehicles; transport of materials; and air transportation for workers.

Operation

Direct habitat loss is expected to be limited during the Operation Phase; however, the alteration of habitat by sensory disturbances (e.g., vehicle traffic, aircraft traffic, dust deposition, maintaining and operating site facilities, and human presence), edge effects, fragmentation, patch size changes, and changes to water quality are expected to continue through Operation. Potential dust deposition is expected to be highest during Operation. Fugitive dust from access roads, the airstrip and the clean waste rock pile have the potential to affect wildlife habitat.

The Project activities expected to have the highest potential for alteration and/or loss of habitat during the Operation Phase are related to operation of the ISR wellfield, wellfield and freeze wall drilling, expansion of ponds and pads, operation of the ISR processing plant and production of uranium concentrate, water treatment, waste, hazardous, and contaminated waste management, nuclear substance management, storage and disposal of process waste rock and radioactive plant precipitates, operation of vehicles and transport of materials, power supply, fuel management, and air transportation for workers.

During Operation, progressive reclamation activities will be completed where possible. Maintenance will occur along the access and site roads, the airstrip, pads and ponds, the processing plant, and all supporting components. These activities are expected to limit the progression of succession of re-established vegetation and the regeneration of wildlife habitat. Progressive reclamation is expected to be positive as revegetation is initiated in reclaimed areas.

Decommissioning

Direct loss of wildlife habitat is not expected during Decommissioning; however, the alteration of habitat is expected to continue during this phase. All permanent structures that cannot be removed from the property as an asset will require demolition. Most process equipment and non-supporting structures will be removed from buildings prior to demolition and the buildings will be demolished and disposed of. Dust production from decommissioning activities is anticipated. Progressive reclamation is expected to continue and result in positive effects as revegetation is continued and regeneration occurs. Following decommissioning and reclamation, wildlife habitat is expected to recover to baseline conditions. The goal is to reclaim the affected portions of the Project Area and establish the appropriate conditions (e.g., soil quality) to support a regeneration path that would lead to and promote a natural seral stage succession that would be compatible with adjacent habitat types (i.e., to pre-disturbance conditions in line with surrounding habitats).

Project activities expected to have the highest potential for alteration and/or loss of habitat during Decommissioning are related to remediation and closure of project components and infrastructure, process and site water treatment and release, salvageable asset removal, demolition and disposal of infrastructure and materials, remediation of contaminated areas, power generation, waste and hazardous management, operation of vehicles, and transport of materials. While the construction of the Project will result in loss of wildlife habitat in the Project Area and alteration of habitat in the Wildlife LSA, following decommissioning and reclamation, wildlife habitat is expected to recover to baseline conditions. All disturbed areas will be reclaimed during this phase, which is expected to result in positive effects on wildlife habitat.

Post-Decommissioning

The effect of habitat alteration and/or loss during Post-Decommissioning is expected to be minimal as regeneration of vegetation is expected to continue within reclaimed areas. No direct loss of habitat is expected to occur during this phase; however, minimal sensory disturbances may occur from monitoring and inspection activities (e.g., vehicle traffic, dust deposition, or human presence).

Valued Components and Key Indicators

Ungulates (Moose KI): The potential effect of alteration and/or loss of habitat on moose is based on vegetation removal and/or ground disturbance due to construction of Project components and infrastructure and edge effects. Clearing of vegetation within the Project Area during Construction will result in a loss of potential moose habitat, even though portions of the Project Area are already disturbed from previous exploration activities.

Current anthropogenic disturbance levels (without areas burnt by past forest fires) for the study areas are estimated as: 24.8 ha (14.6%) for the Project Area, 168 ha (3.5%) for the Wildlife LSA, and 599 ha (1.5%) for the Terrestrial RSA (Figure 9.3-9).

Figure 9.3-9 provides an overview of anthropogenetic disturbances as well as all habitat types observed in the study areas. As described in Section 9.3.3.1.3, moose in the Terrestrial RSA were observed in mixed stands and regenerating deciduous forest habitats as well as riparian areas, and any changes to these areas will reduce available habitat.

The alteration of moose habitat is typically associated with sensory disturbances that may include anthropogenic noises, vehicle traffic, aircraft traffic, and increased predator access (Neilson and Boutin 2017). Vehicle traffic and road networks can influence habitat use by moose. Roads and vehicle traffic can affect moose habitat selection in the areas adjacent to roads up to 1,000 m, with most effects being observed within 250 m of a road (Laurian et al. 2008, 2012; Shanley and Pyare 2011). The density of the road network can affect moose habitat quality (Beazley et al. 2004, Laurian et al. 2012). Moose also avoid areas with a high wolf density, which may include linear features surrounding natural resource developments (Neilson and Boutin 2017).

Noise from Project construction, operation, and decommissioning activities, including the camp, may contribute to alteration of potential moose habitat through displacing moose from using habitats around these features. The proposed access roads and airstrip may temporarily displace moose from using habitats close to these components during periods of frequent traffic. The potential alteration of moose habitat also includes dust deposition during the Construction, Operation, and Decommissioning phases, which may result in affected vegetation being less palatable. Habitat alteration through sensory disturbance effects (such as noise, vibration, dust deposition, and artificial light) is expected to result in reduced habitat quality and effectiveness near Project components and infrastructure reaching beyond the Project Area into the Wildlife LSA. The effect of habitat alteration and/or loss on moose is expected to be minimal during Post-Decommissioning, as regeneration of vegetation is expected to continue within reclaimed areas.

Furbearers (Wolverine, Pine Marten, Mink, and Muskrat KIs): The potential effect of alteration and/or loss of habitat on furbearers is based on vegetation removal, the removal of important features (e.g., dens or lodges), ground disturbance, and/or changes to water bodies due to construction of Project components and infrastructure. Clearing of vegetation, ground disturbance, and changes to water bodies within the Project Area during Construction may result in a decrease of available potential furbearer habitat, even though portions of the Project Area (i.e., 24.8 ha or 14.6%) are already disturbed (Figure 9.3-10 to Figure 9.3-13). Both wolverine and pine marten rely on relatively undisturbed forest habitats, mink require riparian areas in forests, and muskrats prefer marshy and open water habitats; any changes to these areas will reduce available habitat.

Noise from Project construction, operation, and decommissioning activities, including the camp, access roads, and the airstrip, may affect furbearer habitat availability around these features. The potential alteration of habitat includes dust deposition during the Construction, Operation, and Decommissioning phases, which may result in affected vegetation being less palatable. Habitat alteration through sensory disturbance effects (such as noise, vibration, dust deposition, and artificial light) will result in reduced habitat quality and effectiveness near Project components and infrastructure reaching beyond the Project Area into the Wildlife LSA. The overall effect of habitat alteration and/or loss on furbearers is expected to be minimal during Post-Decommissioning as regeneration of vegetation is expected to continue within reclaimed areas.

Woodland Caribou: The potential effect of alteration and/or loss of habitat on woodland caribou is based on vegetation removal and/or ground disturbance due to construction of Project components and infrastructure and edge effects. Clearing of vegetation within the Project Area during Construction is expected to result in a loss of available caribou habitat, even though portions of the Project Area are already disturbed. Woodland caribou habitat in the SK1 Boreal Shield Woodland Caribou Management Unit consists of conifer-dominated habitat with greater than 40-year-old stands suitable for lichen colonization and open muskegs; any changes to these habitat types will reduce available habitat. The SK1 Boreal Shield Woodland Caribou Management Unit has relatively low levels of anthropogenic disturbance and was exposed to large fire disturbances in the past 40 years (ECCC 2020). Environment and Climate Change Canada (2020) identified this caribou population as being self-sustaining at a threshold of 40% undisturbed habitat with the total anthropogenic disturbance not exceeding 5% of their habitat. The current anthropogenic disturbance levels (without areas burnt by past forest fires) for the study areas are below this threshold (with the exception of the already disturbed Project Area) and are estimated as: 24.8 ha (14.6%) for the Project Area, 168 ha (3.5%) for the Wildlife LSA, and 599 ha (1.5%) for the Terrestrial RSA.

Noise from Project construction, operation, and decommissioning activities, including the camp, may contribute to alteration of potential woodland caribou habitat through reducing habitat quality around these features. The proposed access roads and airstrip may also temporarily displace caribou from using habitats close to these components during periods of frequent traffic. The potential alteration of woodland caribou habitat also includes dust deposition during the Construction, Operation, and Decommissioning phases, which may result in affected vegetating being less palatable. Habitat alteration through sensory disturbance effects (such as noise, vibration, dust deposition, and artificial light) will result in reduced habitat effectiveness near Project components and infrastructure reaching beyond the Project Area into the Wildlife LSA. The effect of habitat alteration and/or loss on woodland caribou is expected to be minimal during Post-Decommissioning, as regeneration of vegetation is expected to continue within reclaimed areas.

9.3.4.2.2 Change in Mortality

Overview

A change in mortality, both through direct and indirect sources, can affect population abundance and distribution of Ungulates, Furbearers, and Woodland Caribou VCs. Direct and indirect mortality may result from collisions (i.e., with vehicles, aircraft, and Project equipment), changes in predator-prey dynamics, increased competition for food and other resources, increased hunter access, changes in animal health (e.g., higher stress levels, lower body condition), and increased human-wildlife encounters. Potential mortality from Project activities is anticipated to start during Construction and persist until Post-Decommissioning, when Project components are removed and activities cease.

Mortality may be caused directly by Project components and activities (e.g., vehicle-wildlife collisions or destruction of occupied den sites and lodges), and entrapment in Project facilities (such as buildings or waste ponds or treatment ponds. Release of Project-related treated effluent or the deposition of contaminated dust (e.g., with trace metal and radionuclides) from traffic and uranium stockpiling and transportation processes may result in contamination of wildlife, their habitats and food sources. This risk is assessed in the ERA (Appendix 10-A in Section 10).

There is a limited potential for spills of fuels and other hazardous materials which may affect individual animals, wildlife habitat and food sources; however, this is expected to be a minor contributor to the effect (i.e., an expected interaction, but not a primary interaction, see Section 9.3.4.1). The risks for possible major accidents and malfunctions are addressed in Section 14 Accidents and Malfunctions.

Through Saskatchewan Government Insurance (SGI), the province of Saskatchewan provides public insurance coverage for vehicle accidents and the province gathers data for all vehicle collisions, including wildlife-vehicle collisions (L-P Tardif & Associates Inc. 2003). Between 1996 and 2000, SGI reported a province-wide total of 10,120; 10,174; 9,566; 9,998; and 10,645 wildlife-vehicle collisions, respectively (L-P Tardif & Associates Inc. 2003). Transport Canada (2006) provided additional wildlife-vehicle collision data collected by SGI for 2001, 2002, and 2003, with 11,775, 11,514, and 13,966 SGI claims related to annual wildlife collisions, respectively, throughout the province. During the reported years, deer-vehicle collisions represented more than 80% of all collisions with wildlife. No details on wildlife-vehicle collisions were available for the Terrestrial RSA.

Wildlife attracted to the Project Area (e.g., through olfactory attractants such as food, petroleum-based chemicals, grey water, and sewage) may result in human-wildlife encounters, which may increase the mortality risk of individual animals through intentional destruction or relocation of nuisance or habituated wildlife. Predators that area attracted to the Project Area may also increase the predation risk, which can affect mortality of prey species (Environment Canada 2013).

Mortality can be caused indirectly when interactions with Project components and activities contribute to other sources of mortality (e.g., increased and more efficient hunter access and destruction of nuisance animals; Boer 1990, Beazley et al. 2004) and increased predation rates through easier access for predators via new linear infrastructure (Gehr et al. 2018).

Sensory disturbances from Project activities can result in chronic stress, which in turn may reduce body condition and increased predation risk in some species (Maier 1996, Barber et al. 2010, Ewacha 2016). Reductions in habitat, through decreased habitat effectiveness (i.e., habitat alteration) or loss, may contribute to indirect mortality due to increased intra-specific competition for available food and habitat (Buskirk 2000), and increased predation risk (Gehr et al. 2018, Viejou et al. 2018).

Based on these considerations, a Project-related change in mortality may affect the distribution and/or abundance of the Ungulates, Furbearers, and Woodland Caribou VCs within the Terrestrial RSA.

Project Phases

Construction

The effect of a change in mortality is expected to begin during Construction when initial Project-related activities begin and continue until Post-Decommissioning. The potential effect of change in mortality is species-specific and based on the likelihood of a species encountering sources of potential direct or indirect mortality. The activities expected to have the highest potential for mortality are likely related to site clearing during Construction when the Project Area is cleared of vegetation, and the transport of equipment, materials, and personnel, resulting in increased traffic. In particular, this includes Project activities such as the development of site and access roads and the air strip; clearing, leveling and grading of the site; wellfield and freeze hole drilling; batch plant operation; development of surface infrastructure; waste management; water management; power generation; fuel management; operation of vehicles; transport of materials; and air transportation for workers.

Operation

Changes in direct and indirect mortality are expected to continue during Operation. Collisions with Project vehicles and equipment may result in direct morality of wildlife. Direct mortality may occur during Project-related activities (e.g., vegetation management, snow management, maintenance work) along the linear Project features (e.g., roads, airstrip, and power transmission line). Entrapment in Project components (e.g., waste ponds or treatment ponds) and the results of Project activities (i.e., snow berms created during snow management) may result in direct mortality of wildlife (e.g., drowning, vehicle collisions). Spills or leaks of fuels and other hazardous materials may affect wildlife, their habitats and food sources; however, this is expected to be a minor contributor to the effect. The risks for possible major accidents and malfunctions are addressed in Section 14.

Exposure to hazardous materials (e.g., wildlife gaining access to contaminated waste ponds, release of treated effluent, trace metal and radionuclide depositions) could affect wildlife health and with that contribute to mortality (Appendix 10-A in Section 10).

Indirect mortality may occur through increased and more efficient hunter, trapper, and predator access to the Project Area via new access, decreased wildlife health (e.g., increased stress, reduced body condition), and increased inter- and intra-specific competition for resources.

The activities expected to have the highest potential for change in direct and indirect mortality during Operation are related to operation of the ISR wellfield, wellfield and freeze wall drilling, expansion of pond and pads, operation of the ISR processing plant and production of uranium concentrate, water treatment, waste, hazardous, and contaminated waste management, nuclear substance management, storage and disposal of process waste rock and radioactive plant precipitates, operation of vehicles and transport of materials, power supply, fuel management, and air transportation for workers.

Decommissioning

Changes in direct and indirect mortality are expected to continue during Decommissioning as Project activities cease and Project components are removed or demolished. Collisions with Project vehicles and equipment may result in direct morality of wildlife.

Dust production and deposition (including trace metals and radionuclides) may result in contamination of wildlife habitat and indirectly affect a change in mortality (Appendix 10-A in Section 10). Spills of fuels and other hazardous materials may contribute to the effect on wildlife VCs, however, the risks for possible major accidents and malfunctions are addressed in Section 14**.**

Indirect mortality may occur through increased and more efficient hunter and predator access to the Project Area via new access, decreased wildlife health (e.g., increased stress, reduced body condition), and increased inter- and intra-specific competition for resources.

Project activities expected to have the highest potential for a change in direct and indirect mortality during Decommissioning are related to remediation and closure of project components and infrastructure, process and site water treatment and release, salvageable asset removal, demolition and disposal of infrastructure and materials, remediation of contaminated areas, power generation, waste and hazardous management, operation of vehicles, and transport of materials. All disturbed areas will be reclaimed during this phase, which is expected to result in positive effects on wildlife habitat.

Post-Decommissioning

The effect of change in mortality is expected to be limited during Post-Decommissioning. Project activities will be limited to regular monitoring and occasional inspections and all Project components will be removed, resulting in a reduced risk of vehicle collisions with wildlife, exposure to trace metals and radionuclides, hazardous materials (e.g., spills), and risk of entrapment.

Valued Components and Key Indicators

Ungulates (Moose KI): The effect of a change in mortality on moose is typically caused by vehicle and equipment collisions (including entrapment within snowbanks along roads resulting in an increased risk of vehicle collision, increased or easier hunter access, and increased or easier predator access.

Between 1996 and 2000, the SGI reported 10,120; 10,174; 9,566; 9,998; and 10,645 wildlife-vehicle collisions, respectively, for the province (L-P Tardif & Associates Inc. 2003). During the reported years, deer-vehicle collisions represented more than 80% of all collisions involving wildlife. Across the province, in 2018, more than 14,000 wildlife collision claims were reported to SGI. Of the claims, 12,401 involved deer, while 525 claims were based on collisions with moose (Saskatoon / 650 CKOM 2019).

Anthropogenic features can facilitate the ease of hunter and predator travel, increasing the accessibility into areas and resulting in indirect sources of mortality (Beazley et al. 2004, Ewacha 2016, Mumma and Gilligham 2019). Other indirect anthropogenic sources of mortality may include sensory disturbances that can result in reduced body condition or increased stress (Barber et al. 2010). Changes in direct and indirect mortality are expected to start during Construction and continue through Post-Decommissioning, but the risk of any mortality is anticipated to decline with decreasing Project activity over the life of the Project.

Furbearers (Wolverine, Pine Marten, Mink, and Muskrat KIs): The potential effect of change in mortality is based on the likelihood of a furbearer species encountering sources of potential direct or indirect mortality. Mortality may be caused directly by Project components and activities, including vehicle collisions, destruction or abandonment of den sites and lodges during vegetation clearing and management, entrapment in waste ponds, or entrapment in snow berms created during snow management.

Mortality may be caused indirectly when interactions with Project components and activities contribute to other sources of mortality such as through increased and more efficient hunter and predator access, decreased wildlife health (e.g., increased stress and reduced body condition), and increased inter and intra-specific competition for resources through reduced habitat availability.

Reductions in habitat, through decreased habitat effectiveness (i.e., alteration) or loss, may also contribute to indirect mortality due to increased intra-specific competition for available food and habitat, increased predation risk and hunting efficiency, and abandonment of young (Hargis et al. 1999).

Human-wildlife interactions may result from furbearers being attracted to the Project Area (e.g., through smells from olfactory attractants, such as food, petroleum-based chemicals, grey water, and sewage), which may increase the mortality risk of individual animals through intentional destruction (i.e., euthanasia). Attraction to the Project Area may also increase the predation risk through an influx of predators, which can affect mortality of prey species (Environment Canada 2013).

Changes in direct and indirect mortality on furbearers is expected to begin during Construction when initial Project-related activities begin and continue through Post-Decommissioning. The activities expected to have the highest potential for mortality are likely related to site clearing during Construction and the transport of equipment, materials, and personnel during all phases. The effect of change in mortality on furbearers is expected to be limited during Post-Decommissioning when activities will be reduced, and all Project components will be removed.

Woodland Caribou: The potential effect of change in mortality on woodland caribou considers potential sources of mortality from direct Project interactions and potential effects stemming from landscape changes that could affect indirect mortality from hunting and predation. Direct mortality due to the Project could occur because of vehicle collisions, or caribou getting injured when travelling through the Project Area. Vehicle collisions with caribou are a documented source of caribou mortality in areas where caribou ranges overlap with transportation infrastructure and could add to caribou mortality outside the Project Area where increased Project-related traffic may occur (ECCC 2020). Wildlife-vehicle collisions in the province are mostly caused by collisions with deer; no caribou-vehicle collisions were reported (L-P Tardif & Associates Inc. 2003).

Indirect mortality of caribou could occur through two processes potentially affected by the Project: 1) apparent competition with more productive alternative prey species, and 2) facilitated predation by wolves. Apparent competition occurs when the density of an alternative prey species increases so that it supports a higher density of a shared predator(s), which increases predation on the other prey species. Landscape changes due to the Project may provide habitat for moose (and potentially deer), which may increase the abundance of wolves, which then would likely also prey on caribou (Bergerud and Elliot 1986). Woodland caribou prefer mature forests because mature, open conifer stands provide abundant terrestrial and arboreal lichen (Norbert et al. 2020). In addition, mature forests with sparse understory vegetation do not support high densities of other ungulates and, consequently, predators in these contiguous mature forest stands occur at low densities. Loss and fragmentation of mature forests caused by habitat disturbances with subsequently increased predation rates is considered one of the main causes of woodland caribou declines (Norbert et al. 2020). Facilitated predation occurs with the development, maintenance, and/or use of roads and trails that provide easier movement for predators across the landscape. Predators, particularly wolves, use these linear features to move more quickly and consequently hunt more efficiently within their range (Dickie et al. 2017).

The effect of a change in direct mortality on caribou is expected to begin during Construction when initial Project-related activities start and continue through Post-Decommissioning when Project infrastructure is removed, and reclaimed areas begin to regenerate vegetation communities. The potential for the Project to indirectly affect caribou mortality through apparent competition and/or facilitated predation is limited during the Construction and Operation phases when human activity is more likely to deter alternative prey and predators away from the Project Area. However, during the Decommissioning and Post-Decommissioning phases, the Project Area is expected to temporarily create habitat that could support higher densities of alternative prey species, potentially increasing predator density in the region.

9.3.5 Mitigation Measures

Mitigation in this EIS is defined as the elimination, reduction, or control of potential adverse effects of the Project on the environment throughout all Project phases. Project-specific mitigation measures include Project design; implementation of BMPs; development of management plans; implementation of emergency response programs; and provision of training, education, and awareness (Denison 2020). In addition to implementing mitigation measures, the ISR mining process is acknowledged for minimal adverse environmental effects as it is associated with low noise levels, minimal dust and air emissions, low water consumption levels, minimal treated effluent discharge volumes, and minimal waste rock generation (Denison 2020). The following subsections summarize mitigation measures that will be implemented to avoid or minimize adverse effects on the Ungulates, Furbearers, and Woodland Caribou VCs.

9.3.5.1 Project Design Measures

Potential adverse effects on the Ungulates, Furbearers, and Woodland Caribou VCs will be avoided or minimized to the extent possible through Project design, including:

- The Project Area (i.e., the area of maximum physical disturbance) has been reduced to the extent practicable, resulting in reduced habitat disturbance and noise propagation.
- Much of the proposed Project footprint has been developed within previously disturbed areas, including roads currently used for exploration activities, thereby minimizing additional habitat disturbance.
- During Operation, progressive reclamation activities will be completed where possible, and the progress and success of these activities will be assessed annually.
- Cleared brush will be stockpiled, when possible, to be used in progressive reclamation.
- Ongoing decommissioning of Project components will be completed when possible.

- Dust deposition on vegetation and waterbodies (including potential deposition of trace metals and radionuclides) will be reduced by:
  - directing processing plant exhaust from drying and packaging areas through a stack prior to release outside of the building;
  - designing the stack height based on results of air dispersion modelling to be an appropriate height for optimal dispersion;
  - controlling access to the property with both a north and south security gate (the north gate is on a decommissioned road and the south gate is manned);
  - making a wash bay available to clean items, equipment, and vehicles that may have been in contact with potentially contaminated materials. Contaminated water from the wash bay will be collected in a sump tank and routed to the water treatment plant for treatment and discharge;
  - conducting radiological clearance scanning as required for any items, equipment, and vehicles leaving the Project Area; and
  - road watering and traffic controls on roads.
- Battery-powered light vehicles and mobile equipment, and an AC powered dual rotary drill for ISR wellfield development instead of a traditional diesel-powered unit, will be employed, where practical, to reduce air emissions and noise levels and improve energy efficiency.
- The main sources of noise will be related to transport of people and goods, drilling of holes for the freeze wall and wellfield, operation of the batch plant, operation of the processing plant, and operation of the pumphouses. The use of high-quality, low sound emission equipment and regular maintenance will reduce noise associated with Project activities.
- Bulk storage tanks for processing chemicals such as sulphuric and/or hydrochloric acid, sodium hydroxide, and hydrogen peroxide will sit inside appropriately designed and sized secondary containment basins, physically separated from the containment basins for other chemical systems.
- Surface pipelines will be designed to have secondary containment or catchment and have leak detection systems in place at key locations.
- A freeze wall will be established around the uranium deposit to reduce groundwater disturbance.
- Mining solution and process water will be reused throughout the mining process, reducing water use requirements to the extent feasible and reducing the volume of treated effluent requiring discharge. Make-up water will be preferentially sourced from site runoff where possible.
- Double-walled HDPE or equivalent piping will be used in the wellfields and will be freeze protected and secured to minimize pipe movement.

- Contaminated wastes (e.g., mineralized drill cuttings, solid impurities removed from mining solution, dewatered reject solids) will be properly contained on a double lined waste pad with leak detection capabilities and an associated monitoring program. An adjacent pond will be used to collect runoff from the pad and water in the waste pond will be piped to the water treatment plant. Such waste will be disposed of either on site or off site at an approved facility.
- The ISR wellfield and processing plant will be designed to re-use most of the solutions inside each circuit; any excess water will be released to a surface water body once acceptable water quality is achieved. All treated effluent released to surface water will meet federal and provincial regulatory discharge limits.
- All contaminated areas, such as waste ponds and pads, and the domestic landfill will be fenced to avoid contact with workers and wildlife. Fences will be monitored and maintained.

As not all effects on the Ungulates, Furbearers, and Woodland Caribou VCs can be addressed through Project design, additional wildlife-specific mitigation measures will be implemented, as described in the following section.

9.3.5.2 Additional Wildlife-specific Mitigation Measures

Additional mitigation measures specific to the Ungulates, Furbearers, and Woodland Caribou VCs and tailored to Project features will be incorporated into the various Project management and monitoring plans within the EMS, which will include erosion and sediment controls, soil and vegetation monitoring, Decommissioning Plan, air quality monitoring, Fuel spill control and response, Radiation Protection Plan, surface water and effluent monitoring, and Waste Management Plan. A wildlife monitoring plan and a Draft Caribou Mitigation Plan will be developed to address wildlife-specific mitigation measures based on proven and accepted mitigation following standard industry guidelines and BMPs (see Appendix 9-E). The plans will provide guidance to avoid or minimize potential adverse effects of the Project on wildlife and wildlife habitat, including monitoring and follow-up programs, as appropriate. It will be in place during all phases of the Project and will be subject to ongoing review and revision as required. If monitoring identifies a need for additional or revised mitigation measures, a process of adaptive management (as described in the plan) will be triggered.

The Project is located in the SK1 Boreal Shield Woodland Caribou Management Unit, which has low levels of anthropogenic disturbance and was exposed to large fire disturbances in the past 40 years (ECCC 2020). A Draft Caribou Mitigation Plan will be consistent with the management goals of SK-1 Management Unit.

The Project management plans provide direction on monitoring and adaptive management so that measures are timely and effective. Mitigation measures specific to the Ungulates, Furbearers, and Woodland Caribou VCs are applicable during all Project phases and expected to be effective following implementation.

9.3.5.2.1 Best Management Practices for working in Boreal Woodland Caribou Range in Saskatchewan

It is Denison's understanding that the Government of Saskatchewan is currently compiling a BMP document intended to guide proponents when developing their approaches to avoid or minimize adverse effects of project activities on woodland caribou and woodland caribou habitat However, no guidance currently exists for the Boreal Shield portion of Saskatchewan, in which the Project resides. This area is identified as SK1.

Woodland Caribou are listed as a threatened species under the Federal *Species at Risk Act* with a main driver attributed to habitat fragmentation. It has been recorded that wildlife, particularly bears, wolves, and woodland caribou, are using anthropogenic linear features to move throughout their habitat with greater ease. This can result in increased chance encounters between predators and prey and may be contributing to the reduction in woodland caribou populations (Omnia 2022). Denison is conducting research on linear features used by predators and prey in the Athabasca Basin with an overarching goal to disrupt the current predator/prey movements through linear features.

Currently, no guidelines or protocols are available for assessing the status for disturbance features or for evaluating the need for reclamation set forth by the government. Denison proactively initiated research to provide field-based findings on the effectiveness of linear disruption features on predator/prey movements. This field program will deploy and monitor the effectiveness of five different linear feature treatment types across nine locations. Treatment types include, seeding and/or planting of Jack Pine, spreading coarse woody debris, tree tipping, constructing biodegradable fencing, and earth/debris mounding, Methods vary by location but have a common goal, to discourage prolonged disturbance and encourage new growth in areas of disturbance (Omnia 2022).

Each treatment area is monitored by game cameras year-round to see how wildlife interact with the created physical and visual barriers. All treatments are temporary and biodegradable with the purpose of reducing trail use in the near term so the forest can naturally regenerate.

Results will help the development of proactive and meaningful restoration strategies as an ongoing part of the overall Project (Omnia 2022). Additionally, the 2023 field program will support a program that uses the results from the 2021/2022 Caribou Trail Study in long-term reclamation planning. The program will be led by the University of Saskatchewan and is funded by Denison, an Indigenous-owned environmental company, the Northwest Communities Environmental Services (Métis owned), Mitacs, and the Natural Science and Engineering Research Council of Canada through an alliance grant. The Caribou Trail Study and the reclamation plan will culminate with the development of a Draft Caribou Mitigation Plan (see Appendix 9-E).

9.3.5.2.2 Wildlife Education

- Employees and contractors will be provided with wildlife education and awareness training, including education about potential wildlife issues on site and training on the mitigation measures summarized with the EMS and specifically in the Draft Caribou Mitigation Plan to avoid or minimize potential Project effects on wildlife and wildlife habitat (see Appendix 9-E).
- Employees and contractors will be educated on waste management policies that limit human-wildlife interactions.
- Designated employees will be trained in appropriate wildlife deterrent techniques to minimize wildlife interactions with the Project.
- Employees and contractors will be requested to report wildlife observations, including prompt reporting of caribou observations and immediate communication to on-site staff. Wildlife encounters and outcomes will be monitored, and logbooks will be used to record wildlife observations. Logbooks and reports will be available to employees.

9.3.5.2.3 Wildlife and Habitat Protection

- Personal firearms for employees and contractors will be prohibited within the Project Area to prevent hunting activities.
- If any individual were seeking access around the Project area to undertake Aboriginal and / or Treaty Rights, Denison staff would facilitate this, provided it were safe to do so given activities in the area.
- Policies will be implemented prohibiting employees and contractors from feeding, approaching, or harassing wildlife species within the Project Area.
- To support wildlife habitat regeneration, progressive reclamation and ecosystem-based revegetation will be conducted on disturbed areas as soon as practicable in accordance with the Reclamation and Closure Plan.

9.3.5.2.4 Work Timing Windows

- Project activities will be assessed for their potential to disturb or remove wildlife and/or wildlife habitat (e.g., site clearing, soil disturbance) to determine potential effects on wildlife and wildlife habitat and whether additional mitigation measures may be required.
- Site clearing and other works that involve disturbance of vegetation and/or soil will be completed during least-risk timing windows for wildlife (outside of denning and calving periods) to avoid disturbance during sensitive time periods, whenever practicable.
- Pre-construction wildlife clearance surveys will be conducted within the Project Area in accordance with a wildlife monitoring plan and the Draft Caribou Mitigation Plan (see Appendix 9-E). This would include surveying for important wildlife features that would include wolverine den sites.

9.3.5.2.5 *Wildlife Deterrence and Prevention of Wildlife Entrapment*

- In addition to installing secure fencing around all contaminated areas, buildings and other Project components will be designed and maintained to exclude wildlife from using buildings for refuge or shelter, and to deter wildlife from potentially becoming entrapped.
- Buildings and other Project infrastructure will be designed and maintained to bats as much as possible. This may include installing solid barriers (e.g., corner slope panels or wooden panels) or flexible barriers (e.g., netting, tarps, or geotextiles) under roof eaves or other exterior surfaces.

9.3.5.2.6 *Sensory Disturbance*

- Noise emitting Project activities will be managed to minimize sensory disturbance of wildlife, especially during sensitive time periods (such as denning and calving) in accordance with a wildlife programs within the EMS and specifically with the Draft Caribou Mitigation Plan (see Appendix 9-E).
- Low sound emission equipment, regular maintenance of equipment, and the use of silencers or mufflers (whenever practical) will be used to reduce noise associated with Project activities.
- Excessive noise-generating activities will be avoided whenever practicable.
- Lighting will be focused on work sites and not surrounding areas, to minimize sensory disturbance of wildlife.
- Dust generation and subsequent deposition on vegetation and in waterbodies (including potential deposition of trace metals and radionuclides) will be limited through dust suppression techniques such as road watering and traffic management.
- Should wildlife habitat features (i.e., dens, burrows, or lodges) be identified during pre-clearing wildlife surveys, they will be marked, and, prior to commencement of any construction-related activities, further action will be determined in accordance with federal and provincial regulations.

9.3.5.2.7 *Road and Traffic Management*

- Traffic and access control measures will be implemented in accordance with erosion and sediment controls established under the EMS, including reducing traffic volume by scheduling truck convoys, using high-volume haul trucks, and restricting public access to the Project site and roads (e.g., private vehicles, snowmobiles, all-terrain vehicles, and foot traffic). It is important to note that if any individual were seeking access around the Project area to undertake Aboriginal and / or Treaty Rights, Denison staff would facilitate this, provided it were safe to do so given activities in the area.
- Appropriate road signage will be installed (e.g., speed limits, wildlife crossings) along Project roads to minimize the risk of wildlife-vehicle collisions.
- Speed limits will be implemented to reduce the risk of wildlife-vehicle collisions.

- Wildlife will have the right-of-way on Project roads, unless it is unsafe to stop (i.e., if a collision is imminent). Vehicles will not be used to encourage wildlife to move off Project roads.
- Processes will be implemented for employees and contractors to slow down and/or stop vehicles/equipment to allow animals to move away or off the road before resuming normal road speeds for the area.
- Employees and contractors will report and communicate the location and circumstances of any roadkill observed on or alongside Project roads. Large-bodied wildlife carcasses found will be reported to SK MOE and disposed of as directed to prevent scavenging.
- Vegetation along Project roads will be managed to reduce attractiveness to wildlife (e.g., forage plants) and maintain appropriate sightlines for drivers to minimize wildlife-vehicle collisions.
- Alternative measures on Project roads for de-icing and winter traction (e.g., sand, gravel) or dust suppression (e.g., water) will be implemented, whenever practicable.
- Appropriately sized gaps in the roadside snowbanks during winter will be maintained to facilitate wildlife crossing and escape And, with that, reducing their risk of vehicle collisions.
- New Project site and access roads will be designed to minimize sightlines for predators, whenever practicable, while still maintaining general road safety.
- Ditches and culverts along Project roads will be designed and maintained to minimize pooling of water as roadside pools may attract wildlife.

9.3.5.2.8 Waste and Hazardous Materials Management

- A “no littering policy” for employees and contractors will be implemented within the Project Area.
- Waste will be collected and temporarily stored in wildlife-proof containers to avoid attracting scavengers and with that increase the risk for human-wildlife interactions.
- The wildlife-proof containers will be inspected regularly for evidence of wildlife presence or access to waste disposal facilities. If evidence of wildlife presence or access to waste disposal facilities is detected, modified systems will be implemented and/or off-site waste disposal/incineration frequencies will be increased.
- The use of hazardous materials will be limited as much as possible.
- Hazardous materials will be handled, stored, and disposed of appropriately and in accordance to avoid attracting wildlife (e.g., wildlife-proof containers, exclusion fencing).
- Physical deterrents (e.g., fencing) will be employed around contaminated areas (e.g., waste ponds and waste pads), the domestic landfill, or hazardous materials storage areas to discourage wildlife use.
- Appropriate hazardous materials management practices will be implemented in accordance with industry guidelines to minimize the risk of accidental spills or leakage.

- Appropriate spill response kits will be positioned adjacent to areas where hazardous materials are stored in accordance with the Spill Response Plan.
- A minimum 100 m distance from any waterbody will be maintained for fuel storage, refueling activities, or equipment servicing in accordance with the Spill Response Plan.
- Appropriate fuel, chemical, and materials management practices will be followed in accordance with the Spill Response Plan to minimize the risk of accidental spills or leakage of diesel fuel, other hydrocarbons, and other hazardous materials.
- Air emissions will be reduced to the extent practical through implementation of the development of air emissions management monitoring and monitoring plans within the EMS.
- All vehicles and equipment will be equipped with industry-standard emission control systems; unnecessary idling of vehicles will be prohibited.
- All vehicles and equipment will be maintained in good working condition (e.g., no leaks) and furnished with industry-standard spill response kits.
- Mitigation measures to reduce the potential for dispersion of radiation to vegetation will be implemented in accordance with the Radiation Protection Plan.
- Education on and enforcement of proper waste and hazardous materials management practices will be provided to employees and contractors.

9.3.5.2.9 Sediment and Erosion Control

Erosion control measures that are designed to prevent sediment from entering waters frequented by wildlife species at risk include (but are not limited to):

- the installation of silt fence, straw wattles, and/or erosion control blankets to prevent erosion and limit sediment transport; and
- the maintenance of vegetated barriers between Project components and wetland features, as much as practical.
- Information on erosion and sediment control measures will be provided in applicable management plans, which will be developed to support Project permitting and licensing.
- Routine inspections and management will be completed to document the effectiveness of erosion control measures, and any required replacement of these structures will be completed as required.

9.3.6 Residual Effects Evaluation

This section describes the likely residual effects of the Project on the VCs of Ungulates, Furbearers, and Woodland Caribou and their associated KIs. Residual effects are effects that remain after the implementation of mitigation measures and management strategies and are the expected consequences of the Project.

The approach to assessing residual Project effects on Ungulates, Furbearers, and Woodland Caribou VCs follows the methodology outlined in Section 5.8 in Section 5. For each VC and associated KI, each residual effect is assessed in the context of the Project activities that will occur within each Project phase. Each residual effect is then characterized based on the combined predicted residual effect for all phases.

For the residual effects evaluation for the Ungulates, Furbearers, and Woodland Caribou VCs, Omnia's (2020; see Appendix 9-B) original interpreted ecosite mapping product (referred to in Section 9.3.3) was updated to reflect provincial ecosite classifications used in Section 9.2 of this EIS. These updates relate to novel regenerating forest types, as explained in the following paragraphs.

Novel regenerating forest types characterized within the original interpreted ecosite mapping product by Omnia (2020; see Appendix 9-B) included three upland types and two wetland types. The three novel upland regenerating coniferous forest types (RF1-C, RF2-C, RF3-C) were exclusively referred to as regenerating forest types RF1, RF2, and RF3 in the Terrestrial Baseline Report (Appendix 9-B). They describe structural categories along a natural successional trajectory from a low shrub stage characteristic of recent fire disturbance (RF3) toward a young forest stage (RF1; Appendix 9-B). The two novel regenerating bog types (RF2-B and RF3-B) were introduced but not used in the baseline report (Appendix 9-B).

As described in detail in the Annex Report to the Terrestrial Baseline Report (EDI 2021 in Appendix 9-C), vegetation plots within all three novel upland regenerating forest types indicate a dominance of jack pine within the tallest vegetation layer (sometimes co-dominant with black spruce), with blueberry and reindeer lichen dominating the low shrub layer and ground cover, respectively. Vegetation community observations for the three novel upland regenerating forest types are consistent with the provincial ecosite classifications of BS3 (jack pine – blueberry/lichen) and BS7 (black spruce – blueberry/lichen). For consistency, these provincial ecosite classifications are used instead of RF1, RF2, and RF3 when describing habitat types in the following sections.

9.3.6.1 Definitions for Residual Effects Characterization and Significance

9.3.6.1.1 Residual Effects Characterization

General definitions of the residual effects characteristics are provided in Table 5.8-1 in Section 5. Residual effects characteristics pertaining to the three residual effects specific to Ungulates, Furbearers, and Woodland Caribou VCs are defined in Table 9.3-7.

Table 9.3-7: Ungulates, Furbearers, and Woodland Caribou Valued Components – Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Negative effect or effect is not desirable. **Positive** – Beneficial effect or effect is desirable.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Low** Alteration and/or Loss of Habitat: effect occurs that might be detectable but is expected to be within the range of baseline values, or within the range of natural variability (0 to 5%). Change in Mortality and Change in Tissue Constituent Concentrations: effects occur that might be detectable but are expected to be within the range of baseline values, or within the range of natural variability. **Moderate** Alteration and/or Loss of Habitat: effect is expected to be at or to slightly exceed the limits of baseline values (by greater than 5 to 15%); it is clearly an effect and may become a management concern. Change in Mortality and Change in Tissue Constituent Concentrations: effects are expected to be at or to slightly exceed the limits of baseline values; it is clearly an effect and may become a management concern. **High** Alteration and/or Loss of Habitat: effect is expected to exceed the limits of baseline values (by greater than 15%). It can pose a serious risk and represents a management concern. Change in Mortality and Change in Tissue Constituent Concentrations: effects are expected to exceed the limits of baseline values; it can pose a serious risk and represents a management concern.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the Wildlife LSA. **Regional** – Effect extends beyond the Wildlife LSA into the Terrestrial RSA. **Beyond Regional** – Effect extends beyond Terrestrial RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions. **Partially Reversible** – A residual effect that partially diminishes to baseline conditions. **Irreversible** – A residual effect that will not diminish to baseline conditions.
Context	The extent to which the VC or KI has been	**Low** – VC/KI has high resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem,

Residual Effect Characteristic	Definition	Rating
	affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its ability to recover from that effect (i.e., resilience)	and/or a lack of historic and ongoing anthropogenic or natural disturbance. No species at risk present. **Moderate** – VC/KI has moderate resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or an intermediate level of historic or ongoing anthropogenic or natural disturbance with the capacity to assimilate more change. Presence of species at risk. **High** – VC/KI has weak resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or a high level of historic or ongoing anthropogenic or natural disturbance. Presence of SARA-listed species.
Likelihood	Likelihood that the residual effect will occur including consideration of the likelihood that the mitigation will be successful.	**Likely** – Moderate to high probability that the residual effect will occur. **Unlikely** – Low probability that the residual effect will occur.

9.3.6.1.2 Significance and Confidence

The characterization of residual effects is based on the review of existing conditions (Section 9.3.3), the assessment of Project-related effects and proposed mitigation measures and management strategies, other relevant scientific information, IK, and the professional judgment of the EA team. All residual effects (independent of their significance rating) are carried forward to the CEA.

The significance of the residual effect is rated as **not significant** or **significant**, based on the following:

Not significant – a residual effect that is not expected to result in a change to a VC/KI that would alter its population viability or persistence beyond an acceptable level (e.g., where it is not sustainable or is unavailable to contribute to biodiversity and ecosystem function).

Significant – a residual effect that is expected to result in a change to a VC/KI that would alter its population viability or persistence beyond an acceptable level (e.g., where it is not sustainable or is unavailable to contribute to biodiversity and ecosystem function).

Limitations of existing data and uncertainty associated with the assessment were also characterized by assigning a level of confidence for the assessment predictions made for each residual effect. Confidence levels were considered in relation to:

- scientific certainty relative to the quantification of the effect, including the quality and or quantity of data and the understanding of effect mechanisms;
- scientific certainty relative to the effectiveness of the proposed mitigation measures; and
- professional judgment based on prior experience in predicting effects and the known effectiveness of proven mitigation measures.

Therefore, a low level of confidence is assigned when the VC/KI and/or the Project interaction is not well understood, and/or the mitigation measures have not been proven effective. A moderate level of confidence is assigned where the VC/KI is understood in similar ecosystems and effects have been documented in the larger regional area or in the literature, and/or the mitigation measures have been proven effective elsewhere. A high level of confidence is assigned when the VC/KI and Project interactions are well understood, and the mitigation measures have been proven effective.

9.3.6.2 Residual Effects Evaluation for Ungulates

The Ungulates VC is represented by one KI—moose. The residual effects evaluation, therefore, assesses Project-related effects on moose.

9.3.6.2.1 Alteration and/or Loss of Habitat

The assessment of the alteration and/or loss of habitat residual effect considers the direct loss of habitat and the indirect alteration of habitat during all Project phases. Moose are known to use the Wildlife LSA and Terrestrial RSA. While less frequently than other wildlife, they were captured by wildlife cameras on trails and hand-cut lines.

Moose winter trails were observed during the baseline studies at highest densities in regenerating forest types BS3 and BS7 (jack pine – blueberry/lichen and black spruce – blueberry/lichen) and BS17 (black spruce treed bog) ecosites (Appendix 9-B). Moose winter pellet groups were detected at highest densities in the BS7 (black spruce/blueberry/lichen) ecosite and summer pellet groups were detected at highest density in the BS16 (black spruce/balsam poplar/river alder swamp) ecosite (Appendix 9-B).

Browse of species most consumed by moose in the study areas (alder, willow, and sweet gale) was observed in BS3 (jack pine/blueberry/lichen), BS7 (black spruce – blueberry / lichen), BS16 (black spruce/balsam poplar/river alder swamp), and BS22 (leatherleaf shrubby poor fen) ecosites (Appendix 9-B).

Considering the baseline data (Appendix 9-B), moose habitat is described in the following text without seasonal differentiation and referred to as available moose habitat. Through all seasons, moose sign was detected most frequently in the following ecosites: regenerating forest types BS3 and BS7 (jack pine – blueberry/lichen and black spruce – blueberry/lichen), BS7 (black spruce – blueberry/lichen), BS16 (black spruce/balsam poplar/river alder swamp), BS17 (black spruce treed bog), and BS22 (leatherleaf shrubby poor fen).Figure 9.3-9 depicts available moose habitat in the Project study areas. Table 9.3-8 provides a summary of available moose habitat in the Project Area, Wildlife LSA, and Terrestrial RSA. Ecosite codes and descriptions are adopted from Table 9.2-5.

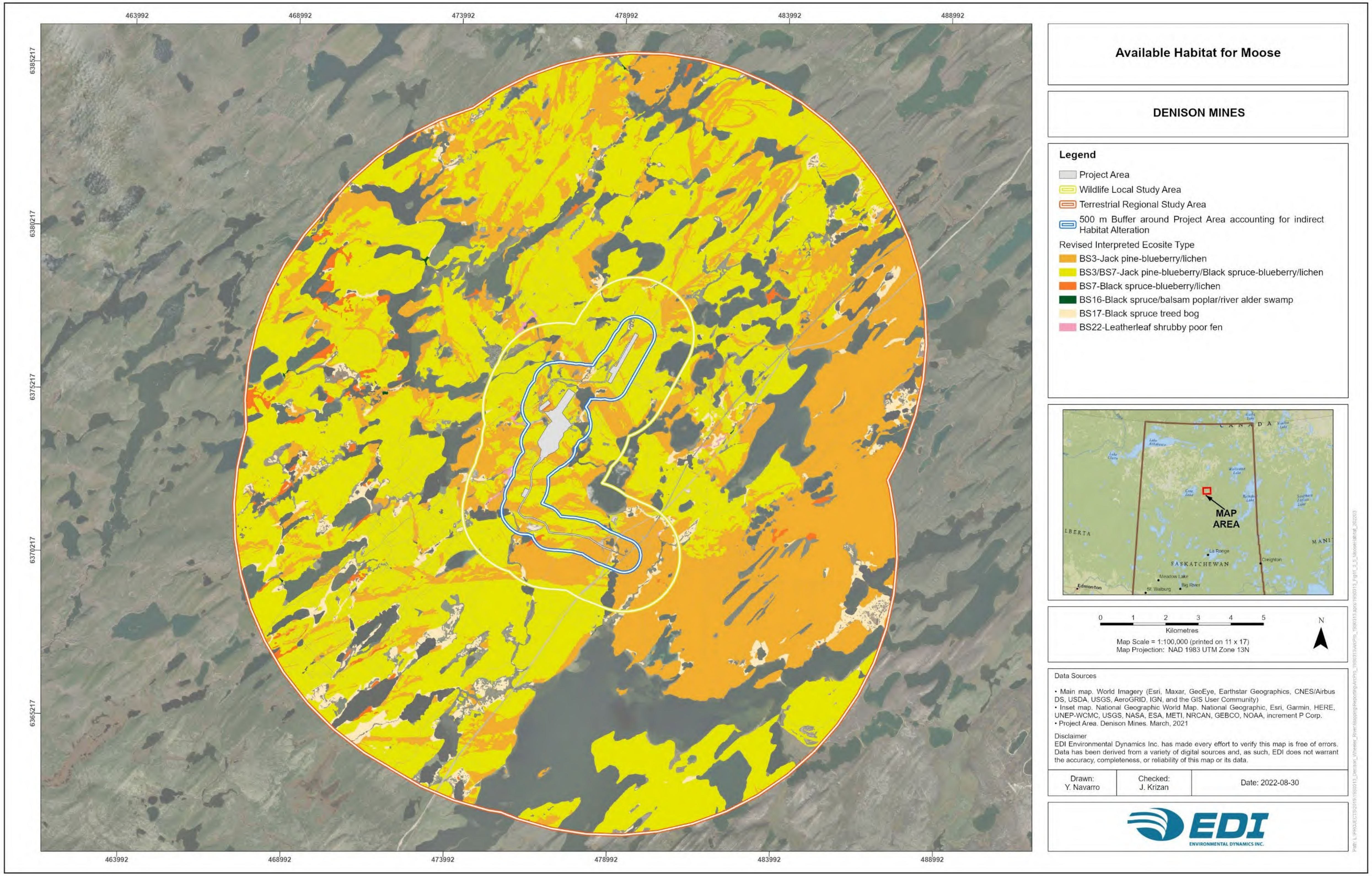

Figure 9.3-9: Available Habitat for Moose

Table 9.3-8: Summary of Available Moose Habitat in the Project Area, Wildlife Local Study Area and the Terrestrial Regional Study Area

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS3 (mature forest)	Jack pine – blueberry / lichen	31.1	18.3	1,693.7	35.0	10,374.8	25.8
BS3 and BS7 (regenerating forest types)	Jack pine – blueberry / lichen and black spruce – blueberry / lichen	110.2	64.9	2,268	46.8	17,494.0	43.5
BS7 (mature forest)	Black spruce – blueberry / lichen	0.04	0.03	9.8	0.2	281.0	0.7
BS16	Black spruce / balsam poplar / river alder swamp	-	-	-	-	8.8	0.02
BS17	Black spruce treed bog	0.4	0.2	98.8	2.0	1,157.1	2.9
BS22	Leatherleaf shrubby poor fen	-	-	-	-	28.5	0.1
Total		**141.7**[1]	**85.0**	**4,070.3**[2]	**84.0**	**29,344.2**[3]	**73.0**

1, 2, 3 These areas represent the total area of available moose habitat within each study area; the percentages are the amount of available habitat relative to the Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha).

The characterization of the alteration and/or habitat loss residual effect considers the Project effects on available moose habitat within the Wildlife LSA and Terrestrial RSA. As outlined in Table 9.3-8, 85.0% of the Project Area, 84% of the Wildlife LSA, and 73% of the Terrestrial RSA provide habitat types that are potentially available to moose year-round.

Based on studies summarized in Section 9.3.3.1.1, the alteration of available moose habitat is quantified by applying a buffer of 500 m around the Project Area in which Project effects in the form of sensory disturbance are assumed to affect available moose habitat and make it functionally unavailable for use. Progressive reclamation is anticipated to begin during Construction; however, a conservative approach is used, in that moose habitat within the Project Area is considered to be unavailable for the duration of the Project and will only become available as habitat following Post-Decommissioning (i.e., during the regeneration of vegetation following Decommissioning).

Direct habitat loss is calculated as the area of available moose habitat lost due to site clearing within the Project Area. Direct habitat loss has been mitigated by reducing the size of the Project Area to the extent practicable during Project design; however, available moose habitat is still predicted to be cleared during Construction. In the Project Area, 141.7 ha or 100% of available moose habitat is assumed to be removed and will not be available to moose for the duration of the Project (Table 9.3-9). This represents 3.9% of available moose habitat within the Wildlife LSA and 0.5% within the Terrestrial RSA.

An additional 1,128.9 ha (27.7%) of available moose habitat in the Wildlife LSA may experience habitat alteration from indirect Project effects, such as sensory disturbance. This represents 3.9% of available moose habitat in the Terrestrial RSA (Table 9.3-9). Mitigation measures outlined in Section 9.3.5 are anticipated to reduce the effects of alteration and/or loss of habitat on moose, but not eliminate them entirely.

Table 9.3-9: Summary of Available Moose Habitat, Direct Habitat Loss, and Habitat Alteration in the Study Areas

Study Area	Ecosite Description	Amount of Available Moose Habitat (ha)	Percent of Available Moose Habitat (%)	Amount of Available Moose Habitat Loss (ha)	Percent of Available Moose Habitat Loss (%)	Amount of Available Moose Habitat Altered (ha)[1]	Percent of Available Moose Habitat Altered (%)
Project Area	BS3 (mature forest) Jack pine – blueberry / lichen	31.1	18.3	31.1	100	N/A	N/A
	BS3 / BS7 (regenerating forest types) Jack pine – blueberry / lichen and black spruce – blueberry / lichen	110.2	64.9	110.2	100	N/A	N/A
	BS7 (mature forest) Black spruce – blueberry / lichen	0.04	0.03	0.04	100	N/A	N/A
	BS16 Black spruce / balsam poplar / river alder swamp	-	-	-	-	-	-
	BS17 Black spruce treed bog	0.4	0.2	0.4	100	N/A	N/A
	BS22 Leatherleaf shrubby poor fen	-	-	-	-	-	-
	Total	141.7[2]	85.0	141.7	100	N/A	N/A
Wildlife LSA	BS3 (mature forest) Jack pine – blueberry / lichen	1,693.7	35.0	31.1	1.8	445.1	26.3
	BS3 / BS7 (regenerating forest types) Jack pine – blueberry / lichen and black spruce – blueberry / lichen	2,268	46.8	110.2	4.9	656.5	29.0
	BS7 (mature forest) Black spruce – blueberry / lichen	9.8	0.2	0.04	0.5	5.3	53.9

Study Area	Ecosite Description	Amount of Available Moose Habitat (ha)	Percent of Available Moose Habitat (%)	Amount of Available Moose Habitat Loss (ha)	Percent of Available Moose Habitat Loss (%)	Amount of Available Moose Habitat Altered (ha)[1]	Percent of Available Moose Habitat Altered (%)
	BS16 Black spruce / balsam poplar / river alder swamp	-	-	-	-	-	-
	BS17 Black spruce treed bog	98.8	2.0	0.4	0.4	22.0	22.3
	BS22 Leatherleaf shrubby poor fen	-	-	-	-	-	-
	Total	4,070.3[3]	84.0	141.7	3.9	1,128.9	27.7
Terrestrial RSA	BS3 (mature forest) Jack pine – blueberry / lichen	10,374.8	25.8	31.1	0.3	445.1	4.3
	BS3 / BS7 (regenerating forest types) Jack pine – blueberry / lichen and black spruce – blueberry / lichen	17,494.0	43.5	110.2	0.6	656.5	3.8
	BS7 (mature forest) Black spruce – blueberry / lichen	281.0	0.7	0.04	0.02	5.3	1.9
	BS16 Black spruce / balsam poplar / river alder swamp	8.8	0.02	-	-	-	-
	BS17 Black spruce treed bog	1,157.1	2.9	0.4	0.03	22.0	1.9
	BS22 Leatherleaf shrubby poor fen	28.5	0.1	-	-	-	-
	Total	29,344.2[4]	73.0	141.7	0.5	1,128.9	3.9

1 Based on a 500 m buffer around the Project Area.

2, 3, 4 This area does not reflect the entire Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha) but represents the total area of available moose habitat in each study area.

N/A = Not Applicable

Residual Effects Characteristics

The residual effects characterization for the alteration and/or loss of available moose habitat is provided in Table 9.3-10.

The direction is predicted to be adverse. The Project is expected to affect available moose habitat directly (through habitat loss) and indirectly (through habitat alteration).

The magnitude is predicted to be low. It is anticipated that up to 4.4% of available moose habitat within the Terrestrial RSA may be altered or lost as a result of the Project: 0.5% of available moose habitat within the Terrestrial RSA will be cleared within the Project Area during Construction, and an additional 3.9% of available moose habitat within the Terrestrial RSA may be altered through indirect effects (such as sensory disturbance through noise and dust deposition) during all Project phases.

Moose densities in the Terrestrial RSA are generally low. Moose in southern areas of Saskatchewan have been reported as declining (SK MOE 2019a). Studies of areas that include the Terrestrial RSA have found relatively low moose densities, even though there are vast areas of regenerating vegetation (i.e., after forest fire disturbances) that provide potential moose forage (Neufeld et al. 2021) indicating that habitat is not limiting. Local Knowledge concurs with the findings of low or declining moose numbers and suggests that this might be caused by moose moving south, which could possibly be a result of a natural change (19-LK-ERFNTrap-134.149). In some areas, it was observed that moose may slowly return into previously burnt areas (21-EN-ERFN-473.24). In addition, the area north of the Terrestrial RSA was thought to provide better habitat for moose than the Project study areas (19-LK-ERFNTrap-134.149) and the area east and north of Three Mile Lake (in the northern portion of the Terrestrial RSA) was pointed out as having moose (19-LK-ERFNTrap-134.149).

The residual effect is predicted to be local in geographic extent. While the direct loss of available moose habitat is expected to be limited to the Project Area during Construction, indirect Project effects are expected to occur within the Wildlife LSA within a 500 m area around the Project Area during all Project phases.

The residual effect is predicted to occur over the medium-term (3 to 38 years) because of the short time required for moose habitat to regenerate following the cessation of disturbance and start of reclamation. Progressive reclamation is anticipated to begin in some parts of the Project Area following Construction; however, revegetation within most of the Project Area is expected to occur as part of reclamation activities during Decommissioning, up to 18 years after clearing during Construction. It is expected that many of the preferred forage species (e.g., willow, alder, and sweet gale; Appendix 9-B) will increase in abundance after reclamation activities, and that the Project Area will likely support areas of suitable foraging habitat within a few years after revegetation.

The frequency of effect is predicted to be frequent. While loss of available moose habitat resulting from vegetation clearing during Construction will occur only initially, additional clearing for maintenance and/or safety purposes may happen throughout Operation. Alteration of available moose habitat within the Wildlife LSA through indirect Project effects is anticipated to be frequent throughout Construction, Operation, and Decommissioning phases, and infrequent during Post-Decommissioning.

The alteration and/or loss of available moose habitat is predicted to be fully reversible. Through progressive and final reclamation, disturbed areas within the Project Area will be revegetated with a focus on achieving baseline conditions. Moose prefer habitat of regenerating forage following a disturbance, and it is anticipated that revegetated areas will become available to moose starting near the end of Post-Decommissioning. Progressive reclamation may occur in some parts of the Project Area prior to Post-Decommissioning; however, most revegetation is anticipated to occur following the end of Operation and become available moose habitat during and following Post-Decommissioning. In addition, the alteration of available moose habitat is expected to be fully reversed within a similar time frame as sensory disturbances diminish with the ceasing of Project operation activities and subsequent decommissioning of Project components.

The context of the residual effect of alteration and/or loss of available moose habitat is predicted to be moderate. Available moose habitat that is altered or cleared will remain so until Post-Decommissioning when final reclamation and revegetation will occur. Revegetated areas are expected to become available moose habitat within a few years of revegetation and moose are known to prefer habitat following disturbance due to a proliferation of preferred forage. While moose and moose sign were observed in the Terrestrial RSA (Appendix 9-B), moose numbers in the Terrestrial RSA have been reported to be generally low, similar to trends in southern Saskatchewan (SK MOE 2019a). Moose habitat is largely disturbance (i.e., forest fires) driven, and adapted to stress. Moose densities in an area that includes the Terrestrial RSA were found to be relatively low, even though there are vast areas of postburn regenerating vegetation providing potential moose forage (Neufeld et al. 2021) and IK concurs with the findings of low moose numbers (19-LK-ERFNTrap-134.149).

The residual effect of alteration and/or loss of available moose habitat is predicted to be likely. Available moose habitat is expected to be cleared in the Project Area during Construction and indirectly affected in the Wildlife LSA during all phases of the Project.

Table 9.3-10: Summary of the Characteristics Ratings for Alteration and/or Loss of Available Moose Habitat

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project is expected to affect available moose habitat directly and indirectly.
Magnitude	Low	Up to 4.4% of available moose habitat within the Terrestrial RSA is predicted to be affected by the Project. This includes 0.5% habitat loss and up to 3.9% of habitat alteration.
Geographic Extent	Local	The direct loss of available moose habitat is expected to be limited to the Project Area during Construction. Indirect effects resulting in habitat alteration are expected to be restricted to the Wildlife LSA during all Project phases.

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Duration	Medium-term	The loss of available moose habitat will mainly occur during Construction; however, the alteration of habitat will continue through all phases. The reclamation and revegetation of the Project Area will not be complete until Post-Decommissioning, at which time revegetated areas are expected to start to become available moose habitat.
Frequency	Frequent	Loss of available moose habitat will occur initially during Construction, and alteration of available moose habitat through indirect Project effects is anticipated to be frequent throughout all Project phases until Post-Decommissioning.
Reversibility	Fully Reversible	Disturbed habitat within the Project Area will be revegetated and will likely become available to moose starting toward the end of Post-Decommissioning. The alteration of available moose habitat is expected to be reversed as sensory disturbances diminish with the ceasing of Project operation activities and subsequent decommissioning of Project components.
Context	Moderate	Revegetated areas are expected to become available moose habitat within a few years of revegetation as moose are known to prefer habitat following disturbance due to a proliferation of preferred forage. In addition, moose densities in the region are low. As such, available moose habitat within the Terrestrial RSA, which is disturbance (i.e., forest fires) driven, is expected to have a moderate resilience to stress.
Likelihood	Likely	Available moose habitat is expected to be cleared in the Project Area during Construction and to be indirectly affected in the Wildlife LSA during all phases of the Project.

Significance and Confidence

The residual effect of alteration and/or loss of available moose habitat is not expected to result in a change that will alter moose habitat integrity to the point where it would not be able to sustain the regional moose population. Therefore, the effect is assessed as **not significant**.

The level of confidence of this prediction is moderate. The effects of habitat loss and alteration on moose are well known, and effective, proven mitigation measures will be implemented. However, some level of uncertainty exists related to the available background and baseline information used to identify available moose habitat in this assessment.

9.3.6.2.2 Change in Mortality

The residual effects evaluation of the change in moose mortality considers Project-related effects within the Terrestrial RSA. Section 9.3.3.1 summarizes the existing knowledge of moose population estimates and mortality in northern Saskatchewan. The assessment includes considerations of direct mortality from Project activities and interactions with Project components, and indirect mortality as a result of the Project. The highest risk of moose mortality is anticipated to be associated with activities during the Construction and Operation phases; however, the risk of indirect moose mortality exists during all Project phases.

Potential sources of a change in direct mortality for moose include interactions with Project activities, most likely vehicle collisions. Speed limits will be implemented on all access and site roads as a proven mitigation measure to reduce the likelihood of wildlife-vehicle collisions.

Additional sources of direct mortality include interactions with Project components, such as entrapment within snowbanks along roads resulting in an increased risk of vehicle collision. Effective mitigation measures (e.g., breaks in snowbanks and speed limits) will be implemented to reduce moose mortality.

Potential sources of a change in indirect mortality for moose may include increased hunter access (20-LK-LEASESUR-267.67; ERFN and SVS 2022), ease of predator travel and access (21-EN-ERFN-473.12), and sensory disturbances that may reduce body condition or increase stress (Beazley et al. 2004, Barber et al. 2010, Ewacha 2016, Mumma and Gilligham 2019). Moose are highly valued by subsistence and sport hunters, and they are an important cultural species for Indigenous people (SK MOE 2019a). Based on 2016 to 2019 harvest reports (SK MOE 2021), the average annual moose harvest by resident hunters for the entire province of Saskatchewan is 4,435 moose (mainly composed of draw and resident regular licences). Between 2014 and 2019 (the years for which data are available), no draw licences were sold for areas including the Terrestrial RSA and, therefore, no associated harvest was reported. It is assumed that most of the annual harvest through resident regular licences occurred in the southern part of the province where a road network provides access for hunters (Section 9.3.3.1.1).

Project-related sensory disturbances, such as increased noise levels from drilling activities, vehicle and aircraft traffic, and dust deposition (including trace metals and radionuclides), could increase stress levels in moose and contribute to reduced reproductions, poor health, and possibly mortality.

Project mitigation measures identified in Section 9.3.5 are expected to limit interactions between moose and potential sources of direct and indirect mortality, thereby minimizing the residual effect of change in mortality. Although Project activities may result in a change of direct and/or indirect mortality of moose within the Terrestrial RSA, with the implementation of mitigation measures, the residual effect is not expected to result in a change to the moose population.

<u>Residual Effects Characteristics</u>

The residual effects characterization for the change in mortality of moose is provided in Table 9.3-11.

The direction of the residual effect of change in mortality is predicted to be adverse. While it is expected that the risks for Project-related moose mortalities is limited (due to effective mitigation measures), any additional mortality in a small and/or declining population will affect the population.

The magnitude of the effect is expected to be low. Mitigation measures are anticipated to be effective at reducing a change in direct and indirect mortality, and the risk of mortality is expected to be within the range of natural variability.

The geographic extent is predicted to be regional. A change of direct mortality is expected to mainly occur within the Project Area; however, indirect moose mortality may occur outside the Wildlife LSA and into the Terrestrial RSA. Sources for direct mortality (e.g., vehicle collisions on access and site roads, exposure to waste pads and ponds) that occur within the Project Area may affect moose with home ranges extending into the Terrestrial RSA. Any increase in traffic on Highway 914 may also affect direct mortality in the Wildlife LSA and Terrestrial RSA. In addition, sources for indirect moose mortality (e.g., increased hunter access, changes to health due to sensory disturbances, changes to predator-prey dynamics) may result in mortality outside the Wildlife LSA.

It is estimated that the duration of the effect will be medium-term (i.e., 3 to 38 years). The potential for a change in direct mortality is expected to be highest during the Construction and Operation phases when vehicle traffic and potential exposure to and entrapment in Project components is likely to be most frequent, and it is predicted to continue through to the end of Post-Decommissioning. The potential for indirect mortality is expected to be highest during Operation, when vehicle/equipment and aircraft traffic, exposure to sensory disturbances, as well as increased hunting and predation pressure may result in indirect mortality. The potential for a change in indirect mortality is anticipated to decrease in Decommissioning following the removal of Project components and a reduction in Project activities and be limited during Post-Decommissioning.

The frequency of effect is assessed as infrequent. Mitigation measures (e.g., speed limits; exclusion fences preventing access to Project components) are anticipated to limit the potential for moose mortality; however, a change in direct and indirect mortality could occur sporadically through all Project phases.

It is predicted that the effect will be fully reversible. The risks of direct or indirect mortality are anticipated to decline during Decommissioning following the removal of Project components and a reduction in Project activities, and to diminish to baseline conditions following Post-Decommissioning.

The context for the residual effect of change in mortality is expected to be moderate. Moose populations are known to be resilient to additional mortality when their populations are stable or increasing; however, the presence of multiple stressors may affect the ability for moose populations to recover from any additional increases in mortality, particularly in small or decreasing populations (Gasaway et al. 1983, Solberg et al. 1999). Estimates of the moose population in most regions of Saskatchewan suggest generally low densities or declining populations (SK MOE 2019a, Neufeld et al. 2021). Therefore, the context rating of moderate considered the potential effect of a limited Project-related increase in mortalities.

The residual effect of change in moose mortality is likely to occur. Mitigation measures are expected to reduce, but not fully eliminate, the residual effect on moose.

Table 9.3-11: Summary of the Characteristics Ratings for Change in Mortality of Moose

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project is expected to affect a change in mortality of moose.
Magnitude	Low	Mitigation measures are anticipated to be effective at reducing the potential for a change in direct and indirect mortality, and the risk of mortality is expected to be within the range of natural variability.
Geographic Extent	Regional	The change in direct mortality is expected to occur mainly within the Project Area; however, indirect mortality may extend into the Terrestrial RSA.
Duration	Medium-term	Moose mortality may occur during all phases of the Project. The potential for a change in direct mortality is expected to be highest during the Construction and Operation phases and the potential for indirect mortality is expected to be highest during Operation, decreasing during Decommissioning, and limited during Post-Decommissioning.
Frequency	Infrequent	It is expected that the potential for a change in direct and indirect moose mortality is limited but the residual effect may occur sporadically throughout the life of the Project.
Reversibility	Fully Reversible	It is anticipated that the change in moose mortality will decline during Decommissioning following the removal of Project components and a reduction in Project activities and will diminish to baseline conditions following Post-Decommissioning.
Context	Moderate	Estimates of moose populations suggest generally low or declining densities in the area. The rating is based on the potential effect of a limited Project-related increase in mortalities.
Likelihood	Likely	Mitigation measures are expected to reduce, but not fully eliminate, the residual effect on moose.

Significance and Confidence

The residual effect of change in mortality is not expected to result in a change in moose mortality that will alter the integrity of the regional moose population to the point where it could not be sustained. Therefore, the effect is assessed as **not significant**.

The level of confidence of this prediction is moderate. The risks of moose mortality are well known, and effective, proven mitigation measures will be implemented. They are anticipated to reduce the change in direct and indirect mortality of moose to levels within the range of natural variability. However, some level of uncertainty exists about the status of the regional moose population and, with that, their ability to assimilate limited additional mortality.

9.3.6.3 Residual Effects Evaluation for Furbearers

The Furbearer VC is represented by four KIs—wolverine, pine marten, mink, and muskrat. The residual effects evaluation, therefore, assesses Project-related effects on these species.

9.3.6.3.1 Alteration and/or Loss of Habitat

The assessment of the alteration and/or loss of habitat residual effect considers the direct loss of habitat and the indirect alteration (e.g., sensory disturbances, edge effects, or perceived barriers) of habitat during all Project phases.

Wolverine

Wolverine were not observed during baseline studies (Appendix 9-B). While they are not encountered regularly in the region, LK holders noted no change in frequency of wolverine observations over the years (19-LK-ERFNTrap-134.162). They are known to occur in low densities across all forest stand and vegetation types, they are absent from most areas of human development and activities, and they avoid linear infrastructure (ABMI 2020a). Based on this evaluation, year-round available wolverine habitat in the Project study areas was determined as comprising all ecosites except for anthropogenic development and waterbodies. Figure 9.3-10 depicts available wolverine habitat in the project study areas.

Table 9.3-12 provides a summary of available wolverine habitat in the Project Area, Wildlife LSA, and Terrestrial RSA. Ecosite codes and descriptions are adopted from Table 9.2-5.

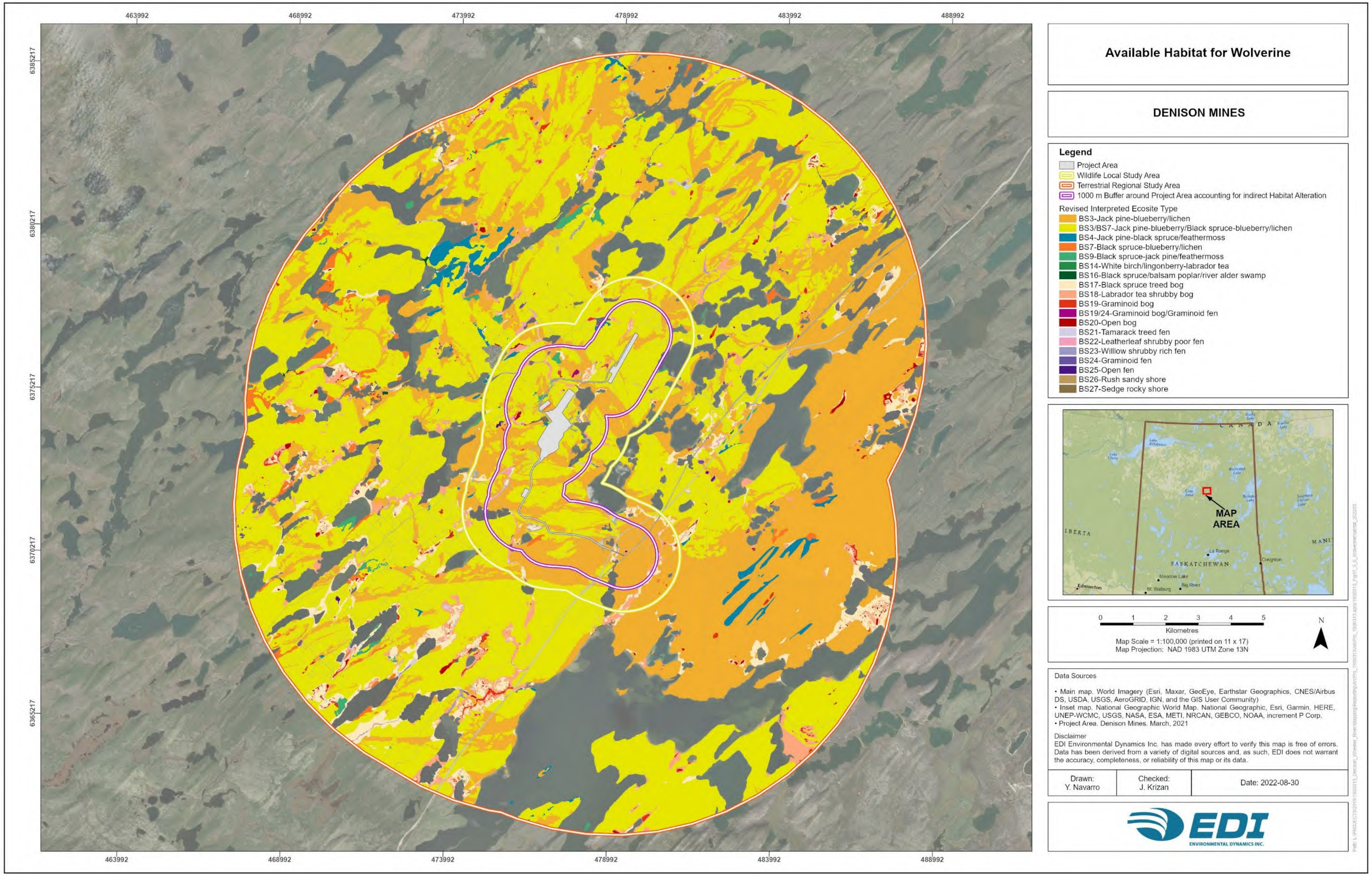

Figure 9.3-10: Available Habitat for Wolverine

Table 9.3-12: Summary of Available Wolverine Habitat in the Project Area, Wildlife Local Study Area, and the Terrestrial Regional Study Area

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS3 (mature forest)	Jack pine – blueberry / lichen	31.1	18.3	1,693.7	35.0	10,374.8	25.8
BS4	Jack pine – black spruce / feathermoss	2.9	1.7	18.2	0.4	332.8	0.8
BS3 and BS7 (regenerating forest types)	Jack pine – blueberry / lichen and black spruce – blueberry / lichen	110.2	64.9	2,268	46.8	17,494.0	43.5
BS7 (mature forest)	Black spruce – blueberry / lichen	0.04	0.03	9.8	0.2	281.0	0.7
BS9	Black spruce – jack pine / feathermoss	0.3	0.2	12.3	0.3	148.5	0.4
BS14	White birch / lingonberry – Labrador tea	-	-	0.03	0.0006	1.8	0.005
BS16	Black spruce / balsam poplar / river alder swamp	-	-	-	-	8.8	0.02
BS17	Black spruce treed bog	0.4	0.2	98.8	2.0	1,157.1	2.9
BS18	Labrador tea shrubby bog	0.003	0.002	105.1	2.2	990.0	2.5
BS19	Graminoid bog	-	-	10.0	0.2	160.5	0.4
BS19 / BS24	Graminoid bog / Graminoid fen	-	-	2.4	0.05	2.4	0.006
BS20	Open bog	-	-	4.8	0.1	65.5	0.2
BS21	Tamarack treed fen	-	-	15.6	0.3	66.5	0.2
BS22	Leatherleaf shrubby poor fen	-	-	13.2	0.3	28.5	0.1
BS23	Willow shrubby rich fen	0.1	0.04	3.2	0.1	20.9	0.05
BS24	Graminoid fen	-	-	-	-	9.0	0.02
BS25	Open fen	-	-	2.1	0.04	5.7	0.01
BS26	Rush sandy shore	-	-	0.8	0.02	15.1	0.04
BS27	Sedge rocky shore	-	-	4.2	0.1	29.3	0.08

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
Total		**145.0[1]**	**85.4**	**4,262.2[2]**	**88.1**	**31,192.2[3]**	**77.7**

1, 2, 3 These areas represent the total area of available wolverine habitat within each study area; the percentages are the amount of available habitat relative to the Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha).

The characterization of the alteration and/or habitat loss residual effect considers the Project effects on available wolverine habitat within the Wildlife LSA and Terrestrial RSA. As outlined in Table 9.3-12, 85.4% of the Project Area, 88.1% of the Wildlife LSA, and 77.7% of the Terrestrial RSA provide habitat types that are potentially available to wolverine year-round.

Due to strong avoidance of anthropogenic developments and linear infrastructure by wolverine (ABMI 2020a), the alteration of available wolverine habitat is quantified by applying a buffer of 1,000 m around the Project Area in which Project effects in the form of sensory disturbance are assumed to affect available wolverine habitat and make it functionally unavailable for use. Progressive reclamation is anticipated to begin during Construction; however, a conservative approach is used, in that wolverine habitat within the Project Area is considered to be unavailable for the duration of the Project and will only become available as habitat following Post-Decommissioning (i.e., during the regeneration of vegetation following Decommissioning).

Direct habitat loss is calculated as the area of available wolverine habitat lost due to site clearing within the Project Area. Direct habitat loss has been mitigated by reducing the size of the Project Area to the extent practicable during Project design; however, available wolverine habitat is still predicted to be cleared during Construction. In the Project Area, 145.0 ha or 100% of available wolverine habitat is assumed to be removed and will not be available to wolverine for the duration of the Project (Table 9.3-13). Similarly, 145.0 ha (3.4%) of available wolverine habitat within the Wildlife LSA is anticipated to be removed, all from the Project Area, during site clearing in Construction. In the Terrestrial RSA, up to 0.5% (145.0 ha; from the Project Area) of available wolverine habitat is anticipated to be removed during site clearing in Construction.

An additional 2,398.8 ha (56.3%) of available wolverine habitat in the Wildlife LSA may experience habitat alteration stemming from indirect Project effects, such as sensory disturbance (Table 9.3-13). This area of indirect effects represents 7.7% of available wolverine habitat in the Terrestrial RSA. Mitigation measures outlined in Section 9.3.5 are anticipated to reduce the effects of alteration and/or loss of habitat on wolverine, but not eliminate them entirely.

Table 9.3-13: Summary of Available Wolverine Habitat, Direct Habitat Loss, and Habitat Alteration in the Study Areas

Study Area	Ecosite Description	Amount of Available Wolverine Habitat (ha)	Percent of Available Wolverine Habitat (%)	Amount of Available Wolverine Habitat Loss (ha)	Percent of Available Wolverine Habitat Loss (%)	Amount of Available Wolverine Habitat Altered (ha)[1]	Percent of Available Wolverine Habitat Altered (%)
Project Area	BS3 (mature forest) Jack pine – blueberry / lichen	31.1	18.3	31.1	100	N/A	N/A
	BS4 Jack pine – black spruce / feathermoss	2.9	1.7	2.9	100	N/A	N/A
	BS3 / BS7 (regenerating forest types) Jack pine – blueberry / lichen and black spruce – blueberry / lichen	110.2	64.9	110.2	100	N/A	N/A
	BS7 (mature forest) Black spruce – blueberry / lichen	0.04	0.03	0.04	100	N/A	N/A
	BS9 Black spruce – jack pine / feathermoss	0.3	0.2	0.3	100	N/A	N/A
	BS14 White birch / lingonberry – Labrador tea	-	-	-	-	-	-
	BS16 Black spruce / balsam poplar / river alder swamp	-	-	-	-	-	-
	BS17 Black spruce treed bog	0.4	0.2	0.4	100	N/A	N/A
	BS18 Labrador tea shrubby bog	0.003	0.002	0.003	100	N/A	N/A
	BS19 Graminoid bog	-	-	-	-	-	-
	BS19 / BS24 Graminoid bog / Graminoid fen	-	-	-	-	-	-
	BS20 Open bog	-	-	-	-	-	-
	BS21 Tamarack treed fen	-	-	-	-	-	-
	BS22 Leatherleaf shrubby poor fen	-	-	-	-	-	-
	BS23 Willow shrubby rich fen	0.1	0.04	0.1	100	N/A	N/A

Study Area	Ecosite Description	Amount of Available Wolverine Habitat (ha)	Percent of Available Wolverine Habitat (%)	Amount of Available Wolverine Habitat Loss (ha)	Percent of Available Wolverine Habitat Loss (%)	Amount of Available Wolverine Habitat Altered (ha)[1]	Percent of Available Wolverine Habitat Altered (%)
	BS24 Graminoid fen	-	-	-	-	-	-
	BS25 Open fen	-	-	-	-	-	-
	BS26 Rush sandy shore	-	-	-	-	-	-
	BS27 Sedge rocky shore	-	-	-	-	-	-
	Total	**145.0[2]**	**85.4**	**145**	**100**	**N/A**	**N/A**
Wildlife LSA	BS3 (mature forest) Jack pine – blueberry / lichen	1,693.7	35.0	31.1	1.8	928.0	54.8
	BS4 Jack pine – black spruce / feathermoss	18.2	0.4	2.9	15.7	6.7	36.9
	BS3 / BS7 (regenerating forest types) Jack pine – blueberry / lichen and black spruce – blueberry / lichen	2,268	46.8	110.2	4.9	1,322.6	58.3
	BS7 (mature forest) Black spruce – blueberry / lichen	9.8	0.2	0.04	0.5	8.9	90.3
	BS9 Black spruce – jack pine / feathermoss	12.3	0.3	0.3	0.3	9.6	77.8
	BS14 White birch / lingonberry – Labrador tea	0.03	0.0006	-	-	-	-
	BS16 Black spruce / balsam poplar / river alder swamp	-	-	-	-	-	-
	BS17 Black spruce treed bog	98.8	2.0	0.4	0.4	35.5	36.0
	BS18 Labrador tea shrubby bog	105.1	2.2	0.003	0.003	52.1	49.6
	BS19 Graminoid bog	10.0	0.2	-	-	4.6	46.0
	BS19 / BS24 Graminoid bog / Graminoid fen	2.4	0.05	-	-	2.4	100

Study Area	Ecosite Description	Amount of Available Wolverine Habitat (ha)	Percent of Available Wolverine Habitat (%)	Amount of Available Wolverine Habitat Loss (ha)	Percent of Available Wolverine Habitat Loss (%)	Amount of Available Wolverine Habitat Altered (ha)[1]	Percent of Available Wolverine Habitat Altered (%)
	BS20 Open bog	4.8	0.1	-	-	3.0	61.2
	BS21 Tamarack treed fen	15.6	0.3	-	-	6.7	42.8
	BS22 Leatherleaf shrubby poor fen	13.2	0.3	-	-	12.3	93.0
	BS23 Willow shrubby rich fen	3.2	0.1	0.1	2.2	1.7	53.6
	BS24 Graminoid fen	-	-	-	-	-	-
	BS25 Open fen	2.1	0.04	-	-	0.4	16.7
	BS26 Rush sandy shore	0.8	0.02	-	-	0.1	8.1
	BS27 Sedge rocky shore	4.2	0.1	-	-	4.2	99.2
	Total	**4,262.2[3]**	**88.1**	**145**	**3.4**	**2,398.8**	**56.3**
Terrestrial RSA	BS3 (mature forest) Jack pine – blueberry / lichen	10,374.8	25.8	31.1	0.3	928.0	8.9
	BS4 Jack pine – black spruce / feathermoss	332.8	0.8	2.9	0.9	6.7	2.0
	BS3 / BS7 (regenerating forest types) Jack pine – blueberry / lichen and black spruce – blueberry / lichen	17,494.0	43.5	110.2	0.6	1,322.6	7.6
	BS7 (mature forest) Black spruce – blueberry / lichen	281.0	0.7	0.04	0.02	8.9	3.2
	BS9 Black spruce – jack pine / feathermoss	148.5	0.4	0.3	0.2	9.6	6.5
	BS14 White birch / lingonberry – Labrador tea	1.8	0.005	-	-	-	-
	BS16 Black spruce / balsam poplar / river alder swamp	8.8	0.02	-	-	-	-

Study Area	Ecosite Description	Amount of Available Wolverine Habitat (ha)	Percent of Available Wolverine Habitat (%)	Amount of Available Wolverine Habitat Loss (ha)	Percent of Available Wolverine Habitat Loss (%)	Amount of Available Wolverine Habitat Altered (ha)[1]	Percent of Available Wolverine Habitat Altered (%)
	BS17 Black spruce treed bog	1,157.1	2.9	0.4	0.03	35.5	3.1
	BS18 Labrador tea shrubby bog	990.0	2.5	0.003	0.0003	52.1	5.3
	BS19 Graminoid bog	160.5	0.4	-	-	4.6	2.9
	BS19 / BS24 Graminoid bog / Graminoid fen	2.4	0.006	-	-	2.4	100
	BS20 Open bog	65.5	0.2	-	-	3.0	4.5
	BS21 Tamarack treed fen	66.5	0.2	-	-	6.7	10.0
	BS22 Leatherleaf shrubby poor fen	28.5	0.1	-	-	12.3	43.1
	BS23 Willow shrubby rich fen	20.9	0.05	0.1	0.3	1.7	8.3
	BS24 Graminoid fen	9.0	0.02	-	-	-	-
	BS25 Open fen	5.7	0.01	-	-	0.4	6.2
	BS26 Rush sandy shore	15.1	0.04	-	-	0.1	0.5
	BS27 Sedge rocky shore	29.3	0.08	-	-	4.16	14.2
	Total	**31,192.2**[4]	**77.7**	**145**	**0.5**	**2,398.8**	**7.7**

1 Based on a 1,000 m buffer around the Project Area.

2, 3, 4 This area does not reflect the entire Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha) but represents the total area of available wolverine habitat in each study area.

N/A = Not Applicable

Pine Marten

Pine marten relative abundance is considered to be similar across all forest stand types and treed fen and treed swamp vegetation types (ABMI 2020b) and the animals were observed during Omnia's (2020; see Appendix 9-B) baseline studies. An LK holder reported that in recent years, pine marten occurred more commonly compared to fisher, which was not always the case. An estimated 90% or more of all observations of these two species were marten, which is also reflected in the trapping results (19-LK-ERFNTrap-134.160).

Pine marten trails were observed in the study areas during 2017 and 2018 (Appendix 9-B). The trails were most often observed in the BS3 (jack pine/blueberry/lichen), BS4 (jack pine – black spruce/feathermoss), BS16 (black spruce/balsam poplar/river alder swamp), BS7 (black spruce/blueberry/feathermoss), and regenerating forest types BS3 and BS7 (jack pine – blueberry/lichen and black spruce – blueberry/lichen) ecosites. In addition, pine marten scat was detected in the BS3 (jack pine/blueberry/lichen) ecosite (Appendix 9-B).

Considering the baseline data (Appendix 9-B), pine marten habitat is described in the following without seasonal differentiation and referred to as available pine marten habitat. Figure 9.3-11 depicts available pine marten habitat in the project study areas.

Table 9.3-14 provides a summary of available pine marten habitat in the Project Area, Wildlife LSA, and Terrestrial RSA. Ecosite codes and descriptions are adopted from Table 9.2-5.

Table 9.3-14: Summary of Available Pine Marten Habitat in the Project Area, Wildlife Local Study Area, and the Terrestrial Regional Study Area

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS3 (mature forest)	Jack pine – blueberry / lichen	31.1	18.3	1,693.7	35.0	10,374.8	25.8
BS4	Jack pine – black spruce / feathermoss	2.9	1.7	18.2	0.4	332.8	0.8
BS3 and BS7 (regenerating forest types)	Jack pine – blueberry / lichen and black spruce – blueberry / lichen	110.2	64.9	2,268	46.8	17,494.0	43.5
BS7 (mature forest)	Black spruce – blueberry / lichen	0.04	0.03	9.8	0.2	281.0	0.7
BS16	Black spruce / balsam poplar / river alder swamp	-	-	-	-	8.8	0.02
Total		**144.2**[1]	**84.9**	**3,989.7**[2]	**82.4**	**28,491.4**[3]	**70.8**

1, 2, 3 These areas represent the total area of available pine marten habitat within each study area; the percentages are the amount of available habitat relative to the Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha).

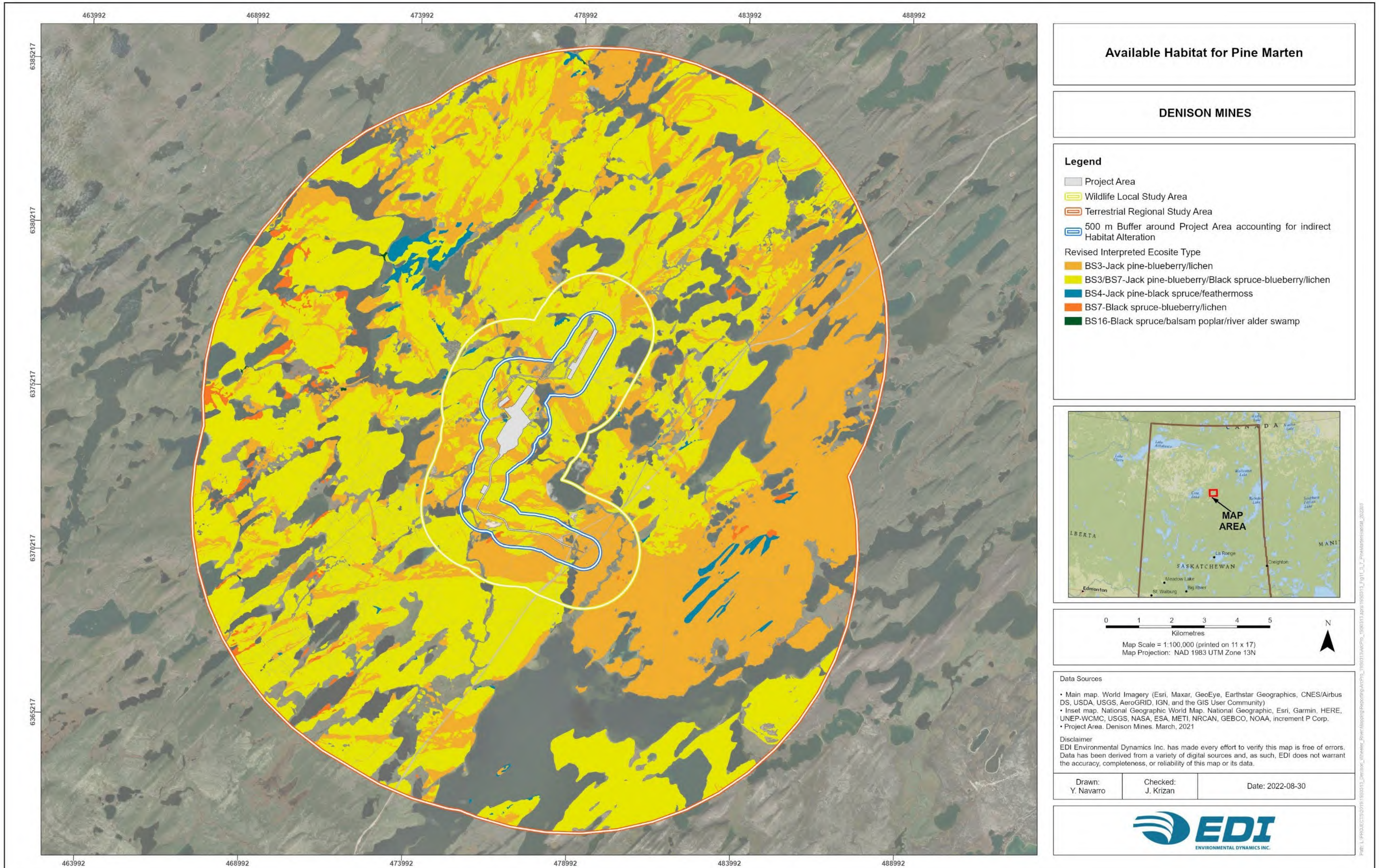

Figure 9.3-11: Available Habitat for Pine Marten

The characterization of the alteration and/or habitat loss residual effect considers the Project effects on available pine marten habitat within the Wildlife LSA and Terrestrial RSA. As outlined in Table 9.3-14, 84.9% of the Project Area, 82.4% of the Wildlife LSA, and 70.8% of the Terrestrial RSA provide habitat types that are potentially available to pine marten year-round.

The alteration of available pine marten habitat is quantified by applying a buffer of 500 m around the Project Area in which Project effects in the form of sensory disturbance are assumed to affect available pine marten habitat and make it functionally unavailable for use. Progressive reclamation is anticipated to begin during Construction; however, a conservative approach is used, in that pine marten habitat within the Project Area is considered to be unavailable for the duration of the Project and will only become available as habitat following Post-Decommissioning (i.e., during the regeneration of vegetation following Decommissioning).

Direct habitat loss is calculated as the area of available pine marten habitat lost due to site clearing within the Project Area. Direct habitat loss has been mitigated by reducing the size of the Project Area to the extent practicable during Project design; however, available pine marten habitat is still predicted to be cleared during Construction. In the Project Area, 144.2 ha or 100% of available pine marten habitat is assumed to be removed and will not be available to marten for the duration of the Project (Table 9.3-15). This represents a removal of 3.6% of available pine marten habitat within the Wildlife LSA and 0.5% in the Terrestrial RSA. An additional 1,110.3 ha (27.8%) of available marten habitat in the Wildlife LSA may experience habitat alteration stemming from indirect Project effects, such as sensory disturbance (Table 9.3-15). This effect corresponds to 3.9% of available marten habitat in the Terrestrial RSA. Mitigation measures outlined in Section 9.3.5 are anticipated to reduce the effects of alteration and/or loss of habitat on pine marten, but not eliminate them entirely.

Table 9.3-15: Summary of Available Pine Marten Habitat, Direct Habitat Loss, and Habitat Alteration in the Study Areas

Study Area	Ecosite Description	Amount of Available Pine Marten Habitat (ha)	Percent of Available Pine Marten Habitat (%)	Amount of Available Pine Marten Habitat Loss (ha)	Percent of Available Pine Marten Habitat Loss (%)	Amount of Available Pine Marten Habitat Altered (ha)[1]	Percent of Available Pine Marten Habitat Altered (%)
Project Area	BS3 (mature forest) Jack pine – blueberry / lichen	31.1	18.3	31.1	100	N/A	N/A
	BS4 Jack pine – black spruce / feathermoss	2.9	1.7	2.9	100	N/A	N/A

Study Area	Ecosite Description	Amount of Available Pine Marten Habitat (ha)	Percent of Available Pine Marten Habitat (%)	Amount of Available Pine Marten Habitat Loss (ha)	Percent of Available Pine Marten Habitat Loss (%)	Amount of Available Pine Marten Habitat Altered (ha)[1]	Percent of Available Pine Marten Habitat Altered (%)
	BS3 / BS7 (regenerating forest types) Jack pine – blueberry / lichen and black spruce – blueberry / lichen	110.2	64.9	110.2	100	N/A	N/A
	BS7 (mature forest) Black spruce – blueberry / lichen	0.04	0.03	0.04	100	N/A	N/A
	BS16 Black spruce / balsam poplar / river alder swamp	-	-	-	-	-	-
	Total	**144.2**[2]	**84.9**	**144.2**	**100**	**N/A**	**N/A**
Wildlife LSA	BS3 (mature forest) Jack pine – blueberry / lichen	1,693.7	35.0	31.1	1.8	445.1	26.3
	BS4 Jack pine – black spruce / feathermoss	18.2	0.4	2.9	15.7	3.4	18.5
	BS3 / BS7 (regenerating forest types) Jack pine – blueberry / lichen and black spruce – blueberry / lichen	2,268	46.8	110.2	4.9	656.5	29.0
	BS7 (mature forest) Black spruce – blueberry / lichen	9.8	0.2	0.04	0.5	5.3	53.9
	BS16 Black spruce / balsam poplar / river alder swamp	-	-	-	-	-	-
	Total	**3,989.7**[3]	**82.4**	**144.2**	**3.6**	**1,110.3**	**27.8**
Terrestrial RSA	BS3 (mature forest) Jack pine – blueberry / lichen	10,374.8	25.8	31.1	0.3	445.1	4.3
	BS4 Jack pine – black spruce / feathermoss	332.8	0.8	2.9	0.9	3.4	1.0
	BS3 / BS7 (regenerating forest types) Jack pine – blueberry / lichen and black spruce – blueberry / lichen	17,494.0	43.5	110.2	0.6	656.5	3.8

Study Area	Ecosite Description	Amount of Available Pine Marten Habitat (ha)	Percent of Available Pine Marten Habitat (%)	Amount of Available Pine Marten Habitat Loss (ha)	Percent of Available Pine Marten Habitat Loss (%)	Amount of Available Pine Marten Habitat Altered (ha)[1]	Percent of Available Pine Marten Habitat Altered (%)
	BS7 (mature forest) Black spruce – blueberry / lichen	281.0	0.7	0.04	0.02	5.3	1.9
	BS16 Black spruce / balsam poplar / river alder swamp	8.8	0.02	-	-	-	-
	Total	**28,491.4**[4]	**70.8**	**144.2**	**0.5**	**1110.3**	**3.9**

1 Based on a 500 m buffer around the Project Area.

2, 3, 4 This area does not reflect the entire Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha) but represents the total area of available moose habitat in each study area.

N/A = Not Applicable

Mink

A habitat model based on actual observations in Alberta showed a strong positive association of mink detections with three habitat types: swamp, non-treed bog fen, and marsh. The results of the study suggest that minks select for wet habitat types and avoid dryer forests, grasslands, and any type of human activity or development (ABMI 2020c). Mink were observed during baseline studies with trails observed most frequently in the BS17 (black spruce treed bog), BS21 (tamarack treed fen), and BS18 (Labrador tea shrubby bog) ecosites. In addition, mink scat was detected in the BS17 (black spruce treed bog) ecosite (Appendix 9-B). Considering the baseline data (Appendix 9-B), mink habitat is described in the following without seasonal differentiation and referred to as available mink habitat. Figure 9.3-12 depicts available mink habitat in the project study areas.

Table 9.3-16 provides a summary of available mink habitat in the Project Area, Wildlife LSA and Terrestrial RSA. Ecosite codes and descriptions are adopted from Table 9.2-5.

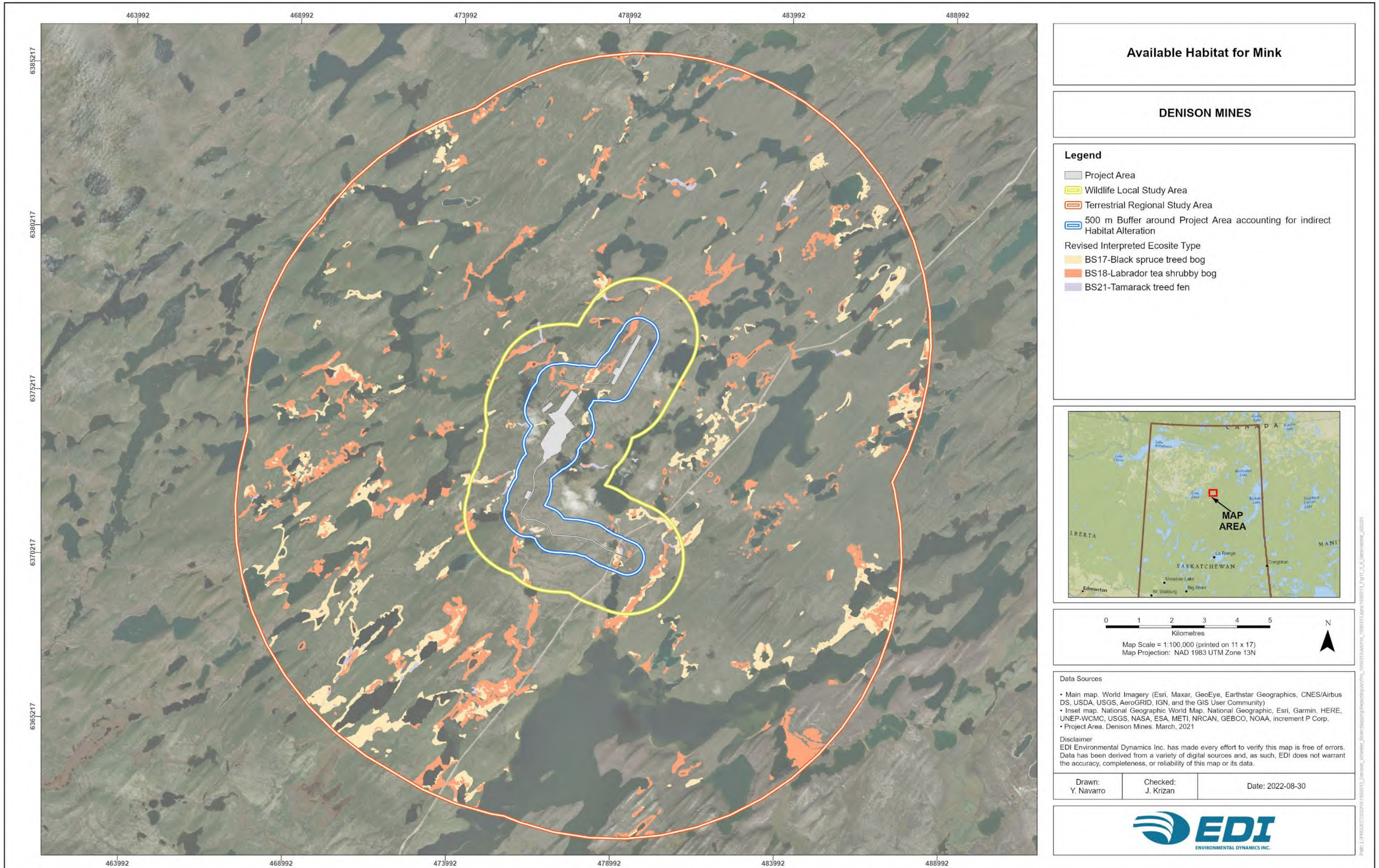

Figure 9.3-12: Available Habitat for Mink

Table 9.3-16: Summary of Available Mink Habitat in the Project Area, Wildlife Local Study Area, and the Terrestrial Regional Study Area

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS17	Black spruce treed bog	0.4	0.2	98.8	2.0	1,157.1	2.9
BS18	Labrador tea shrubby bog	0.003	0.002	105.1	2.2	990.0	2.5
BS21	Tamarack treed fen	-	-	15.6	0.3	66.5	0.2
Total		**0.4[1]**	**0.2**	**219.5[2]**	**4.5**	**2,213.6[3]**	**5.6**

1, 2, 3 These areas represent the total area of available mink habitat within each study area; the percentages are the amount of available habitat relative to the Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha).

The characterization of the alteration and/or habitat loss residual effect considers the Project effects on available mink habitat within the Wildlife LSA and Terrestrial RSA. As outlined in Table 9.3-16, 0.2% of the Project Area, 4.5% of the Wildlife LSA, and 5.6% of the Terrestrial RSA provide habitat types that are potentially available to mink year-round.

The alteration of available mink habitat is quantified by applying a buffer of 500 m around the Project Area in which Project effects in the form of sensory disturbance are assumed to affect available mink habitat and make it functionally unavailable for use. Progressive reclamation is anticipated to begin during Construction; however, a conservative approach is used, in that mink habitat within the Project Area is considered to be unavailable for the duration of the Project and will only become available as habitat following Post-Decommissioning (i.e., during the regeneration of vegetation following Decommissioning).

Direct habitat loss is calculated as the area of available mink habitat lost due to site clearing within the Project Area. Direct habitat loss has been mitigated by reducing the size of the Project Area to the extent practicable during Project design; however, available mink habitat is still predicted to be cleared during Construction. In the Project Area, 0.4 ha or 100% of available mink habitat is assumed to be removed and will not be available to mink for the duration of the Project (Table 9.3-17). This represents a removal of 0.2% of available mink habitat within the Wildlife LSA and 0.02% in the Terrestrial RSA. An additional 54.2 ha (24.7%) of available mink habitat in the Wildlife LSA may experience habitat alteration stemming from indirect Project effects, such as sensory disturbance (Table 9.3-17). This area of indirect effect represents 2.5% of available mink habitat in the Terrestrial RSA that may experience habitat alteration stemming from indirect Project effects, such as sensory disturbance (Table 9.3-17). Mitigation measures outlined in Section 9.3.5 are anticipated to reduce the effects of alteration and/or loss of habitat on mink, but not eliminate them entirely.

Table 9.3-17: Summary of Available Mink Habitat, Direct Habitat Loss, and Habitat Alteration in the Study Areas

Study Area	Ecosite Description	Amount of Available Mink Habitat (ha)	Percent of Available Mink Habitat (%)	Amount of Available Mink Habitat Loss (ha)	Percent of Available Mink Habitat Loss (%)	Amount of Available Mink Habitat Altered (ha)[1]	Percent of Available Mink Habitat Altered (%)
Project Area	BS17 Black spruce treed bog	0.4	0.2	0.4	100	N/A	N/A
	BS18 Labrador tea shrubby bog	0.003	0.002	0.003	100%	N/A	N/A
	BS21 Tamarack treed fen	-	-	-	-	-	-
	Total	0.4[2]	**0.2**	**0.4**	**100**	**N/A**	**N/A**
Wildlife LSA	BS17 Black spruce treed bog	98.8	2.0	0.4	0.4	22.0	22.3
	BS18 Labrador tea shrubby bog	105.1	2.2	0.003	0.003	30.0	28.6
	BS21 Tamarack treed fen	15.6	0.3	-	-	2.2	14.2
	Total	219.5[3]	**4.5**	**0.4**	**0.2**	**54.2**	**24.7**
Terrestrial RSA	BS17 Black spruce treed bog	1,157.1	2.9	0.4	0.03	22.0	1.9
	BS18 Labrador tea shrubby bog	990.0	2.5	0.003	0.0003	30.0	3.0
	BS21 Tamarack treed fen	66.5	0.2	-	-	2.2	3.3
	Total	2,213.6[4]	**5.6**	**0.4**	**0.02**	**54.2**	**2.5**

1 Based on a 500 m buffer around the Project Area.

2, 3, 4 This area does not reflect the entire Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha) but represents the total area of available mink habitat in each study area.

N/A = Not Applicable

Muskrat

A habitat model based on actual observations in Alberta showed a strong positive association of muskrat detection with pine, white spruce, swamp, grass, shrub, non-treed bog fen, and marsh (ABMI 2020d). However, no open water habitats (e.g., ponds, lakes, and streams) were included in the surveyed habitat types. As part of the baseline studies for the Project, semi-aquatic furbearer shoreline surveys were completed in 2016 along the shorelines of 6 creeks and 17 lakes/ponds in the Wildlife LSA and Terrestrial RSA. Muskrat sign was frequently observed, with 70% of the surveyed water bodies having muskrat sign (Appendix 9-B). Muskrats, or evidence of their presence, were not observed during any other baseline surveys (Appendix 9-B).

Based on these studies, available muskrat habitat is described in the following text as waterbodies (streams, ponds, and lakes), grassy and shrubby bogs and fens, and open bogs and fens. Waterbody classifications in this assessment include wetland habitat, delineated as lakes (described in Section 9.2.3.3). Figure 9.3-13 depicts available muskrat habitat in the project study areas.

Table 9.3-18 provides a summary of available muskrat habitat in the Project Area, Wildlife LSA, and Terrestrial RSA. Ecosite codes and descriptions are adopted from Table 9.2-5.

Table 9.3-18: Summary of Available Muskrat Habitat in the Project Area, Wildlife Local Study Area, and the Terrestrial Regional Study Area

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS18	Labrador tea shrubby bog	0.003	0.002	105.1	2.2	990.0	2.5
BS19	Graminoid bog	-	-	10.0	0.2	160.5	0.4
BS19 / BS24	Graminoid bog / Graminoid fen	-	-	2.4	0.05	2.4	0.006
BS20	Open bog	-	-	4.8	0.1	65.5	0.2
BS22	Leatherleaf shrubby poor fen	-	-	13.2	0.3	28.5	0.1
BS23	Willow shrubby rich fen	0.1	0.04	3.2	0.1	20.9	0.05
BS24	Graminoid fen	-	-	-	-	9.0	0.02
BS25	Open fen	-	-	2.1	0.04	5.7	0.01
Waterbody and Lakes	Waterbody	0.02	0.01	412.2	8.5	8,381.6	20.9
Total		**0.09**[1]	**0.05**	**553.0**[2]	**11.5**	**9,664.1**[3]	**24.2**

1, 2, 3 These areas represent the total area of available muskrat habitat within each study area; the percentages are the amount of available habitat relative to the Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha).

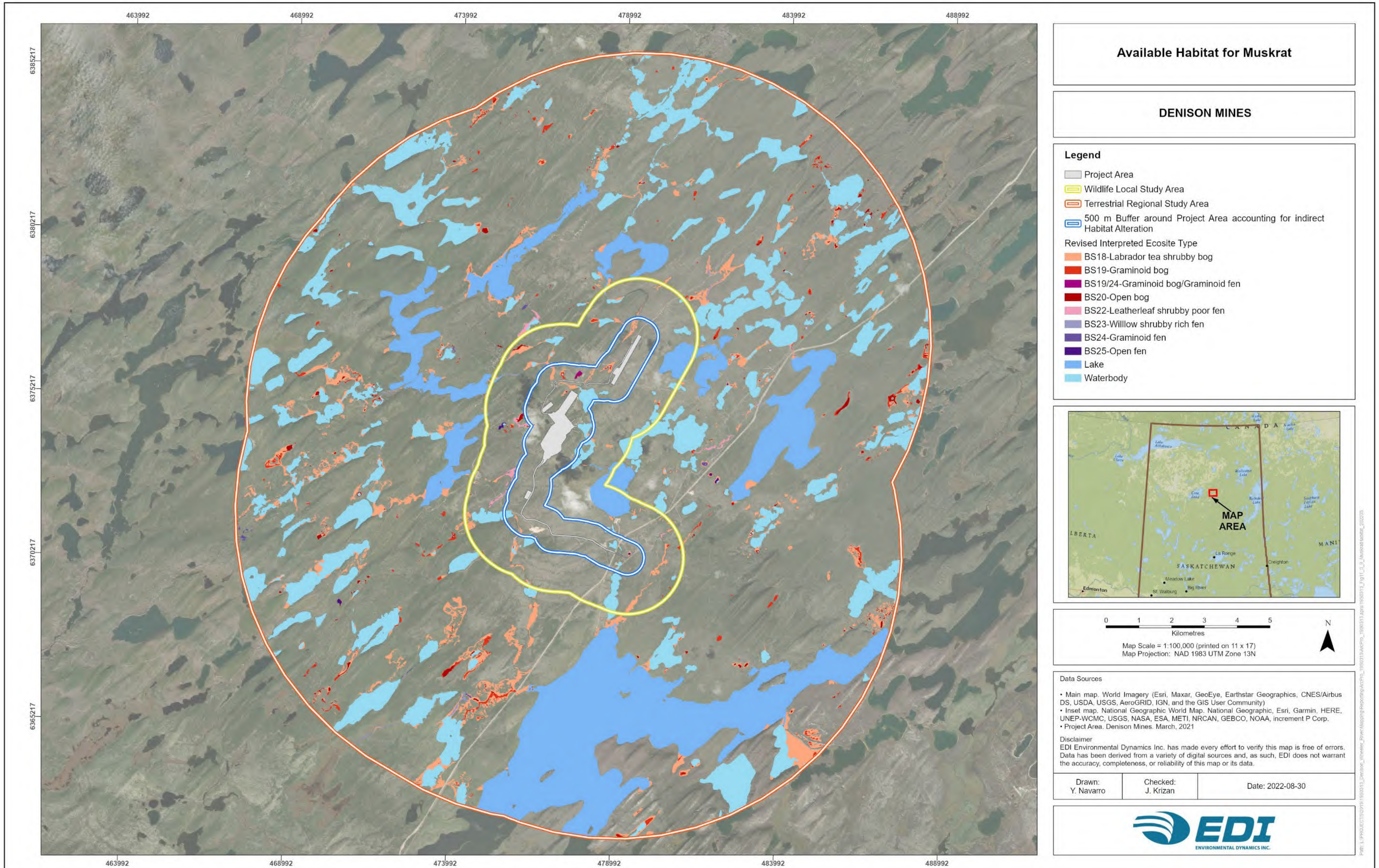

Figure 9.3-13: Available Habitat for Muskrat

The characterization of the alteration and/or habitat loss residual effect considers the Project effects on available muskrat habitat within the Wildlife LSA and Terrestrial RSA. As outlined in Table 9.3-18, 0.05% of the Project Area, 11.5% of the Wildlife LSA, and 24.2% of the Terrestrial RSA provide habitat types that are potentially available to muskrats.

Muskrats are not deterred by human presence (ABMI 2020d); however, as a conservative approach, the alteration of available muskrat habitat is quantified by applying a buffer of 500 m around the Project Area in which Project effects in the form of sensory disturbance are assumed to affect available muskrat habitat and could make it functionally unavailable for use. Progressive reclamation is anticipated to begin during Construction; however, a conservative approach is used, in that muskrat habitat within the Project Area is considered to be unavailable for the duration of the Project and will only become available as habitat following Post-Decommissioning (i.e., during the regeneration of vegetation following Decommissioning).

Direct habitat loss is calculated as the area of available muskrat habitat lost due to site clearing within the Project Area. Direct habitat loss has been mitigated by reducing the size of the Project Area to the extent practicable during Project design; however, available muskrat habitat is still predicted to be cleared during Construction. In the Project Area, 0.09 ha or 100% of available muskrat habitat is assumed to be removed and will not be available to muskrat for the duration of the Project (Table 9.3-19). This considers that the Project Area has previously been disturbed (i.e., almost 15% of the Project Area is disturbed by anthropogenic development) and includes only 0.02 ha (0.01%) of landscape covered by waterbodies. This relates to a removal of 0.02% of available muskrat habitat within the Wildlife LSA and 0.001% in the Terrestrial RSA.

An additional 93.9 ha (17.0%) of available muskrat habitat in the Wildlife LSA may experience habitat alteration stemming from indirect Project effects, such as sensory disturbance (Table 9.3-19). This area of indirect effect represents 1.0% of available muskrat habitat in the Terrestrial RSA that may experience habitat alteration.

Mitigation measures outlined in Section 9.3.5 are anticipated to reduce the effects of alteration and/or loss of habitat on muskrat, but not eliminate them entirely.

Table 9.3-19: Summary of Available Muskrat Habitat, Direct Habitat Loss, and Habitat Alteration in the Study Areas

Study Area	Ecosite Description	Amount of Available Muskrat Habitat (ha)	Percent of Available Muskrat Habitat (%)	Amount of Available Muskrat Habitat Loss (ha)	Percent of Available Muskrat Habitat Loss (%)	Amount of Available Muskrat Habitat Altered (ha)[1]	Percent of Available Muskrat Habitat Altered (%)
Project Area	BS18 Labrador tea shrubby bog	0.003	0.002	0.003	100	N/A	N/A
	BS19 Graminoid bog	-	-	-	-	-	-

Study Area	Ecosite Description	Amount of Available Muskrat Habitat (ha)	Percent of Available Muskrat Habitat (%)	Amount of Available Muskrat Habitat Loss (ha)	Percent of Available Muskrat Habitat Loss (%)	Amount of Available Muskrat Habitat Altered (ha)[1]	Percent of Available Muskrat Habitat Altered (%)
	BS19 / BS24 Graminoid bog / Graminoid fen	-	-	-	-	-	-
	BS20 Open bog	-	-	-	-	-	-
	BS22 Leatherleaf shrubby poor fen	-	-	-	-	-	-
	BS23 Willow shrubby rich fen	0.1	0.04	0.1	100	N/A	N/A
	BS24 Graminoid fen	-	-	-	-	-	-
	BS25 Open fen	-	-	-	-	-	-
	Waterbody	0.02	0.01	0.02	100	N/A	N/A
	Total	**0.09[2]**	**0.05**	**0.09**	**100**	**N/A**	**N/A**
Wildlife LSA	BS18 Labrador tea shrubby bog	105.1	2.2	0.003	0.003	30.0	28.6
	BS19 Graminoid bog	10.0	0.2	-	-	2.8	28.5
	BS19 / BS24 Graminoid bog / Graminoid fen	2.4	0.05	-	-	2.4	100
	BS20 Open bog	4.8	0.1	-	-	0.6	11.6
	BS22 Leatherleaf shrubby poor fen	13.2	0.3	-	-	-	-
	BS23 Willow shrubby rich fen	3.2	0.1	0.1	2.2	0.7	21.3
	BS24 Graminoid fen	-	-	-	-	-	-
	BS25 Open fen	2.1	0.04	-	-	0.4	16.7
	Waterbody	412.2	8.5	0.02	0.004	57.0	13.8
	Total	**553[3]**	**11.5**	**0.09**	**0.02**	**93.9**	**17.0**
Terrestrial RSA	BS18 Labrador tea shrubby bog	990.0	2.5	0.003	0.0003	30.0	3.0
	BS19 Graminoid bog	160.5	0.4	-	-	2.8	1.8
	BS19 / BS24 Graminoid bog / Graminoid fen	2.4	0.006	-	-	2.4	100
	BS20 Open bog	65.5	0.2	-	-	0.6	0.9
	BS22 Leatherleaf shrubby poor fen	28.5	0.1	-	-	-	-

Study Area	Ecosite Description	Amount of Available Muskrat Habitat (ha)	Percent of Available Muskrat Habitat (%)	Amount of Available Muskrat Habitat Loss (ha)	Percent of Available Muskrat Habitat Loss (%)	Amount of Available Muskrat Habitat Altered (ha)[1]	Percent of Available Muskrat Habitat Altered (%)
	BS23 Willow shrubby rich fen	20.9	0.05	0.1	0.3	0.7	3.3
	BS24 Graminoid fen	9.0	0.02	-	-	-	-
	BS25 Open fen	5.7	0.01	-	-	0.4	6.2
	Waterbody	8,381.6	20.9	0.02	0.0002	57.0	0.7
	Total	**9,664.1[4]**	**24.2**	**0.09**	**0.001**	**93.9**	**1.0**

1 Based on a 500 m buffer around the Project Area.

2, 3, 4 This area does not reflect the entire Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha) but represents the total area of available muskrat habitat in each study area.

N/A = Not Applicable

Residual Effects Characteristics for Furbearers

The residual effects characterization for the alteration and/or loss of available furbearer habitat is provided in Table 9.3-20.

The direction of alteration and/or loss of available furbearer habitat is predicted to be adverse. The Project is expected to affect available furbearer habitat directly (through habitat loss) and indirectly (through habitat alteration).

The magnitude is predicted to be moderate for wolverine and low for pine marten, mink, and muskrat. It is anticipated that up to 8.2% of available wolverine habitat within the Terrestrial RSA may be altered or lost due to the Project: 0.5% of available wolverine habitat within the Terrestrial RSA will be cleared, and an additional 7.7% may be altered through indirect effects during all Project phases. Available pine marten habitat in the Terrestrial RSA that may be altered or lost due to the Project is expected to be 4.4%, with 0.5% being directly affected, and an additional 3.9% being indirectly affected during all Project phases. Available mink habitat in the Terrestrial RSA that may be altered or lost because of the Project is expected to be 2.5%, with 0.02 % being directly affected, and an additional 2.5% may be indirectly affected. The Project Area includes minimal available habitat for mink (0.4 ha or 0.2% of the Project Area; Table 9.3-16) and, therefore, the effect of direct habitat loss on mink is limited. Available muskrat habitat in the Project Area is most limited of all Furbearer KIs (0.09 ha or 0.05%; Table 9.3-18), which is reflected in the minimal percentage (0.001%) of available muskrat habitat that may be lost because of the Project. In addition, 1.0% of available muskrat habitat may be altered through indirect effects during all Project phases.

The residual effect is predicted to be local in geographic extent. While the direct loss of available furbearer habitat is expected to be limited to the Project Area during Construction, indirect Project effects are expected to occur within the Wildlife LSA within a 1,000 m buffer (for wolverine) or a 500 m buffer (for pine marten, mink, and muskrat) around the Project Area during all Project phases.

The residual effect of alteration and/or loss of available furbearer habitat is predicted to occur over the long-term (greater than 33 years) because of the time required for available habitat to regenerate following disturbance. Progressive reclamation is anticipated to begin in some parts of the Project Area following Construction; however, the revegetation within most of the Project Area will occur as part of reclamation activities during Decommissioning, up to 18 years after clearing during Construction. Wolverine do not require specific habitat types as long as their prey base is available (Siemens Worsely 2011), and pine marten can persist at lower population levels in regenerating forests, when both fur harvesting and timber harvesting are managed together (Natural Resources Canada 2020). Available mink and muskrat habitat in the Project Area are currently limited, which is reflected in a minimal predicted effect of direct habitat loss on these Furbearer KIs. It is expected that the area will return to baseline conditions after reclamation activities, and that the Project Area will likely support furbearer habitat within several years after revegetation, i.e., after Post-Decommissioning. Alteration of available furbearer habitat within the Wildlife LSA is expected to be reduced as soon as Project and decommissioning activities cease.

The frequency of the effect is predicted to be frequent. While loss of available furbearer habitat during Construction will occur initially, additional clearing for maintenance and/or safety purposes may happen throughout Operation. Alteration of available furbearer habitat within the Wildlife LSA through indirect Project effects is anticipated to be frequent throughout the Construction, Operation, and Decommissioning phases, and infrequent during Post-Decommissioning.

The alteration and/or loss of available furbearer habitat is predicted to be fully reversible. Through progressive and final reclamation, disturbed areas within the Project Area will be revegetated with a focus on achieving baseline conditions. Progressive reclamation may occur in some parts of the Project Area prior to Post-Decommissioning; however, most revegetation is anticipated to occur following the end of Operation and become available furbearer habitat during and following Post-Decommissioning. Wolverine and pine marten require larger, undisturbed areas; however, wolverine habitat is not restricted to specific vegetation cover types and is more dependent on available food sources (Siemens Wolsely 2011; COSEWIC 2014) and pine marten can persist at low densities in regenerating forests (Natural Resources Canada 2020). The current availability of mink and muskrat habitat in the Project Area is limited and once disturbed, it is predicted to return to baseline conditions during and following Post-Decommissioning. In addition, the alteration of available furbearer habitat is expected to be reversed within a similar time frame as sensory disturbances diminish with the ceasing of Project operation activities and subsequent decommissioning of Project components after Decommissioning.

The context of the residual effect of alteration and/or loss of available furbearer habitat is predicted to be high. Available furbearer habitat that is altered or cleared is expected to remain affected until Post-Decommissioning when final reclamation and revegetation will occur. Pine marten, mink, and muskrat populations in Saskatchewan are considered secure and are expected to have a moderate resilience to stress. Wolverine, however, are listed on Schedule 1 of the federal SARA and by COSEWIC as Special Concern (ECCC 2021); in Saskatchewan they have been assigned the status of S2 (Imperiled/Very Rare: at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats, or other factors) (SK CDC 2021).

The residual effect of alteration and/or loss of available furbearer habitat is predicted to be likely. Available furbearer habitat is expected to be cleared in the Project Area during Construction and indirectly affected in the Wildlife LSA during all phases of the Project.

Table 9.3-20: Summary of the Characteristics Ratings for Alteration and/or Loss of Available Furbearer Habitat

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project is expected to affect available furbearer habitat directly and indirectly.
Magnitude	Moderate	Wolverine (Moderate): 8.2% of available wolverine habitat within the Terrestrial RSA may be altered or lost: 0.5% will be cleared within the Project Area during Construction, and an additional 7.7% may be altered through indirect effects during all Project phases. Pine marten (Low): 4.4% of available pine marten habitat within the Terrestrial RSA may be altered or lost: 0.5% will be cleared within the Project Area during Construction, and an additional 3.9% may be altered through indirect effects during all Project phases. Mink (Low): 2.5 of available mink habitat within the Terrestrial RSA may be altered or lost: 0.02 % will be cleared within the Project Area during Construction, and an additional 2.5% may be altered through indirect effects during all Project phases. Muskrat (Low): 1.0% of available muskrat habitat within the Terrestrial RSA may be altered or lost: 0.001% will be cleared within the Project Area during Construction, and an additional 1.0% may be altered through indirect effects during all Project phases.
Geographic Extent	Local	The direct loss of available furbearer habitat is expected to be limited to the Project Area during Construction, and indirect effects resulting in habitat alteration are expected to be restricted to the Wildlife LSA during all Project phases.
Duration	Long-term	The loss of available furbearer habitat will mainly occur during Construction; however, the alteration of habitat will likely continue through all phases. The reclamation and revegetation of the entire Project Area will not be complete until after Post-Decommissioning at which time revegetated areas are starting to become available furbearer habitat.
Frequency	Frequent	Loss of available furbearer habitat will occur initially during construction, and alteration of available furbearer habitat through indirect Project effects is anticipated to be frequent throughout all Project phases until Post-Decommissioning.
Reversibility	Fully Reversible	Disturbed habitat within the Project Area will be revegetated and will likely become available to furbearers starting toward the end of Post-Decommissioning. The alteration of available furbearer habitat is expected to be reversed as sensory disturbances diminish with the end of Project operation activities and subsequent decommissioning of Project components after Decommissioning.

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Context	High	Revegetated areas are expected to become available furbearer habitat once disturbed areas have been reclaimed and revegetation has started to return the area to baseline conditions. While pine marten, mink, and muskrat populations in Saskatchewan are considered secure, wolverine are listed federally as Special Concern (ECCC 2021) and in provincially as S2 (Imperiled / Very Rare; at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats, or other factors) (SK CDC 2021). The context for the other three KIs is considered to be moderate based on their expected moderate resilience to stress.
Likelihood	Likely	Available furbearer habitat is expected to be cleared in the Project Area during Construction and to be indirectly affected in the Wildlife LSA during all phases of the Project.

Significance and Confidence

The residual effect of alteration and/or loss of available furbearer habitat is not expected to result in a change that will alter furbearer habitat integrity to the point where it would not be able to sustain the regional populations of wolverine, pine marten, mink, and muskrat. Therefore, the effect is assessed as **not significant**.

The level of confidence of this prediction is moderate. The effects of habitat loss and alteration on the Furbearer KIs are well known, and mitigation measures have been proven effective during past projects and activities. However, some level of uncertainty exists related to the available background and baseline information used to identify available furbearer habitat in this assessment.

9.3.6.3.2 Change in Mortality

The residual effects evaluation of the change in furbearer mortality considers Project-related effects within the Terrestrial RSA. Section 9.3.3.2 summarizes the existing knowledge of furbearer KI population trends and mortality in northern Saskatchewan. The assessment includes considerations of direct mortality from Project activities and interactions with Project components, and indirect mortality due to the Project. The highest risk of furbearer mortality is anticipated to be associated with activities during the Construction and Operation phases; however, the risk of indirect furbearer mortality exists during all Project phases.

Potential sources of a change in direct mortality for furbearers include interactions with Project activities, most likely vehicle collisions. Speed limits will be implemented on all access and site roads as a proven mitigation measure to reduce the likelihood of wildlife-vehicle collisions. Between 1999 and 2003, on average, 10,970 wildlife-vehicle collisions were reported to SGI per year, with over 80% involving deer and no counts provided for other species (L-P Tardif & Associates Inc. 2003, Transport Canada 2006).

Direct mortality of furbearers can also be caused by the destruction or abandonment of den sites and lodges during vegetation clearing and management, or entrapment in snow berms created during snow management (leading to an increased risk of vehicle collisions). Effective mitigation measures, including pre-clearing wildlife surveys, implementing breaks in snowbanks, and speed limits on Project roads will be implemented for the Project (Section 9.3.5).

Mortality may also be caused when interactions with Project components and activities contribute to indirect sources of mortality, such as through increased and more efficient access for people (20-LK-LEASESUR-267.67), decreased wildlife health (e.g., through increased stress and reduced body condition), and increased inter- and intra-specific competition for resources through reduced habitat availability.

As described in Section 9.3.3.2.3, pine marten, mink and muskrat are highly valued furbearers in the region and fur harvest return information for 30 years was obtained and summarized for furbearer species for FCA N-18, an area that includes the Terrestrial RSA (Appendix 9-B). In FCA N-18, from the period 1985/1986 through 2017/2018, fur returns for all four representative Furbearer KIs were reported as follows: pine marten (4,167), mink (2,761), muskrat (702), and wolverine (5). Pine marten, mink, and muskrat were the most harvested species of 16 species for which records were kept, indicating that these species are important furbearers. Indigenous Knowledge on furbearer species (Section 9.3.3.2.2) describes the importance of marten harvest and the additional value of muskrats as a food source. While trapping is an important cultural and economic activity in the region and trappers are making use of existing trails and roads, it is not anticipated that additional access to the Project Area will facilitate increased trapping pressure in the Terrestrial RSA due to the remoteness of the area and the gated access control. While there are no restrictions on furbearer harvest, wolverine harvest is monitored, and quotas could be imposed if harvest levels were to increase (Siemens Worsely 2011, SK MOE 2021).

Reductions in habitat, through decreased habitat effectiveness (i.e., alteration) or loss, may also contribute to indirect mortality due to increased intra-specific competition for available food and habitat, increased predation risk and hunting efficiency, and abandonment of young (Hargis et al. 1999, Environment Canada 2013).

Human-wildlife interactions may result from wildlife being attracted to the Project Area (e.g., through smells from olfactory attractants, such as food, petroleum-based chemicals, grey water, and sewage), which may increase the mortality risk of individual animals through intentional destruction (i.e., euthanasia). Attraction to the Project Area may also increase the predation risk through an influx of predators, which can affect mortality of prey species (Environment Canada 2013).

Project mitigation measures identified in Section 9.3.5 are expected to limit interactions between furbearers and potential sources of direct and indirect mortality, thereby minimizing the residual effect of change in mortality. Although Project activities may result in a change of direct and/or indirect mortality of furbearers within the Terrestrial RSA, with the implementation of mitigation measures, the residual effect is not expected to result in a change to furbearer populations.

Residual Effects Characteristics

The residual effects characterization for the change in mortality of furbearers is provided in Table 9.3-21.

The direction of the residual effect of change in mortality is predicted to be adverse. While it is expected that the risks for Project-related furbearer mortalities is limited (due to effective mitigation measures), any additional mortality may affect the furbearer populations.

The magnitude of the effect is expected to be low for all four Furbearer KIs. Mitigation measures are anticipated to be effective at reducing a change in direct and indirect mortality, and the risk of mortality is expected to be within the range of natural variability. The Project is also not expected to facilitate additional trapping effort through increased access.

The geographic extent is predicted to be regional. A change of direct mortality is expected to mainly occur within the Project Area; however, indirect furbearer mortality (particularly for wolverine) may occur outside the Wildlife LSA and into the Terrestrial RSA. Sources for direct mortality (e.g., vehicle collisions on access and site roads; exposure to waste pads and ponds) that occur within the Project Area may affect wolverine with home ranges extending into the Terrestrial RSA. Potentially increased vehicle traffic on Highway 914 may also affect direct mortality in the Wildlife LSA and Terrestrial RSA. In addition, sources of indirect furbearer mortality (changes to health due to sensory disturbances; changes to predator-prey dynamics) may result in mortality outside the Wildlife LSA.

It is estimated that the duration of the effect will be medium-term (i.e., 3 to 38 years). The potential for a change in direct mortality is expected to be highest during the Construction and Operation phases when vehicle traffic and potential exposure to and entrapment in Project components is most frequent, and it is predicted to continue through to Post-Decommissioning. The potential for indirect mortality is expected to be highest during Operation, when vehicle traffic, exposure to sensory disturbances, as well as increased trapping and predation pressure may result in indirect mortality. The potential for a change in indirect mortality is anticipated to decrease in Decommissioning following the removal of Project components and a reduction in Project activities and is expected to be limited during Post-Decommissioning.

The frequency of effect is assessed as infrequent. Mitigation measures (e.g., speed limits; exclusion fences preventing access to Project components) are anticipated to limit the potential for furbearer mortality; however, a change in direct and indirect mortality could occur sporadically through all Project phases.

It is predicted that the effect will be fully reversible. The risk of a change in direct or indirect mortality is anticipated to decline during Decommissioning following the removal of Project components and a reduction in Project activities and is expected to diminish to baseline conditions following Post-Decommissioning.

The context for the residual effect of change in mortality is expected to be high. Most furbearer populations in Saskatchewan are considered healthy based on three decades of harvest return information (Appendix 9-B) and IK information (19-LK-ERFNTrap-134.160, 19-LK-ERFNTrap-134.162). Muskrats in the region may be declining, based on scientific and IK information (Ward and Gorelick 2018, 19-LK-ERFNTrap-134.64). While pine marten, mink, and muskrat populations in Saskatchewan are considered secure and are expected to have a moderate resilience to stress, wolverine are listed on Schedule 1 of the federal SARA and by COSEWIC as Special Concern (ECCC 2021); in Saskatchewan they have been assigned the status of S2 (Imperiled/Very Rare; at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats, or other factors) (SK CDC 2021).

The residual effect of change in furbearer mortality is likely to occur. Mitigation measures are expected to reduce, but not eliminate, the residual effect on furbearers.

Table 9.3-21: Summary of the Characteristics Ratings for Change in Mortality of Furbearers

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project is expected to affect a change in mortality of furbearers.
Magnitude	Low	Mitigation measures are anticipated to be effective at reducing the potential for a change in direct and indirect mortality, and the risk of mortality is expected to be within the range of natural variability.
Geographic Extent	Regional	The change in direct mortality is expected to occur mainly within the Project Area; however, indirect furbearer mortality may extend into the Terrestrial RSA, particularly for wolverine.
Duration	Medium-term	Furbearer mortality may occur during all phases of the Project. The potential for a change in direct mortality is expected to be highest during the Construction and Operation phases and the potential for indirect mortality is expected to be highest during Operation, decreasing during Decommissioning, and limited during Post-Decommissioning.
Frequency	Infrequent	It is expected that the potential for a change in direct and indirect furbearer mortality is limited but the residual effect may occur sporadically throughout the life of the Project.
Reversibility	Fully Reversible	It is anticipated that the change in mortality of furbearers will decline during Decommissioning following the removal of Project components and a reduction in Project activities and that it will diminish to baseline conditions following Post-Decommissioning.
Context	High	Most furbearer populations in Saskatchewan are considered healthy based on three decades of harvest return information; however, muskrats in the region may be declining, based on scientific and IK information. While pine marten, mink, and muskrat populations in Saskatchewan are considered secure, wolverine are listed federally as Special Concern (ECCC 2021) and provincially as S2 (Imperiled/Very Rare; at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats, or other factors) (SK CDC 2021).
Likelihood	Likely	Mitigation measures are expected to reduce, but not fully eliminate, the residual effect on furbearers.

Significance and Confidence

The residual effect of change in mortality is not expected to result in a change in furbearer mortality that will alter the integrity of the wolverine, pine marten, mink, and muskrat populations to the point where the regional populations could not be sustained. Therefore, the effect is assessed as **not significant**.

The level of confidence of this prediction is moderate. The risks of increased mortality are well known, and mitigation measures that will be implemented have been proven effective in other developments. They are anticipated to reduce the change in direct and indirect mortality of furbearers to levels within the range of natural variability. The Project is not expected to facilitate additional trapping effort through increased access. However, some level of uncertainty exists regarding the status of the regional furbearer populations and, with that, their ability to assimilate limited additional mortality.

9.3.6.4 Residual Effects Evaluation for Woodland Caribou

The Woodland Caribou VC is represented by one KI—woodland caribou. The residual effects evaluation, therefore, assesses Project-related effects on woodland caribou.

9.3.6.4.1 Alteration and/or Loss of Habitat

The assessment of the alteration and/or loss of habitat residual effect considers the direct loss of habitat and the indirect alteration (e.g., sensory disturbances, edge effects, or perceived barriers) of habitat during all Project phases. Caribou are known to use the Wildlife LSA and Terrestrial RSA.

During Omnia's (2020) baseline studies, woodland caribou were the second most photographed species; they were captured by wildlife cameras on all three categories of linear features (roads, trails, and hand-cut lines) in mature and regenerating forest types. Indigenous Knowledge also confirmed caribou use of linear features (19-LK-ERFNTrap-134.153). Woodland caribou winter trails were observed during the baseline studies at highest densities in the BS9 (black spruce - jack pine/feathermoss), BS7 (black spruce/blueberry/lichen), and BS17 (black spruce treed bog) ecosites (Appendix 9-B).

Woodland caribou winter pellet groups were detected at highest densities in the BS3 (jack pine/blueberry/lichen) and BS7 (black spruce/blueberry/lichen) ecosites. Summer pellet groups were detected in the BS18 (Labrador tea shrubby bog) ecosite (Appendix 9-B).

Terrestrial and arboreal feeding activity by woodland caribou was noted in the study areas. All observations were within the BS3 (jack pine/blueberry/lichen), as well as the regenerating forest types BS3 and BS7 (jack pine - blueberry/lichen and black spruce - blueberry/lichen) ecosite (Appendix 9-B).

Terrestrial lichen was most abundant in the BS3 (jack pine/blueberry/lichen), BS7 (black spruce/blueberry/lichen), and regenerating forest types BS3 and BS7 (jack pine - blueberry/lichen and black spruce - blueberry/lichen) ecosites (Appendix 9-B). Arboreal lichen were observed most frequently in BS3 (jack pine/blueberry/lichen), BS7 (black spruce/blueberry/lichen), BS16 (black spruce/balsam poplar/river alder swamp), BS21 (tamarack treed fen), and BS23 (willow shrubby rich fen).

Considering the baseline data, including the lichen survey (Appendix 9-B), woodland caribou habitat is described in the following without seasonal differentiation and referred to as available woodland caribou habitat. Through all seasons, caribou sign was detected most frequently in the following ecosites: BS3 (jack pine/blueberry/ lichen), BS7 (black spruce - blueberry/lichen), regenerating forest types BS3 and BS7 (jack pine - blueberry/lichen and black spruce - blueberry/lichen), BS9 (black spruce - jack pine/feathermoss), BS16 (black spruce/balsam poplar/river alder swamp), BS17 (black spruce treed bog), BS18 (Labrador tea shrubby bog), BS21 (tamarack treed fen), and BS23 (willow shrubby rich fen). Figure 9.3-14 depicts available woodland caribou habitat in the project study areas.

To be conservative, the environmental assessment assumed caribou use of all habitat types during all seasons, as appropriate. This is expected to appropriately address all of the biophysical features outlined in Appendix H of the *Amended Recovery Strategy for the Woodland Caribou (Rangifer tarandus caribou), Boreal population, in Canada 2020*.

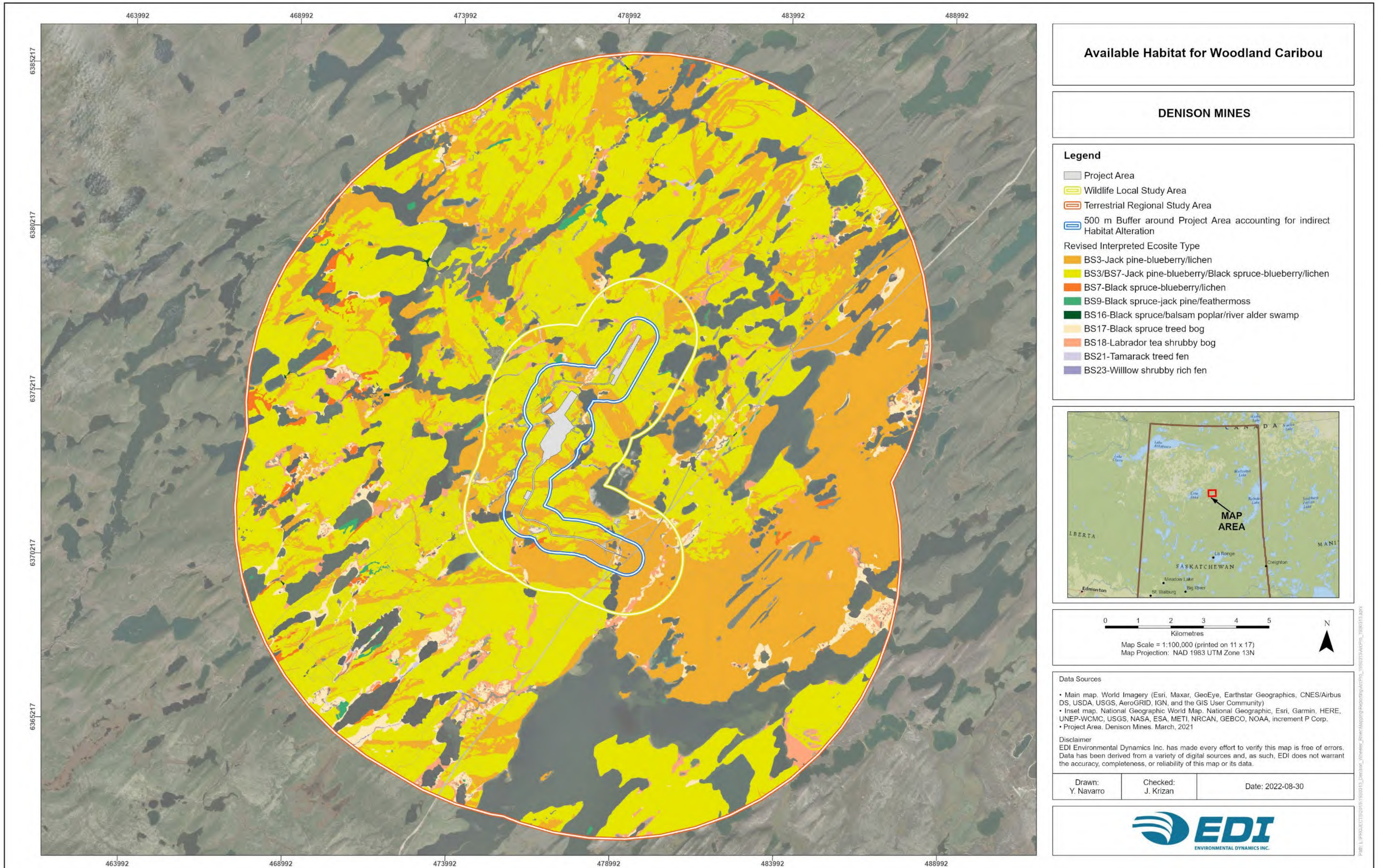

Figure 9.3-14: Available Habitat for Woodland Caribou

Table 9.3-22 provides a summary of available woodland caribou habitat in the Project Area, Wildlife LSA and Terrestrial RSA. Ecosite codes and descriptions are adopted from Table 9.2-5.

Table 9.3-22: Summary of Available Woodland Caribou Habitat in the Project Area, Wildlife Local Study Area, and the Terrestrial Regional Study Area

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS3 (mature forest)	Jack pine - blueberry / lichen	31.1	18.3	1,693.7	35.0	10,374.8	25.8
BS3 and BS7 (regenerating forest types)	Jack pine - blueberry / lichen and black spruce - blueberry / lichen	110.2	64.9	2,268	46.8	17,494.0	43.5
BS7 (mature forest)	Black spruce - blueberry / lichen	0.04	0.03	9.8	0.2	281.0	0.7
BS9	Black spruce - jack pine/feathermoss	0.2	0.3	12.3	0.3	148.5	0.4
BS16	Black spruce / balsam poplar / river alder swamp	-	-	-	-	8.8	0.02
BS17	Black spruce treed bog	0.4	0.2	98.8	2.0	1,157.1	2.9
BS18	Labrador tea shrubby bog	0.002	0.003	105.1	2.2	990.0	2.5
BS21	Tamarack treed fen	-	-	15.6	0.3	66.5	0.2
BS23	Willow shrubby rich fen	0.04	0.1	3.2	0.1	20.9	0.05
Total		**142.0[1]**	**83.8**	**4,206.5[2]**	**86.9**	**30.541.6[3]**	**76.1**

1, 2, 3 These areas represent the total area of available woodland caribou habitat within each study area; the percentages are the amount of available habitat relative to the Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha).

The characterization of the alteration and/or habitat loss residual effect considers the Project effects on available woodland caribou habitat within the Wildlife LSA and Terrestrial RSA. As outlined in Table 9.3-22, 83.8% of the Project Area, 86.9% of the Wildlife LSA, and 76.1% of the Terrestrial RSA provide habitat types that are potentially available to woodland caribou year-round.

In accordance with ECCC's (2019) assessment of disturbed areas, which buffered (500 m) anthropogenic disturbances to evaluate woodland caribou habitat, the alteration of available woodland caribou habitat is quantified in this EIS by applying a buffer of 500 m around the Project Area in which Project effects in the form of sensory disturbance are likely to affect available woodland caribou habitat and make it functionally unavailable for use. Progressive reclamation is anticipated to begin during Construction; however, a conservative approach is used, in that woodland caribou habitat within the Project Area is considered to be unavailable for the duration of the Project and will only become available as habitat following Post-Decommissioning (i.e., during the regeneration of vegetation following Decommissioning).

Direct habitat loss is calculated as the area of available woodland caribou habitat lost due to site clearing within the Project Area. Direct habitat loss has been mitigated by reducing the size of the Project Area to the extent practicable during Project design; however, available woodland caribou habitat is still predicted to be cleared during Construction. In the Project Area, 142 ha or 100% of available woodland caribou habitat is assumed to be removed and will not be available to caribou for the duration of the Project (Table 9.3-23). This represents a loss of 3.8% of available woodland caribou habitat within the Wildlife LSA and 0.5% in the Terrestrial RSA (Table 9.3-23). An additional 1,165.3 ha (27.7%) of available caribou habitat in the Wildlife LSA may experience habitat alteration stemming from indirect Project effects, such as sensory disturbance, relating to 3.8% of available woodland caribou habitat likely affected in the Terrestrial RSA (Table 9.3-23). Mitigation measures outlined in Section 9.3.5 are anticipated to reduce the effects of alteration and/or loss of habitat on woodland caribou, but not eliminate them entirely.

Table 9.3-23: Summary of Available Woodland Caribou Habitat, Direct Habitat Loss, and Habitat Alteration in the Study Areas

Study Area	Ecosite Description	Amount of Available Woodland Caribou Habitat (ha)	Percent of Available Woodland Caribou Habitat (%)	Amount of Available Woodland Caribou Habitat Loss (ha)	Percent of Available Woodland Caribou Habitat Loss (%)	Amount of Available Woodland Caribou Habitat Altered (ha)[1]	Percent of Available Woodland Caribou Habitat Altered (%)
Project Area	BS3 (mature forest) Jack pine - blueberry / lichen	31.1	18.3	31.1	100	N/A	N/A
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry / lichen and black spruce - blueberry / lichen	110.2	64.9	110.2	100	N/A	N/A
	BS7 (mature forest) Black spruce - blueberry / lichen	0.04	0.03	0.04	100	N/A	N/A
	BS9 Black spruce - jack pine /feathermoss	0.2	0.3	0.2	100	N/A	N/A
	BS16 Black spruce / balsam poplar / river alder swamp	-	-	-	-	-	-
	BS17 Black spruce treed bog)	0.4	0.03	0.4	100	N/A	N/A
	BS18 Labrador tea shrubby bog	0.002	0.003	0.002	100	N/A	N/A

Study Area	Ecosite Description	Amount of Available Woodland Caribou Habitat (ha)	Percent of Available Woodland Caribou Habitat (%)	Amount of Available Woodland Caribou Habitat Loss (ha)	Percent of Available Woodland Caribou Habitat Loss (%)	Amount of Available Woodland Caribou Habitat Altered (ha)[1]	Percent of Available Woodland Caribou Habitat Altered (%)
	BS21 Tamarack treed fen	-	-	-	-	-	-
	BS23 Willow shrubby rich fen	0.04	0.1	0.04	100	N/A	N/A
	Total	**142.0**[2]	**83.6**	**142.0**	**100**	**N/A**	**N/A**
Wildlife LSA	BS3 (mature forest) Jack pine - blueberry / lichen	1,693.7	35.0	31.1	1.8	445.1	26.3
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry / lichen and black spruce - blueberry / lichen	2,268	46.8	110.2	4.9	656.5	29.0
	BS7 (mature forest) Black spruce - blueberry / lichen	9.8	0.2	0.04	0.5	5.3	53.9
	BS9 Black spruce - jack pine /feathermoss	12.3	0.3	0.2	1.6	3.5	28.3
	BS16 Black spruce / balsam poplar / river alder swamp	-	-	-	-	-	-
	BS17 Black spruce treed bog	98.8	2.0	0.4	0.4	22.0	22.3
	BS18 Labrador tea shrubby bog	105.1	2.2	0.002	0.002	30.0	28.6
	BS21 Tamarack treed fen	15.6	0.3	-	-	2.2	14.2
	BS23 Willow shrubby rich fen	3.2	0.1	0.04	1.3	0.7	21.3
	Total	**4,206.5**[3]	**86.9**	**142.0**	**3.8**	**1,165.3**	**27.7**
Terrestrial RSA	BS3 (mature forest) Jack pine - blueberry / lichen	10,374.8	25.8	31.1	0.3	445.1	4.3
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry / lichen and black spruce - blueberry / lichen	17,494.0	43.5	110.2	0.6	656.5	3.8

Study Area	Ecosite Description	Amount of Available Woodland Caribou Habitat (ha)	Percent of Available Woodland Caribou Habitat (%)	Amount of Available Woodland Caribou Habitat Loss (ha)	Percent of Available Woodland Caribou Habitat Loss (%)	Amount of Available Woodland Caribou Habitat Altered (ha)[1]	Percent of Available Woodland Caribou Habitat Altered (%)
	BS7 (mature forest) Black spruce - blueberry / lichen	281.0	0.7	0.04	0.02	5.3	1.9
	BS9 Black spruce - jack pine/ feathermoss	148.5	0.4	0.2	0.1	3.5	2.4
	BS16 Black spruce / balsam poplar / river alder swamp	8.8	0.02	-	-	-	-
	BS17 Black spruce treed bog	1,157.1	2.9	0.4	0.03	22.0	1.9
	BS18 Labrador tea shrubby bog	990.0	2.5	0.002	0.0002	30.0	3.0
	BS21 Tamarack treed fen	66.5	0.2	-	-	2.2	3.3
	BS23 Willow shrubby rich fen	20.9	0.05	0.04	0.2	0.7	3.4
	Total	**30,541.6**[4]	**76.1**	**142.0**	**0.5**	**1,165.3**	**3.8**

1 Based on a 500 m buffer around the Project Area.

2, 3, 4 This area does not reflect the entire Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha) but represents the total area of available woodland caribou habitat in each study area. N/A = Not Applicable.

Residual Effects Characteristics

The residual effects characterization for the alteration and/or loss of available woodland caribou habitat is provided in Table 9.3-24.

The direction of alteration and/or loss of available woodland caribou habitat is predicted to be adverse. The Project is expected to affect available caribou habitat directly (through habitat loss) and indirectly (through habitat alteration).

The magnitude of the residual effect is predicted to be low. It is anticipated that up to 4.3% of available caribou habitat within the Terrestrial RSA may be altered or lost due to the Project: 0.5% of available woodland caribou habitat within the Terrestrial RSA will be cleared within the Project Area during Construction, and an additional 3.8% of available caribou habitat may be altered through indirect effects during all Project phases. Indigenous Knowledge holders stated that while woodland caribou densities in the area may not have changed over the years (19 -LK-ERFNTrap-134.156), the use of the area has changed since Highway 914 was built (19-LK-ERFNTrap-134.150). *"Caribou don't seem to be bothered by visual sightings of vehicles (smaller trucks) but seem to react* *to regular traffic of larger bigger vehicles and are sensitive to the vibrations*” (19-LK-ERFNTrap-134.150).

The residual effect is predicted to be local in geographic extent. While the direct loss of available woodland caribou habitat is expected to be limited to the Project Area during Construction, indirect Project effects are expected to occur within the Wildlife LSA within a 500 m area around the Project Area during all Project phases.

The residual effect of alteration and/or loss of available woodland caribou habitat is predicted to occur over the long-term (greater than 33 years) because of the long time required for available caribou habitat, including mature forests, to regenerate following disturbance. Norbert et al. (2020) found that lichen cover was lower in timber harvested and burned areas compared to intact undisturbed forests by 10 to 20 years post-disturbance, respectively. Forest habitats experiencing anthropogenic disturbances may not provide suitable woodland caribou habitat until 20 years after the disturbance ceases (i.e., 20 years after Post-Decommissioning is completed). Progressive reclamation is anticipated to begin in some parts of the Project Area following Construction; however, the revegetation within most of the Project Area will occur as part of reclamation activities during Decommissioning, up to 18 years after clearing during Construction. It is expected that available woodland caribou habitat regrowth will require up to 20 years after reclamation activities have been completed, and that the Project Area will likely support areas of suitable foraging habitat at that time.

The frequency of the residual effect is predicted to be frequent. While loss of available caribou habitat resulting from vegetation clearing during Construction will occur only initially, alteration of available caribou habitat within the Wildlife LSA through indirect Project effects is anticipated to be frequent throughout Construction, Operation, and Decommissioning phases, and infrequent during Post-Decommissioning.

The alteration and/or loss of available woodland caribou habitat is predicted to be fully reversible. Through progressive and final reclamation, disturbed areas within the Project Area will be revegetated with a focus on achieving baseline conditions. Woodland caribou prefer habitat types that support lichen growth, and it is anticipated that revegetated areas will become available to caribou following the end of Post-Decommissioning. Progressive reclamation may occur in some parts of the Project Area prior to Post-Decommissioning; however, most revegetation is anticipated to occur following the end of Operation and become available woodland caribou habitat during and following Post-Decommissioning. In addition, the alteration of available woodland caribou habitat is expected to be reversed within a similar time frame as sensory disturbances diminish with the ceasing of Project operation activities and subsequent decommissioning of Project components after Decommissioning.

The context of the residual effect of alteration and/or loss of available woodland caribou habitat is predicted to be high. Available caribou habitat that is altered or cleared will remain so until well after Post-Decommissioning during which final reclamation and revegetation is scheduled to occur. It is expected that revegetated areas will not become available woodland caribou habitat until terrestrial and arboreal lichen have re-established in the regenerated vegetation communities, up to 20 years post-disturbance (Norbert et al. 2020). In addition, woodland caribou are listed federally as Threatened (ECCC 2021) and the SK CDC assigned the species a status of S3 (Vulnerable/Rare to Uncommon: at moderate risk of extinction or extirpation due to a restricted range, relatively few populations, recent and widespread declines, threats, or other factors) in Saskatchewan (SK CDC 2020).

The residual effect of alteration and/or loss of available woodland caribou habitat is predicted to be likely. Available caribou habitat is expected to be cleared in the Project Area during Construction and indirectly affected in the Wildlife LSA during all phases of the Project.

Table 9.3-24: Summary of the Characteristics Ratings for Alteration and/or Loss of Available Woodland Caribou Habitat

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project is expected to affect available woodland caribou habitat directly and indirectly.
Magnitude	Low	Up to 4.3% of available woodland caribou habitat within the Terrestrial RSA are predicted to be affected by the Project. This includes 0.5% habitat loss and up to 3.8% of habitat alteration in the Terrestrial RSA.
Geographic Extent	Local	The direct loss of available woodland caribou habitat is expected to be limited to the Project Area during Construction, and indirect effects resulting in habitat alteration are expected to be restricted to the Wildlife LSA during all Project phases.
Duration	Long-term	The loss of available woodland caribou habitat will mainly occur during Construction; however, the alteration of habitat will continue through all phases. The reclamation and revegetation of the entire Project Area will not be complete until after Post-Decommissioning. It may take up to 20 years for lichen to recolonize the reclaimed forest habitats and provide woodland caribou habitat.
Frequency	Frequent	Loss of available woodland caribou habitat will occur initially during Construction, and alteration of available caribou habitat through indirect Project effects is anticipated to be frequent throughout all Project phases until Post-Decommissioning.
Reversibility	Fully Reversible	Disturbed habitat within the Project Area will be revegetated and will likely not become available to woodland caribou until well after the end of Post-Decommissioning. The alteration of available woodland habitat is expected to be reversed as sensory disturbances diminish with the ceasing of Project operation activities and subsequent decommissioning of Project components after Decommissioning.
Context	High	It is expected that revegetated areas will not become available woodland caribou habitat until terrestrial and arboreal lichen have re-established in the regenerated vegetation communities, up to 20 years post-disturbance. In addition, woodland caribou are listed federally as Threatened and as S3 in Saskatchewan.
Likelihood	Likely	Available woodland caribou habitat is expected to be cleared in the Project Area during Construction and to be indirectly affected in the Wildlife LSA during all phases of the Project.

Significance and Confidence

The residual effect of alteration and/or loss of available woodland caribou habitat is not expected to result in a change that will alter caribou habitat integrity to the point where it would not be able to sustain the regional woodland caribou population. Therefore, the effect is assessed as **not significant**.

The level of confidence of this prediction is moderate. The effects of habitat loss and alteration on woodland are well understood, and mitigation measures have been proven effective during past projects and activities. However, some level of uncertainty exists related to the available background and baseline information used to identify available woodland caribou habitat in this assessment.

9.3.6.4.2 Change in Mortality

The residual effects characterization of the change in mortality of woodland caribou considers Project-related effects within the Terrestrial RSA. Section 9.3.3.3 summarizes the existing knowledge of woodland caribou population estimates and mortality within the Terrestrial RSA. The assessment includes considerations of direct mortality from Project activities and interactions with Project components, and indirect mortality due to the Project, such as increased predation. The highest risk of direct woodland caribou mortality is anticipated to be associated with activities during the Construction and Operation phases; however, the risk of indirect caribou mortality exists during all Project phases.

A change in direct mortality due to the Project could result from vehicle collisions with caribou, or caribou getting injured when travelling through the Project Area. The potential for the Project to adversely affect direct mortality of caribou is considered to be low. Almost 15% of the Project Area is already disturbed by previous developments and therefore not considered suitable caribou habitat (as per guidance provided in ECCC 2020), and no caribou or caribou sign was observed in the Project Area during baseline studies (Appendix 9-B).

Vehicle collisions with caribou are a documented source of caribou mortality in areas where caribou ranges overlap with transportation infrastructure and could add to caribou mortality outside the Project Area where increased Project-related traffic may occur (ECCC 2020). Wildlife-vehicle collision data for the entire province are available for select years, and the available information showed that more than 80% of the accidents were collisions with deer; no caribou-vehicle collisions were reported (L-P Tardif & Associates Inc. 2003). Additional sources of direct mortality may include entrapment within snowbanks along roads resulting in an increased risk of vehicle collision.

A change in indirect mortality of caribou could occur through two processes potentially affected by the Project: 1) apparent competition with more productive alternative prey species, and 2) facilitated predation by wolves. Apparent competition occurs when the density of an alternative prey species increases so that it supports a higher density of a shared predator(s), which increases predation on the other prey species. Landscape changes due to the Project may provide habitat for moose (and potentially deer), which may increase the abundance of wolves, which then will also prey on caribou (Bergerud and Elliot 1986).

Woodland caribou prefer mature forests because mature, open conifer stands provide abundant terrestrial and arboreal lichen (Norbert et al. 2020). In addition, mature forests with sparse understory vegetation do not support high densities of other ungulates and, consequently, predators in these contiguous mature forest stands occur at low densities. Loss and fragmentation of mature forests caused by habitat disturbances with subsequently increased predation rates is considered one of the main causes of woodland caribou declines (Norbert et al. 2020). Facilitated predation occurs with the development, maintenance, and/or use of roads and trails that provide easier movement for predators across the landscape. Predators, particularly wolves, use these linear features as accessible travel corridors and, consequently, hunt more efficiently within their range (Dickie et al. 2017).

Indigenous Knowledge and LK holders reported more cabins in the area, with more boat traffic on lakes due to anglers accessing the area for fishing (19-LK-ERFNTrap-134.24; ERFN and SVS 2022). Anglers have been observed to cut access trails to the lakes, which will affect caribou through increased use of the trails by wolves who are now accessing these areas in search of prey (19-LK-ERFNTrap-134.24, 19-LK-ERFNTrap-134.159). In addition to the new access created for wolves, caribou also travel on roads, trails, and hand-cut lines (19-LK-ERFNTrap-134.153).

The potential for the Project to indirectly affect caribou mortality through apparent competition is limited during Construction and Operation phases when human activity is more likely to deter alternative prey and predators away from the Project Area. However, during the Decommissioning and Post-Decommissioning phases, the Project Area is expected to temporarily create habitat that could locally support higher densities of alternative prey species, potentially increasing predator density in the region. Similarly, the potential for the Project to indirectly affect caribou mortality through facilitated predation through the construction and maintenance of roads and trails is unlikely to occur during the Construction and Operation phases because wolves are more likely to avoid the Project Area due to increased levels of human activities. During the Decommissioning and Post-Decommissioning phases, human activity within the Project Area will likely be reduced and wolves could start using the roads and trails within the Project Area as travel corridors and potentially access parts of the woodland caribou range.

Project-related sensory disturbances, such as increased noise levels from drilling activities, vehicle and aircraft traffic, dust deposition, and artificial light, could increase stress levels in woodland caribou and contribute to reduced reproductions, poor health, and possibly mortality.

Mitigation measures to reduce the potential for changes in direct and indirect woodland caribou mortality due to the Project include the Project mitigation measures identified in Section 9.3.5.

Mitigation measures to reduce direct woodland caribou mortality (e.g., through collisions) are known to be effective and include traffic management (such as the use of signage and speed limits), employee awareness and education, and mandatory reporting of caribou observations and immediate communication to staff for avoidance. Effective and proven mitigation measures to reduce the risk of additional direct mortality, such as exposure to contaminated waste pads and ponds and entrapment within snowbanks along roads, include exclusion fencing around pads and ponds and the implementation of breaks in snowbanks.

Mitigation measures to reduce the potential for a change in indirect woodland caribou mortality include the decommissioning and reclamation of trails and roads that may facilitate predator movement.

Project mitigation measures identified in Section 9.3.5 are expected to limit interactions between woodland caribou and potential sources of direct and indirect mortality, thereby minimizing the residual effect of change in mortality and the likelihood to result in a change of the woodland caribou population.

Residual Effects Characteristics

The residual effects characterization for the change in mortality of woodland caribou is provided in Table 9.3-25.

The direction of the residual effect for change in mortality is predicted to be adverse. While it is expected that the risks for Project-related woodland caribou mortalities are limited (due to effective mitigation measures), any additional mortality may affect the population.

The magnitude of the effect is expected to be low. Mitigation measures are anticipated to be effective at reducing direct and indirect woodland caribou mortality, and the risk of mortality is expected to be within the range of natural variability.

The geographic extent of change in mortality is predicted to be regional. A change in direct mortality is expected to mainly occur within the Project Area; however, indirect woodland caribou mortality may occur outside the Wildlife LSA and into the Terrestrial RSA (due to the size of their home range). Sources for a change in direct mortality (e.g., vehicle collisions on access and site roads, exposure to waste pads and ponds) that occur within the Project Area may affect the caribou population in the Terrestrial RSA. Potentially increased traffic on Highway 914 and may also affect direct mortality in the Wildlife LSA and Terrestrial RSA. Sources for indirect mortality (e.g., apparent competition and facilitated predation; changes to health due to sensory disturbance) may also result in mortality in the Terrestrial RSA.

It is estimated that the duration of the effect will be medium-term. The potential for direct mortality is expected to be highest during the Construction and Operation phases when vehicle traffic as well as exposure to and entrapment in Project components are likely to be most frequent, and it is predicted to continue through to the end of Post-Decommissioning. The potential for indirect mortality is expected to be highest during Operation, when vehicle and aircraft traffic, exposure to sensory disturbances, and increased predation pressure may result in indirect mortality. The potential for indirect mortality is anticipated to decrease in Decommissioning following the removal of Project components and a reduction in Project activities and to be limited during Post-Decommissioning. Indirect mortality through facilitated predation is expected to be limited to the Construction and Operation phases. Mortality through the process of apparent competition is expected to remain until the Project Area is starting to be reclaimed during Post-Decommissioning and no longer has the potential to support higher densities of alternative prey.

The frequency of the residual effect is assessed as infrequent. Mitigation measures (e.g., speed limits; exclusion fences preventing access to Project components) are anticipated to limit the potential for caribou mortality; however, direct and indirect mortality could occur sporadically through all Project phases.

It is predicted that the effect of change in mortality will be fully reversible. The risks of direct or indirect mortality are anticipated to decline during Decommissioning following the removal of Project components and a reduction in Project activities, and to diminish to baseline conditions following Post-Decommissioning.

The context for the residual effect of change in mortality is expected to be high. While the woodland caribou population in the region is reported to be stable (19 -LK-ERFNTrap-134.156) and their habitat disturbance is below the threshold of anthropogenic disturbance recommended as required to sustain viable populations (ECCC 2020), woodland caribou are listed federally as Threatened (ECCC 2021) and the SK CDC assigned the species a status of S3 (Vulnerable/Rare to Uncommon: at moderate risk of extinction or extirpation due to a restricted range, relatively few populations, recent and widespread declines, threats, or other factors) (SK CDC 2020).The context rating of high considers the federal and provincial listing.

The residual effect of change in woodland caribou mortality is likely to occur. Mitigation measures are expected to reduce, but not fully eliminate, the residual effect on woodland caribou.

Table 9.3-25: Summary of the Characteristics Ratings for Change in Mortality of Woodland Caribou

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project is expected to affect a change in mortality of woodland caribou.
Magnitude	Low	Mitigation measures are anticipated to be effective at reducing the potential for a change in direct and indirect mortality, and the risk of mortality is expected to be within the range of natural variability.
Geographic Extent	Regional	The change in direct mortality is expected to occur mainly within the Project Area; however, indirect mortality may extend into the Terrestrial RSA.

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Duration	Medium-term	Woodland caribou mortality may occur during all phases of the Project. The potential for direct mortality is expected to be highest during the Construction and Operation phases and the potential for indirect mortality is expected to be highest during Operation and decreasing during the Decommissioning and Post-Decommissioning phases.
Frequency	Infrequent	It is expected that the potential for a change in direct and indirect woodland caribou mortality is limited but the residual effect may occur sporadically throughout the life of the Project.
Reversibility	Fully Reversible	It is anticipated that the potential for a change in woodland caribou mortality will decline during Decommissioning following the removal of Project components and a reduction in Project activities and will diminish to baseline conditions following Post-Decommissioning.
Context	High	Estimates of the regional caribou populations suggest a stable population in a habitat with limited anthropogenic disturbances. However, woodland caribou are listed federally as Threatened and as S3 in Saskatchewan.
Likelihood	Likely	Mitigation measures are expected to reduce, but not fully eliminate, the residual effect on woodland caribou.

Significance and Confidence

The residual effect of change in mortality is not expected to result in an increase in woodland caribou mortality that will alter the integrity of the population to the point where the regional woodland caribou population could not be sustained. Therefore, the effect is assessed as **not significant**.

The level of confidence of this prediction is moderate. The effects of increased mortality are well known, and effective, proven mitigation measures will be implemented. These measures are anticipated to reduce direct and indirect mortality to levels within the range of natural variability. However, some level of uncertainty exists about the status of the regional predator populations and their potentially Project-related increased ability to successfully prey on woodland caribou in the Terrestrial RSA.

9.3.6.5 Summary of Project-related Residual Effects on Ungulates, Furbearers, and Woodland Caribou Valued Components

The residual effects evaluation process in Section 9.3.6 assessed the following residual effects of the Project on the Ungulates, Furbearers, and Woodland Caribou VCs:

- alteration and/or loss of habitat; and
- change in mortality.

The evaluation process characterized the residual effects of the Project on the respective VCs, the results of which are summarized in Table 9.3-26 and Table 9.3-27**.** The residual effects of the

Project are not expected to result in a change to the viability and persistence of the VCs and associated KIs and were, therefore, predicted to be **not significant**.

Table 9.3-26: Ungulates, Furbearers, and Woodland Caribou Valued Components – Summary of the Characteristics Ratings for Alteration and/or Loss of Habitat

Residual Effects Characteristic	Rating			Summary Rationale for Rating
	Ungulates	Furbearers	Woodland Caribou	
Direction	Adverse	Adverse	Adverse	**Ungulates:** The Project is expected to affect available moose habitat. **Furbearers:** The Project is expected to affect available furbearer habitat. **Woodland Caribou:** The Project is expected to affect available woodland caribou habitat.
Magnitude	Low	Moderate	Low	**Ungulates:** Up to 4.4% of available moose habitat within the Terrestrial RSA are predicted to be affected by the Project. This includes 0.5% habitat loss and up to 3.9% of habitat alteration in the Terrestrial RSA. **Furbearers:** <u>Wolverine (Moderate):</u> 8.2% of available wolverine habitat within the Terrestrial RSA may be altered or lost: 0.5% will be cleared within the Project Area, and an additional 7.7% may be altered through indirect effects. <u>Pine marten (Low):</u> 4.4% of available pine marten habitat within the Terrestrial RSA may be altered or lost: 0.5% will be cleared within the Project Area and an additional 3.9% may be altered through indirect effects. <u>Mink (Low):</u> 2.5% of available mink habitat within the Terrestrial RSA may be altered or lost: 0.02 % will be cleared within the Project Area and an additional 2.5% may be altered through indirect effects. <u>Muskrat (Low):</u> 1.0% of available muskrat habitat within the Terrestrial RSA may be altered or lost: 0.001% will be cleared within the Project Area and an additional 1.0% may be altered through indirect effects. **Woodland Caribou:** Up to 4.3% of available woodland caribou habitat within the Terrestrial RSA are predicted to be affected by the Project. This includes 0.5% habitat loss and up to 3.8% of habitat alteration in the Terrestrial RSA.
Geographic Extent	Local	Local	Local	**Ungulates:** The direct loss of available moose habitat is expected to be limited to the Project Area and indirect effects resulting in habitat alteration are expected to be restricted to the Wildlife LSA. **Furbearers:** The direct loss of available furbearer habitat is expected to be limited to the Project Area and indirect effects resulting in habitat alteration are expected to be restricted to the Wildlife LSA.

Residual Effects Characteristic	Rating			Summary Rationale for Rating
	Ungulates	Furbearers	Woodland Caribou	
				Woodland Caribou: The direct loss of available woodland caribou habitat is expected to be limited to the Project Area and indirect effects resulting in habitat alteration are expected to be restricted to the Wildlife LSA.
Duration	Medium-term	Long-term	Long-term	**Ungulates:** The loss of available moose habitat will mainly occur during Construction; however, the alteration of habitat will continue through all phases. The reclamation and revegetation of the Project Area will not be complete until Post-Decommissioning at which time revegetated areas are starting to become available moose habitat. **Furbearers:** The loss of available furbearer habitat will mainly occur during Construction; however, the alteration of habitat will continue through all phases. The reclamation and revegetation of the Project Area will not be complete until after Post-Decommissioning at which time revegetated areas are starting to become available furbearer habitat. **Woodland Caribou:** The loss of available woodland caribou habitat will mainly occur during Construction; however, the alteration of habitat will continue through all phases. The reclamation and revegetation of the Project Area will not be complete until after Post-Decommissioning. It may take up to 20 years for lichen to recolonize the reclaimed forest habitats and provide woodland caribou habitat.
Frequency	Frequent	Frequent	Frequent	**Ungulates:** Loss of available moose habitat will occur initially during Construction, and alteration of available moose habitat is anticipated to be frequent throughout all Project phases until Post-Decommissioning. **Furbearers:** Loss of available furbearer habitat will occur initially during construction, and alteration of available furbearer habitat through indirect Project effects is anticipated to be frequent throughout all Project phases until Post-Decommissioning. **Woodland Caribou:** Loss of available woodland caribou habitat will occur initially during Construction, and alteration of available caribou habitat through indirect Project effects is anticipated to be frequent throughout all Project phases until Post-Decommissioning.
Reversibility	Fully Reversible	Fully Reversible	Fully Reversible	**Ungulates:** Disturbed habitat within the Project Area will be revegetated and will likely become available to moose. The alteration of available moose habitat is expected to be reversed as sensory disturbances diminish with the ceasing of Project operation activities and subsequent decommissioning of Project components. **Furbearers:** Disturbed habitat within the Project Area will be revegetated and will likely become available to furbearers. The alteration of available furbearer habitat is expected to be reversed as sensory disturbances

Residual Effects Characteristic	Rating			Summary Rationale for Rating
	Ungulates	Furbearers	Woodland Caribou	
				diminish with the ceasing of Project operation activities and subsequent decommissioning of Project components. **Woodland Caribou:** Disturbed habitat within the Project Area will be revegetated and will likely not become available to woodland caribou until well after the end of Post-Decommissioning. The alteration of available woodland habitat is expected to be reversed as sensory disturbances diminish with the ceasing of Project operation activities and subsequent decommissioning of Project components after Decommissioning.
Context	Moderate	High	High	**Ungulates:** Revegetated areas are expected to become available moose habitat within a few years of revegetation. In addition, moose densities in the region are low. As such, available moose habitat within the Terrestrial RSA is expected to have a moderate resilience to stress. **Furbearers:** Revegetated areas are expected to become available furbearer habitat once disturbed areas have been reclaimed and revegetation has started to return the area to baseline conditions. While pine marten, mink, and muskrat populations in Saskatchewan are considered secure, wolverine are listed federally as Special Concern and in provincially as S2. **Woodland Caribou:** It is expected that revegetated areas will not become available woodland caribou habitat until terrestrial and arboreal lichen have re-established in the regenerated vegetation communities, up to 20 years post-disturbance. In addition, woodland caribou are listed federally as Threatened and provincially as S3.
Likelihood	Likely	Likely	Likely	**Ungulates:** Available moose habitat is expected to be cleared in the Project Area during the Construction Phase and to be indirectly affected in the Wildlife LSA during all phases of the Project. **Furbearers:** Available furbearer habitat is expected to be cleared in the Project Area during the Construction Phase and to be indirectly affected in the Wildlife LSA during all phases of the Project. **Woodland Caribou:** Available woodland caribou habitat is expected to be cleared in the Project Area during the Construction Phase and to be indirectly affected in the Wildlife LSA during all phases of the Project.
Significance	Not Significant	Not Significant	Not Significant	The residual effect of habitat loss and alteration on Ungulates, Furbearers, and Woodland Caribou VCs and associated KIs is not expected to result in a change in habitat that will alter habitat integrity to the point where it would not be able to sustain regional populations.

Residual Effects Characteristic	Rating			Summary Rationale for Rating
	Ungulates	Furbearers	Woodland Caribou	
Level of Confidence	Moderate	Moderate	Moderate	The effects of habitat loss and alteration on Ungulates, Furbearers, and Woodland Caribou VCs and associated KIs are well known, and proven, effective mitigation measures will be implemented. However, there is some level of uncertainty related to the available background and baseline information used to identify available habitat in this assessment.

Table 9.3-27: Ungulates, Furbearers, and Woodland Caribou Valued Components – Summary of the Characteristics Ratings for Change in Mortality

Residual Effects Characteristic	Rating			Summary Rationale for Rating
	Ungulates	Furbearers	Woodland Caribou	
Direction	Adverse	Adverse	Adverse	**Ungulates:** The Project is expected to affect a change in mortality of moose. **Furbearers:** The Project is expected to affect a change in mortality of furbearers. **Woodland Caribou:** The Project is expected to affect a change in mortality of woodland caribou.
Magnitude	Low	Low	Low	**Ungulates:** Mitigation measures are anticipated to be effective at reducing the potential for a change in direct and indirect mortality, and the risk of mortality is expected to be within the range of natural variability for moose. **Furbearers:** Mitigation measures are anticipated to be effective at reducing the potential for a change in direct and indirect mortality, and the risk of mortality is expected to be within the range of natural variability for furbearers. **Woodland Caribou:** Mitigation measures are anticipated to be effective at reducing the potential for a change in direct and indirect mortality, and the risk of mortality is expected to be within the range of natural variability for woodland caribou.
Geographic Extent	Regional	Regional	Regional	**Ungulates:** The change in direct mortality is expected to occur mainly within the Project Area; however, indirect moose mortality may extend into the Terrestrial RSA. **Furbearers:** The change in direct mortality is expected to occur mainly within the Project Area; however, indirect furbearer mortality may extend into the Terrestrial RSA, particularly for wolverine.

Residual Effects Characteristic	Rating			Summary Rationale for Rating
	Ungulates	Furbearers	Woodland Caribou	
				Woodland Caribou: The change in direct mortality is expected to occur mainly within the Project Area; however, indirect woodland caribou mortality may extend into the Terrestrial RSA.
Duration	Medium-term	Medium-term	Medium-term	**Ungulates:** Moose mortality may occur during all phases of the Project. The potential for a change in direct mortality is expected to be highest during the Construction and Operation phases and the potential for indirect mortality is expected to be highest during Operation, decreasing during Decommissioning, and limited during Post-Decommissioning. **Furbearers:** Furbearer mortality may occur during all phases of the Project. The potential for a change in direct mortality is expected to be highest during the Construction and Operation phases and the potential for indirect mortality is expected to be highest during Operation, decreasing during Decommissioning, and limited during Post-Decommissioning. **Woodland Caribou:** Woodland caribou mortality may occur during all phases of the Project. The potential for direct mortality is expected to be highest during the Construction and Operation phases and the potential for indirect mortality is expected to be highest during Operation and decreasing during the Decommissioning and Post-Decommissioning phases.
Frequency	Infrequent	Infrequent	Infrequent	**Ungulates:** It is expected that the potential for a change in direct and indirect moose mortality is limited but the residual effect may occur sporadically throughout the life of the Project. **Furbearers:** It is expected that the potential for a change in direct and indirect furbearer mortality is limited but the residual effect may occur sporadically throughout the life of the Project. **Woodland Caribou:** It is expected that the potential for a change in direct and indirect woodland caribou mortality is limited but the residual effect may occur sporadically throughout the life of the Project.
Reversibility	Fully Reversible	Fully Reversible	Fully Reversible	**Ungulates:** It is anticipated that the change in moose mortality will decline during Decommissioning following the removal of Project components and a reduction in Project activities and will diminish to baseline conditions following Post-Decommissioning. **Furbearers:** It is anticipated that the change in mortality of furbearers will decline during Decommissioning following the removal of Project components and a reduction in Project activities and that it will diminish to baseline conditions following Post-Decommissioning.

Residual Effects Characteristic	Rating			Summary Rationale for Rating
	Ungulates	Furbearers	Woodland Caribou	
				Woodland Caribou: It is anticipated that the potential for a change in woodland caribou mortality will decline during Decommissioning following the removal of Project components and a reduction in Project activities and will diminish to baseline conditions following Post-Decommissioning.
Context	Moderate	High	High	**Ungulates:** Estimates of moose populations suggest generally low or declining densities in the area. The rating is based on the potential effect of a limited Project-related increase in mortalities. **Furbearers:** Most furbearer populations in Saskatchewan are considered healthy based on three decades of harvest return information, however, muskrats in the region may be declining, based on scientific and IK information. While pine marten, mink, and muskrat populations in Saskatchewan are considered secure, wolverine are listed federally as Special Concern and in provincially as S2. **Woodland Caribou:** Estimates of the regional caribou populations suggest a stable population in a habitat with limited anthropogenic disturbances. However, woodland caribou are listed federally as Threatened and as S3 in Saskatchewan.
Likelihood	Likely	Likely	Likely	**Ungulates:** Mitigation measures are expected to reduce, but not eliminate, the residual effect on moose. **Furbearers:** Mitigation measures are expected to reduce, but not eliminate, the residual effect on furbearers. **Woodland Caribou:** Mitigation measures are expected to reduce, but not eliminate, the residual effect on woodland caribou.
Significance	Not Significant	Not Significant	Not Significant	The residual effect is not expected to result in a change in moose, furbearer, or woodland caribou mortality that will alter the integrity of the populations to the point where the regional populations could not be sustained.
Level of Confidence	Moderate	Moderate	Moderate	The effects of increased mortality are well known, and mitigation measures that will be implemented are anticipated to reduce the change in direct and indirect mortality of moose, furbearers, and woodland caribou to levels within the range of natural variability. However, some level of uncertainty exists about the status of their regional populations and with that their ability to assimilate limited additional mortality. There is also some uncertainty about the status of the regional predator populations (e.g., wolves) and their potentially Project-related increased ability (through additional roads) to successfully prey on moose and woodland caribou.

9.3.7 Cumulative Effects

The CEA considers whether residual adverse effects of the Project on the Ungulates, Furbearers, and Woodland Caribou VCs will overlap spatially and/or temporally with the same residual adverse effects resulting from other past, present, and reasonably foreseeable projects or activities. The CEA follows standard methodology as per provincial (e.g., Guidelines for an Environmental Assessment under the [Saskatchewan] *Environmental Assessment Act* 1980) and federal (e.g., Assessing Cumulative Environmental Effects under the Canadian *Environmental Assessment Act* 2012) guidance, and is discussed in Section 5.9.

The spatial boundary of the CEA for Ungulates, Furbearers, and Woodland Caribou VCs is defined as the Terrestrial RSA. Projects/activities that are outside of the Terrestrial RSA but could have potential effects that extend into the Terrestrial RSA, were also considered.

The temporal boundaries of the CEA encompass the periods during which the proposed Project-related residual effects are expected to interact with residual effects of other past, present, or reasonably foreseeable future projects and activities, and include the Construction, Operation, Decommissioning, and Post-Decommissioning phases of the Project.

Baseline conditions (described in Section 9.3.3) represent the effects of past and present projects and activities, including all resulting disturbances that may still exist. As such, the focus of the CEA is ongoing and reasonably foreseeable future projects and activities. All projects and activities listed in the Project and Activity Inclusion List (Section 5) that are not listed below in Section 9.3.7.1 are not considered in the CEA for Ungulates, Furbearers, and Woodland Caribou VCs because the residual effects of these developments are not anticipated to overlap spatially or temporally with the residual effects of the Project.

9.3.7.1 Potential Cumulative Effects

As outlined in Section 9.3.4.2, the following Project-related residual effects were considered for their potential to interact cumulatively with the residual effects of projects and activities identified within, or extending into the Terrestrial RSA:

- alteration and/or loss of habitat; and
- change in mortality.

9.3.7.2 Ongoing and Future Projects and Activities

Spatial information is not available for some future projects and most activities. The following projects and activities are expected to interact cumulatively with the residual Project effects on the

Ungulates, Furbearers, and Woodland Caribou VCs, within or extending into the Terrestrial RSA (Figure 9.3-15):

- **Infrastructure Use and Maintenance Activities**

Existing infrastructure within the Terrestrial RSA, such as old exploration roads and trails, Highway 914, and the power transmission line ROW are anticipated to be continuously used during the lifetime of the Project and may require varying levels of maintenance. Maintenance activities may include vegetation management for safety and line-of-sight, road grading and gravelling, improvement of surface water management infrastructure (e.g., culvert replacement and recontouring of ditches and drainages), and other repairs. Such activities have the potential to contribute to the cumulative effects on the Ungulates, Furbearers, and Woodland Caribou VCs through habitat loss, increased sensory disturbance (e.g., noise and dust deposition), potential wildlife-vehicle collisions, and increased hunting and predation pressure within the Terrestrial RSA.

- **Exploration and Mining Activities**

Wildlife habitat within the Terrestrial RSA has experienced historic anthropogenic disturbance such as line cutting, drilling, and access development in support of past exploration and mining activities, and future exploration activities within the Terrestrial RSA are likely. Such exploration activities are expected to contribute to the cumulative effects on the Ungulates, Furbearers, and Woodland Caribou VCs through habitat loss, increased sensory disturbance (e.g., noise and dust deposition), potential wildlife-vehicle collisions, increased hunting and predation pressure, increased risk of human-wildlife encounters, and deposition of trace metals and radionuclides to soil, vegetation, and waterbodies in the Terrestrial RSA.

- **Indigenous and Other Land Use Activities**

Highway 914 is presently gated at the Key Lake Operation (approximately 30 km south of the Terrestrial RSA), which restricts further access to the northeast. Increased access to the area was identified as a concern (20-LK-LEASESUR-267.67; ERFN and SVS 2022). While this highway is the main access into the Terrestrial RSA, trails and old exploration roads exist that connect to Highway 914 and are used to access areas within and beyond the Terrestrial RSA (Figure 9.3-15). Improved access to the Terrestrial RSA is expected to contribute to the cumulative effects on the Ungulates, Furbearers, and Woodland Caribou VCs through increased sensory disturbance (e.g., noise and dust deposition), potential wildlife-vehicle collisions, increased hunting and predation pressure, and increased risk of human-wildlife encounters in the Terrestrial RSA.

- **Lodges/Outfitters and Tourist/Recreational Activities**

Ongoing and potential future use of access roads and trails within the Terrestrial RSA may interact cumulatively with the residual effects of the Project through increased recreational activities and/or additional trail development (19-LK-ERFNTrap-134.133). Roads and trails may be used to support guided hunting and fishing tours, as well as canoe, hiking, and mountain biking tours. These activities have the potential to contribute to cumulative effects on Ungulates, Furbearers, and Woodland Caribou VCs through increased sensory disturbance (e.g., noise and dust deposition), potential wildlife-vehicle collisions, increased hunting and predation pressure, and increased risk of human-wildlife encounters in the Terrestrial RSA.

The above-described projects and activities were used in the CEA. In the absence of comprehensive activity details and spatial information, the assessment was primarily qualitative, based on available information and understanding of the scope of these projects and activities.

9.3.7.2.1 Additional Mitigation Measures

It is assumed that the projects and activities included in the CEA include regulatory approvals, mitigation measures, and BMPs set by the applicable jurisdictional and regulatory agencies and with appropriate consideration of IK. Additional mitigation (i.e., in addition to the mitigation considered in the assessment of Project-related effects [Section 9.3.5]) is not considered necessary to avoid or minimize the predicted cumulative effects on the Ungulates, Furbearers, and Woodland Caribou VCs.

9.3.7.3 Cumulative Effects Characterization and Determination of Significance

The interactions between the predicted Project residual effects and the residual effects of other projects and activities were reviewed to determine potential cumulative effects on the Ungulates, Furbearers, and Woodland Caribou VCs.

In the following, cumulative effects on the Ungulates, Furbearers, and Woodland Caribou VCs are assessed and characterized in terms of magnitude, geographical extent, duration, frequency, reversibility, context, likelihood, significance, and level of confidence of the assessment predictions. Characterization criteria and significance definitions for this CEA are consistent with those presented in Section 9.3.6.

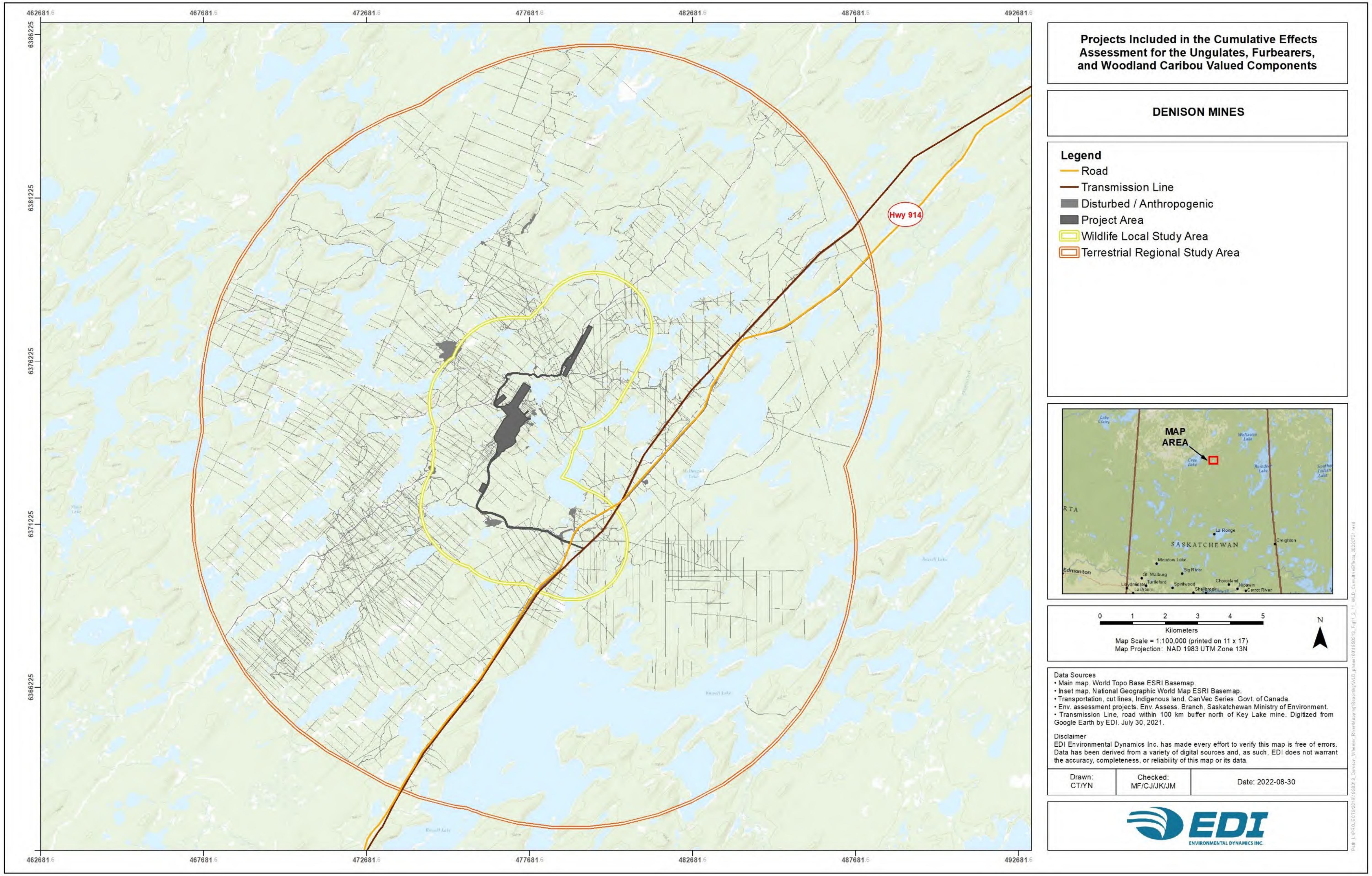

Figure 9.3-15: Projects Included in the Cumulative Effects Assessment for the Ungulates, Furbearers, and Woodland Caribou Valued Components

9.3.7.3.1 Ungulates

Residual effects on the Ungulates VC and associated KI (i.e., moose) resulting from the Project were identified and assessed as **not significant** in Section 9.3.6.2**.** Residual effects stemming from the Project in combination with those from ongoing and reasonably foreseeable projects and activities identified and described in Section 9.3.7.2 are expected to act cumulatively to potentially affect moose in the Terrestrial RSA through the alteration and/or loss of habitat and change in mortality.

Alteration and/or Loss of Habitat

The residual effect of alteration and/or loss of habitat on moose resulting from the Project was identified and assessed as **not significant** in Section 9.3.6.2.1. The assessment of the cumulative effects of alteration and/or loss of moose habitat considers the direct loss of habitat and the indirect alteration of habitat, which is caused by a change in the quality or availability of habitat in the area surrounding a project or activity stemming from associated activities. It determines if the Project-related residual effect interacts with the residual effects of other past, current, or reasonably foreseeable projects and activities in the Terrestrial RSA. As described in Section 9.3.4.2.1, existing habitat disturbances due to past and ongoing anthropogenic development have altered the Terrestrial RSA resulting currently in 1.5% of habitat loss in the Terrestrial RSA. The Terrestrial RSA currently provides 29,344.23 ha (73.0%) of available moose habitat (Section 9.3.6.2.1).

The cumulative effect characteristics for the alteration and/or loss of habitat for moose are summarized below and provided in Table 9.3-28.

Vegetation clearing is anticipated to be required for the Project and most of the ongoing and reasonably foreseeable projects and activities; however, the amount, location and timing are unknown. Mining exploration and development are expected to be responsible for most of the ongoing and future habitat loss and alteration within the Terrestrial RSA. The spatial and temporal extent of these activities is unknown, but it is anticipated that all future exploration and development will be conducted in accordance with all applicable provincial and federal approval processes and will follow BMPs and implement proven mitigation measures.

In addition, natural disturbances such as fires and forest pests have the potential to affect moose habitat within the Terrestrial RSA. The Terrestrial RSA is located within the Boreal Shield Ecozone, known to experience a largely natural fire regime that results in the most area burned per unit area and the highest proportion of very large fires (more than 50,000 ha) in the province (Parisien et al. 2004). As a result, much of the vegetation within the Terrestrial RSA (70.6%) is comprised of post-fire regeneration (Appendix 9-B), and additional forest fire disturbance within the Terrestrial RSA is likely to occur in the future. Moose habitat includes regenerating forest sites and, as such, future forest fires, are expected to affect available habitat only temporarily until vegetation regeneration begins. During engagement sessions for this Project, it was mentioned, that based on the Elders' experience, it could take 35 years after natural disasters for the habitat to grow back. "*This land that Denison is on is pretty burnt except for some patches …….*" (*21-EN-ERFN-473.24)*.

Despite the spatial and temporal uncertainty of ongoing and reasonably foreseeable future developments and activities and natural disturbances, it is expected that the amount of moose habitat lost or altered within the Terrestrial RSA is minimal and, therefore, the magnitude of the cumulative effect resulting from the Project's residual effect interacting with residual effects from other projects and activities is predicted to be low.

The residual effects of the Project are expected to interact with the residual effects of other projects and activities that are located in the Terrestrial RSA. Therefore, the cumulative effect of alteration and/or loss of habitat is predicted to be regional in geographic extent.

The residual effects of the Project are expected to end during Post-Decommissioning and will cease to interact with the residual effects of other past, current, and reasonably foreseeable future projects and activities. Therefore, the cumulative effect is expected to be medium-term in duration.

The Project and other ongoing and reasonably foreseeable future projects and activities that are anticipated to require vegetation clearing are anticipated to occur as one-time events at the project/activity location and habitat loss is, therefore, predicted to be infrequent. However, sensory disturbances (e.g., vehicle traffic) associated with ongoing and reasonably foreseeable future projects and activities may result in the ongoing alteration of habitat, and the cumulative effect is, therefore, predicted to be frequent.

The residual effects from past, current, and reasonably foreseeable future projects and activities that may result in the alteration and/or loss of habitat are expected to interact with the Project's residual effects; however, the Project residual effects are expected to end following Post-Decommissioning. The same is predicted for cumulative interactions with the residual effects of other projects and activities. Therefore, the reversibility of the cumulative effect is considered fully reversible.

Available moose habitat is considered to be reasonably resilient to stress and to regenerate within a few years of a disturbance (e.g., vegetation clearing, forest fire); however, the natural disturbances (i.e., forest fires) within the Boreal Shield Ecozone (including the Terrestrial RSA) are expected to increase with a changing climate (Wang et al. 2014). Therefore, a moderate rating is predicted for the context of the cumulative alteration and/or loss of habitat.

Vegetation clearing and sensory disturbances as the result of the Project and past, current, and reasonably foreseeable projects and activities are likely to result in the cumulative alteration and/or loss of habitat.

It is not expected that the cumulative effect of alteration and/or loss of habitat will alter the integrity of moose habitat within the Terrestrial RSA to the point where it is not sustainable or available to contribute to ecological functions. Therefore, the cumulative effect resulting from the

Project's residual effect interacting with residual effects from other projects and activities is predicted to be **not significant**.

The effects of habitat alteration and/or loss on moose are well known, and effective mitigation measures will be implemented. The spatial and temporal details of cumulative habitat loss, mostly due to ongoing and future mining exploration and development and potential natural disturbances are unknown, as is the amount of habitat alteration through sensory disturbances and habitat fragmentation. As a result, the level of confidence of the prediction for the cumulative effect is moderate.

Change in Mortality

The residual effect of change in mortality on moose resulting from the Project was identified and assessed as **not significant** in Section 9.3.6.2.2. The assessment of the cumulative effect of change in moose mortality considers potential direct and indirect sources of mortality. It determines if the Project-related residual effect interacts with the residual effects of other past, current, or reasonably foreseeable projects and activities in the Terrestrial RSA.

The cumulative effect characteristics for the change in moose mortality are summarized below and are provided in Table 9.3-28.

Approved projects and activities have the potential to result in a change in mortality through increased vehicle activity (i.e., through wildlife-vehicle collisions) and increased ease of access (e.g., for hunting). These projects and activities are expected to follow mitigation measures, BMPs, and applicable regulations and legislation that are effective at maintaining mortality within the range of natural variability and management guidelines. Therefore, it is anticipated that the magnitude of the cumulative effect resulting from the Project's residual effect interacting with residual effects from other projects and activities is expected to be low.

The Project's residual effects may interact with the residual effects of other projects and activities that are located throughout the Terrestrial RSA. Therefore, the cumulative effect of change in mortality is predicted to be regional in geographic extent.

It is expected that the interactions between the residual effects of the Project with the residual effects of other projects and activities will cease during Post-Decommissioning. Therefore, the cumulative effect resulting from the Project's residual effect interacting with residual effects from other projects and activities is expected to be medium-term in duration.

Collisions with vehicles are known to be a cause wildlife mortality in Saskatchewan; however, while geographic data are not available, it is assumed that most of the collisions occur in the southern part of the province where the road density is higher (L-P Tardif & Associates Inc. 2003, Transport Canada 2006). Moose are highly valued by subsistence and sport hunters, and they are an important cultural species for Indigenous people (SK MOE 2019a). Between 2014 and 2019 (the years for which data are available), no draw licences were sold for areas including the Terrestrial

RSA, and, therefore, no associated harvest was reported to have occurred in the Terrestrial RSA (SK MOE 2021). It is assumed that most of the annual harvest through resident regular licences occurred in the southern part of the province. The frequency of collision mortality and moose harvest are not anticipated to change over the timeframe of the assessment (i.e., the life of the Project), therefore, the cumulative effect of change in mortality is predicted to be infrequent.

The residual Project effect of change in mortality is anticipated to revert to baseline conditions upon Project completion; the same is predicted for cumulative interactions with the residual effects of other projects and activities. Therefore, the cumulative effect of change in mortality is considered to be fully reversible.

Estimates of the moose population in most regions of the province suggest generally low densities or declining populations (SK MOE 2019a, Neufeld et al. 2021, 19-LK-ERFNTrap-134.149; 19-LK-ERFNTrap-134.237). The presence of multiple stressors may affect the ability for moose populations to recover from any additional increases in mortality, particularly in small or decreasing populations (Gasaway et al. 1983, Solberg et al. 1999). Therefore, the cumulative effect resulting from the Project’s residual effect interacting with residual effects from other projects and activities is considered to be of moderate context.

The cumulative effect of change in moose mortality is likely to occur. Other projects and activities are likely to result in increased traffic on existing roads and may result in the development of additional linear infrastructure. Mitigation measures implemented by the Project and other projects and activities are expected to reduce, but not fully eliminate, the cumulative effect on moose.

It is not expected that the cumulative effect of a change in mortality will alter the integrity of the regional moose population to the point where it is not sustainable or available to contribute to ecological functions. Therefore, the cumulative effect is predicted to be **not significant**.

Moose mortality may be affected by the Project and ongoing and reasonably foreseeable projects and activities; however, moose populations can be resilient to additional mortality and BMPs and mitigation measures will be followed and implemented. The resulting moderate confidence rating of the residual effect considered the uncertainty related to moose population characteristics.

Table 9.3-28: Summary of Cumulative Effects on Ungulates (Moose)

Cumulative Effects	Project Phases	Cumulative Effects Characterisation[1]								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Alteration and/or Loss of Habitat	Construction Operation Decommissioning Post-Decommissioning	L	RSA	MT	FF	FR	M	L	NS	M
Change in Mortality	Construction Operation Decommissioning Post-Decommissioning	L	RSA	MT	IF	FR	M	L	NS	M

[1] Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility: Fully Reversible (FR), Partially Reversible (PR), Irreversible (IR)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (U), Likely (L)
Significance: Not Significant (NS), Significant (S)
Level of Confidence: High (H), Moderate (M), Low (L)

9.3.7.3.2 Furbearers

Residual effects on the Furbearers VC and associated KIs (i.e., wolverine, pine marten, mink, and muskrat) resulting from the Project were identified and assessed as **not significant** in Section 9.3.6.3. Residual effects stemming from the Project in combination with those from ongoing and reasonably foreseeable projects and activities identified and described in Section 9.3.7.2 are expected to act cumulatively to potentially affect Furbearers in the Terrestrial RSA through the alteration and/or loss of habitat and change in mortality.

Alteration and/or Loss of Habitat

The CEA of the alteration and/or loss of habitat residual effect on Furbearers considers the direct loss of habitat and the indirect alteration of habitat, which is caused by a change in the quality or availability of habitat in the area surrounding a project stemming from project activities. It determines if the Project-related residual effect interacts cumulatively with the residual effects of other past, current, or reasonably foreseeable projects and activities in the Terrestrial RSA. As described in Section 9.3.4.2.1, existing habitat disturbances due to past and ongoing anthropogenic development have altered the Terrestrial RSA resulting currently in 1.5% of habitat loss in the

Terrestrial RSA. The Terrestrial RSA currently provides furbearer habitat for the four KIs (Section 9.3.6.3.1), which includes:

- 1,192.2 ha (77.7%) of available wolverine habitat;
- 28,401.4 ha (70.8%) of available pine marten habitat;
- 2,213.6 ha (5.6%) of available mink habitat; and
- 9,664.1 ha (24.2%) of available muskrat habitat.

The cumulative effect characteristics for the alteration and/or loss of habitat for the Furbearers VC are summarized below and provided in Table 9.3-29.

Vegetation clearing is anticipated to be required for the Project and most of the ongoing and reasonably foreseeable projects and activities; however, the amount, location and timing for the ongoing and reasonably foreseeable projects and activities are unknown. Mining exploration and development are expected to be responsible for most of the ongoing and future habitat loss and alteration within the Terrestrial RSA. The spatial and temporal extent of these activities are unknown, but it is anticipated that all future exploration and development will be conducted in accordance with all applicable provincial and federal approval processes and will follow BMPs and implement effective mitigation measures.

In addition, natural disturbances such as fires and forest pests have the potential to affect furbearer habitat within the Terrestrial RSA. The Terrestrial RSA is located within the Boreal Shield Ecozone, known to experience a largely natural fire regime that results in the most area burned per unit area and the highest proportion of very large fires (more than 50,000 ha) in the province (Parisien et al. 2004). As a result, much of the vegetation within the Terrestrial RSA (70.6%) is comprised of post-fire regeneration (Appendix 9-B), and additional forest fire disturbance within the Terrestrial RSA is likely to occur in the future. During engagement sessions for this Project, it was mentioned, that based on the Elders' experience, it could take 35 years after natural disasters for the habitat to grow back. *"This land that Denison is on is pretty burnt except for some patches …."* (21-EN-ERFN-473.24).

Due to the spatial and temporal uncertainty of ongoing and reasonably foreseeable future developments and activities and natural disturbances, which may affect wolverine and pine marten, it is expected that furbearer habitat might be lost or altered and, therefore, the magnitude of the cumulative effect is predicted to be moderate.

The residual effects of the Project are expected to interact with the residual effects of other projects and activities located in the Terrestrial RSA. Therefore, the cumulative effect of alteration and/or loss of habitat on furbearers is predicted to be regional in geographic extent.

The residual effects of the Project are expected to end during Post-Decommissioning at which time they will cease to interact with the residual effects of other past, current, and reasonably foreseeable future projects and activities. Regenerating stands following vegetation clearing and/or reclaimed areas are anticipated to become suitable furbearer habitat. Wolverine and pine marten populations can maintain viable populations in revegetating forest stands likely to establish well after Post-Decommissioning is completed (Siemens Worsely 2011, Natural Resources Canada 2020). The cumulative effect is expected to be long-term in duration.

The Project and other past, current, and reasonably foreseeable future projects and activities that are anticipated to require vegetation clearing and soil disturbance are anticipated to occur as one-time events at a location and habitat loss is, therefore, predicted to be infrequent. However, sensory disturbances (e.g., vehicle traffic) associated with ongoing and reasonably foreseeable future projects and activities may result in the ongoing alteration of habitat, and the cumulative effect is, therefore, predicted to be frequent.

The residual effects from past, current, and reasonably foreseeable future projects and activities that may result in the alteration and/or loss of habitat are expected to interact with the Project's residual effects, which are expected to end after Post-Decommissioning. It is anticipated that most areas of cleared vegetation as the result of the Project and other past, current, or reasonably foreseeable project or activity will be reclaimed and/or vegetation will be allowed to regenerate upon Project completion. The Project Area is, therefore, expected to return to near-baseline conditions, similar to the future state of the areas of other projects and activities that operate within the Terrestrial RSA. As a result, the cumulative effect is considered fully reversible.

Available furbearer habitat can be reasonably resilient to stress and regenerate after a disturbance (e.g., vegetation clearing, forest fire); however, the variability in natural disturbances (i.e., forest fires) within the Boreal Shield Ecozone (including the Terrestrial RSA) is expected to increase, and natural disturbance events may increase in frequency (Wang et al 2014). While pine marten, mink, and muskrat populations in Saskatchewan are considered secure, wolverine are listed on Schedule 1 of the federal SARA and by COSEWIC as Special Concern (ECCC 2021) and in Saskatchewan they have been assigned the status of S2 (Imperiled/Very Rare: at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats, or other factors) (SK CDC 2021). Therefore, the context of the residual effect of alteration and/or loss of available furbearer habitat is predicted to be high.

Vegetation clearing and sensory disturbances as the result of the Project and past, current, and reasonably foreseeable projects and activities are likely to result in the cumulative alteration and/or loss of habitat.

It is not expected that the cumulative effect of alteration and/or loss of habitat will alter the integrity of furbearer habitat within the Terrestrial RSA to the point where it is not sustainable or available to contribute to ecological functions. Therefore, the cumulative effect is predicted to be **not significant**.

The effects of habitat alteration and/or loss on furbearers are well known, and effective mitigation measures will be implemented. The spatial and temporal extent of cumulative habitat loss, mostly due to ongoing and future mining exploration and development and natural disturbances is unknown, as is the amount of habitat alteration through sensory disturbances and habitat fragmentation. As a result, the level of confidence of the prediction for the cumulative effect of habitat alteration and/or loss on the Furbearer VC is moderate.

Change in Mortality

The residual effect of change in mortality on furbearers resulting from the Project was identified and assessed as **not significant** in Section 9.3.6.3.2. The assessment of the cumulative effect of change in furbearer mortality considers potential direct and indirect sources of mortality. It determines if the Project-related residual effect interacts with the residual effects of other past, current, or reasonably foreseeable projects and activities in the Terrestrial RSA.

The cumulative effect characteristics for the change in furbearer mortality are summarized below and are provided in Table 9.3-29.

Approved projects and activities have the potential to result in a change in mortality through increased vehicle activity (i.e., through wildlife-vehicle collisions), ease of access (i.e., for trapping), and human-wildlife interactions. These projects and activities are expected to implement mitigation measures and BMPs and follow applicable regulations and legislation that are effective at maintaining mortality within the range of natural variability and management guidelines. Therefore, it is anticipated that the magnitude of the cumulative effect is expected to be low.

The Project’s residual effects may interact with the residual effects of other projects and activities that are located throughout the Terrestrial RSA. Therefore, the cumulative effect of change in mortality is predicted to be regional in geographic extent.

It is expected that the interactions between the residual effects of the Project with the residual effects of other projects and activities will cease following the end of the Project. Therefore, the cumulative effect resulting from the Project’s residual effect interacting with residual effects from other projects and activities is expected to be medium-term in duration.

Potential sources of a change in direct mortality for furbearers include interactions with Project activities, most likely vehicle collisions. While wildlife-vehicle collisions frequently occur in Saskatchewan, no information is available for furbearer species (L-P Tardif & Associates Inc. 2003, Transport Canada 2006). Trapping is an important cultural and economic activity in the region and trappers are accessing the area through existing roads and trails; it is, however, not anticipated that additional access to the Project Area through ongoing and reasonably foreseeable future projects and activities will facilitate increased trapping pressure in the Terrestrial RSA due to the remoteness of the area. It is anticipated that the cumulative effect of change in mortality will be infrequent.

The residual Project effect of change in mortality is anticipated to revert to baseline conditions upon Project completion, and as a result, the same is predicted for cumulative interactions with the residual effects of other projects and activities. The same is predicted for cumulative interactions with the residual effects of other projects and activities. Therefore, the cumulative effect of change in mortality is fully reversible.

Most furbearer populations in Saskatchewan are considered healthy based on three decades of harvest return information (Appendix 9-B). Muskrats in the region may be declining, based on scientific and IK information (Ward and Gorelick 2018, 19-LK-ERFNTrap-134.64). While pine marten, mink, and muskrat populations in Saskatchewan are considered secure, wolverine are listed on Schedule 1 of the federal SARA and by COSEWIC as Special Concern (ECCC 2021) and in Saskatchewan they have been assigned the status of S2 (Imperiled/Very Rare: at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats, or other factors) (SK CDC 2021). Therefore, the cumulative effect is considered to be of high context.

The cumulative effect of change in furbearer mortality (i.e., through increased vehicle traffic, trapping, and human-wildlife interactions) is likely to occur. Other projects and activities are likely to result in increased traffic on existing roads and may develop additional linear infrastructure. Mitigation measures implemented by the Project and other projects and activities are expected to reduce, but not fully eliminate, the cumulative effect on furbearers.

It is not expected that the cumulative effect of a change in mortality will alter the integrity of the regional furbearer populations (i.e., wolverine, pine marten, mink, and muskrat populations) to the point where they are not sustainable or available to contribute to ecological functions. Therefore, the cumulative effect is predicted to be **not significant**.

Furbearer mortality may be affected by the Project and ongoing and reasonably foreseeable projects and activities; however, furbearer populations can be resilient to additional mortality and effective BMPs and mitigation measures will be implemented. The resulting moderate confidence rating of the residual effect considered the uncertainty related to furbearer population characteristics.

Table 9.3-29: Summary of Cumulative Effects on Furbearers (Wolverine, Pine Marten, Mink, and Muskrat)

Cumulative Effects	Project Phases	Cumulative Effects Characterisation[1]								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Alteration and/or Loss of Habitat	Construction Operation Decommissioning Post-Decommissioning	M	RSA	LT	FF	FR	H	L	NS	M
Change in Mortality	Construction Operation Decommissioning Post-Decommissioning	L	RSA	MT	IF	FR	H	L	NS	M

[1] Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility: Fully Reversible (FR), Partially Reversible (PR), Irreversible (IR)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (U), Likely (L)
Significance: Not Significant (NS), Significant (S)
Level of Confidence: High (H), Moderate (M), Low (L)

9.3.7.3.3 Woodland Caribou

Residual effects on the Woodland Caribou VC and associated KI (i.e., woodland caribou) resulting from the Project were identified and assessed as **not significant** in Section 9.3.6.4. Residual effects stemming from the Project in combination with those from ongoing and reasonably foreseeable projects and activities identified and described in Section 9.3.7.2 are expected to act cumulatively to potentially affect woodland caribou in the Terrestrial RSA through the alteration and/or loss of habitat and change in mortality.

Alteration and/or Loss of Habitat

The residual effect of alteration and/or loss of habitat on woodland caribou resulting from the Project was identified and assessed as **not significant** in Section 9.3.6.4.1. The assessment of the cumulative effects of alteration and/or loss of woodland caribou habitat considers the direct loss of habitat and the indirect alteration of habitat, which is caused by a change in the quality or availability of habitat in the area surrounding a project or activity stemming from associated activities. It determines if the Project-related residual effect interacts with the residual effects of other past, current, or reasonably foreseeable projects and activities in the Terrestrial RSA. As described in Section 9.3.4.2.1, existing habitat disturbances due to past and ongoing anthropogenic development have altered the Terrestrial RSA resulting currently in 1.5% of habitat loss in the Terrestrial RSA and the Project would add another 0.4% of anthropogenic disturbance (considering the Project Area of 169.6 ha) to the disturbance resulting in up to 1.9% of total anthropogenic disturbance in the Terrestrial RSA. While the Terrestrial RSA currently provides 30,541.63 ha (76.1%) of habitat available for woodland caribou (Section 9.3.6.4.1), the SK1 Boreal Shield Woodland Caribou Management Unit is the applicable management unit for the woodland caribou population that uses the Terrestrial RSA (Section 9.3.3.3.1). Environment and Climate Change Canada (2020) identified the caribou population in the SK1 range as being self-sustaining at a threshold of 40% undisturbed habitat and recommended that total anthropogenic disturbance in the SK1 Boreal Shield range should not exceed 5% with the remainder (i.e., 55%) being attributed to natural disturbance (while maintaining a minimum of 40% undisturbed habitat in the range). Environment and Climate Change Canada (2020) calculated that approximately 58% of the SK1 Boreal Shield range are currently affected by past forest fires and 3% of the range are affected by anthropogenic disturbances. The size of the SK1 Boreal Shield range is estimated at 18,034,870 ha (ECCC 2020), resulting in an estimated additional Project-related disturbance of 0.001% at the scale of the SK1 Boreal Shield Woodland Caribou Management Unit.

The cumulative effect characteristics for the alteration and/or loss of habitat for woodland caribou are summarized below and provided in Table 9.3-30.

Vegetation clearing is anticipated to be required for the Project and most of the ongoing and reasonably foreseeable projects and activities; however, the amount, location and timing are unknown. Mining exploration and development are expected to be responsible for most of the ongoing and future habitat loss and alteration within the Terrestrial RSA. The spatial and temporal extent of these activities are unknown, but it is anticipated that all future exploration and development will be conducted in accordance with applicable provincial and federal approval processes and will follow BMPs and implement effective mitigation measures.

In addition, natural disturbances such as fires and forest pests have the potential to affect woodland caribou habitat within the Terrestrial RSA. The Terrestrial RSA is located within the Boreal Shield Ecozone, known to experience a largely natural fire regime that results in the most area burned per unit area and the highest proportion of very large fires (more than 50,000 ha) in the province (Parisien et al. 2004). As a result, much of the vegetation within the Terrestrial RSA (70.6%) is comprised of post-fire regeneration (Appendix 9-B), and additional forest fire disturbance within the Terrestrial RSA is likely to occur in the future (Wang et al. 2014). During engagement sessions for this Project, it was mentioned, that based on the Elders' experience, it could take 35 years after natural disasters for the habitat to grow back. "*This land that Denison is on is pretty burnt except for some patches that are areas for caribou*" (*21-EN-ERFN-473.24)*.

Indigenous Knowledge, provided in a 2011 study, pointed out that low woodland caribou densities in the English River Traditional Territory were caused by forest fires (ERFN 2011). It was stated that most of the northern part of the English River Traditional Territory was burnt, and that caribou moved elsewhere to calve now (ERFN 2011). In the study, forest fires were considered the main threat to woodland caribou in the English River Traditional Territory.

Forest habitats experiencing disturbances may not provide suitable woodland caribou habitat until 20 years after the disturbance ceases (Norbert et al. 2020), at which time the Project will not be interacting any longer cumulatively with other projects and activities. Due to the spatial and temporal uncertainty of ongoing and reasonably foreseeable future developments and activities and the likely increase in natural disturbances (Wang et al. 2014) and the known effects of past forest fires, it is expected that woodland caribou habitat will be affected, and, therefore, the magnitude of the cumulative effect resulting from the Project's residual effect interacting with residual effects from other projects and activities is predicted to be moderate.

The residual effects of the Project are expected to interact with the residual effects of other projects and activities located in the Terrestrial RSA. Therefore, the cumulative effect of alteration and/or loss of habitat is predicted to be regional in geographic extent.

The residual effects of the Project are expected to end after Post-Decommissioning and will cease to interact with the residual effects of other past, current, and reasonably foreseeable future projects and activities. Norbert et al. (2020) found that lichen cover was lower in timber harvested and burned areas compared to intact undisturbed forests by 10 to 20 years post-disturbance, respectively. Forest habitats experiencing anthropogenic disturbances may not provide suitable woodland caribou habitat until 20 years after the disturbance ceases (i.e., 20 years after Post-Decommissioning is completed). Progressive reclamation is anticipated to begin in some parts of the Project Area following Construction; however, the revegetation within most of the Project Area will occur as part of reclamation activities during the Decommissioning and Post-Decommissioning phases. Therefore, the cumulative effect is expected to be long-term in duration.

The Project and other past, current, and reasonably foreseeable future projects and activities that are anticipated to require vegetation clearing are anticipated to occur as one-time events at a location and habitat loss is therefore predicted to be Infrequent. However, sensory disturbances (e.g., vehicle traffic) associated with reasonably foreseeable future projects and activities may result in the ongoing alteration of habitat, and the cumulative effect is therefore predicted to be frequent.

The residual effects from past, current, and reasonably foreseeable future projects and activities that may result in the alteration and/or loss of habitat are expected to interact with the Project's residual effects; however, the Project residual effects are expected to end after Post-Decommissioning. The same is predicted for cumulative interactions with the residual effects of other projects and activities. Therefore, the reversibility of the cumulative effect is considered fully reversible.

The context of the cumulative effect of alteration and/or loss of available woodland caribou habitat is predicted to be high. Available caribou habitat that is altered or cleared will remain so until well after Post-Decommissioning during which final reclamation and revegetation will occur and until which time the residual effects will likely interact cumulatively with residual effects from other projects and activities. It is expected that revegetated areas will not become available woodland caribou habitat until terrestrial and arboreal lichen have re-established in the regenerated vegetation communities, up to 20 years post-disturbance (Norbert et al. 2020). The woodland caribou population in the region is reported to be stable and their anthropogenic habitat disturbance is currently estimated at 1.5% in the Terrestrial RSA, which is below the 5% threshold of anthropogenic disturbance recommended as a requirement to sustain viable populations (ECCC 2020). The Project will add another 0.4% of anthropogenic disturbance (considering the Project Area of 169.6 ha) adding up to 1.9% of anthropogenic disturbance in the Terrestrial RSA. However, the high context rating considers that woodland caribou are listed federally as Threatened (ECCC 2021) and the SK CDC assigned the species a status of S3 (Vulnerable/Rare to Uncommon; at moderate risk of extinction or extirpation due to a restricted range, relatively few populations, recent and widespread declines, threats, or other factors) (SK CDC 2020).

Vegetation clearing and sensory disturbances as the result of the Project and past, current, and reasonably foreseeable projects and activities are likely to result in the cumulative alteration and/or loss of habitat.

It is not expected that the cumulative effect of alteration and/or loss of habitat will alter the integrity of woodland caribou habitat within the Terrestrial RSA to the point where it is not sustainable or available to contribute to ecological functions. Therefore, the cumulative effect resulting from the Project's residual effect interacting with residual effects from other projects and activities is predicted to be **not significant**.

The effects of habitat alteration and/or loss on woodland caribou are well known, and effective mitigation measures will be implemented (including development of a Draft Caribou Mitigation Plan; see Appendix 9-E). The spatial and temporal extent of cumulative habitat loss, mostly due to ongoing and future mining exploration and development and potential natural disturbances are unknown, as is the amount of habitat alteration through sensory disturbances and habitat fragmentation. As a result, the level of confidence of the prediction for the cumulative effect of the alteration and/or loss of woodland caribou habitat is moderate.

Change in Mortality

The residual effect of change in mortality on woodland caribou resulting from the Project was identified and assessed as **not significant** in Section 9.3.6.4.2. The assessment of the cumulative effect of change in woodland caribou mortality considers potential direct and indirect sources of mortality. It determines if the Project-related residual effect interacts with the residual effects of other past, current, or reasonably foreseeable projects and activities in the Terrestrial RSA.

The cumulative effect characteristics for the change in woodland caribou mortality are summarized below and are provided in Table 9.3-30.

Approved projects and activities have the potential to result in a change in mortality through increased vehicle activity (i.e., through wildlife-vehicle collisions), and increased predation (i.e., through apparent competition with more productive alternative prey species and facilitated predation by wolves). These projects and activities are expected to implement mitigation measures and BMPs and follow applicable regulations and legislation that are effective at maintaining mortality within the range of natural variability and management guidelines. Therefore, it is anticipated that the magnitude of the cumulative effect is low.

The Project's residual effects may interact with the residual effects of other projects and activities that are located throughout the Terrestrial RSA. Therefore, the cumulative effect of change in mortality is predicted to be regional in geographic extent.

It is expected that the interactions between the residual effects of the Project with the residual effects of other projects and activities will cease following the end of the Project when all Project and commissioning activities have stopped. At that time the Project residual effects will not interact any longer cumulatively with the residual effects from other projects and activities. Therefore, the cumulative effect is expected to be medium-term in duration.

Vehicle collisions with caribou are a documented source of caribou mortality in areas where caribou ranges overlap with transportation infrastructure (ECCC 2020). Wildlife-vehicle collision data for the entire province are available for select years, and the available information showed that more than 80% of the accidents were collisions with deer; no caribou-vehicle collisions were reported (L-P Tardif & Associates Inc. 2003, Transport Canada 2006). Landscape changes due to the Project and other ongoing and reasonably foreseeable future projects and activities may provide habitat for moose (and potentially deer), which may increase the abundance of wolves, which then will also prey on caribou (apparent competition; Bergerud and Elliot 1986). Woodland caribou prefer mature forests with abundant terrestrial and arboreal lichen (Norbert et al. 2020). In addition, mature forests with sparse understory vegetation do not support high densities of other ungulates and consequently, predators in these contiguous mature forest stands occur at low densities. Wolves may use newly established linear features as accessible travel corridors and, consequently, hunt more efficiently within their range (facilitated predation; Dickie et al. 2017). However, the frequency of collision mortality and caribou predation is not anticipated to change over the life of the Project; therefore, the cumulative effect of change in mortality is predicted to be Infrequent.

The residual Project effect of change in mortality is anticipated to revert to baseline conditions upon Project completion, and as a result, the same is predicted for cumulative interactions with the residual effects of other projects and activities. Therefore, the cumulative effect of change in mortality is considered to be fully reversible.

The context for the residual effect of change in mortality is expected to be high. While the woodland caribou population in the region is reported to be stable and their habitat disturbance is below the threshold of anthropogenic disturbance recommended as a requirement to sustain viable populations (ECCC 2020), woodland caribou are listed federally as Threatened (ECCC 2021) and the provincial SK CDC assigned the species a status of S3 (Vulnerable/Rare to uncommon; at moderate risk of extinction or extirpation due to a restricted range, relatively few populations, recent and widespread declines, threats, or other factors) (SK CDC 2020).

The cumulative effect of change in woodland caribou mortality is likely to occur. In addition to Project-related residual effects, other projects and activities are likely to result in increased traffic on existing roads and may develop additional linear infrastructure resulting in a change in mortality. Mitigation measures implemented by the Project and other projects and activities are expected to reduce, but not eliminate, the cumulative effect on woodland caribou.

It is not expected that the cumulative effect of a change in mortality will alter the integrity of the woodland caribou population to the point where it is not sustainable or available to contribute to ecological functions. Therefore, the cumulative effect is predicted to be **not significant**.

Woodland caribou mortality (most likely through predation) may be affected by the Project and ongoing and reasonably foreseeable projects and activities; however, woodland caribou populations can be resilient to additional mortality and effective BMPs and mitigation measures will be implemented. However, some level of uncertainty exists about the status of the regional predator populations and their potentially Project-related increased ability to successfully prey on woodland caribou in the Terrestrial RSA.

Table 9.3-30: Summary of Cumulative Effects on Woodland Caribou

Cumulative Effects	Project Phases	Cumulative Effects Characterisation[1]								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Alteration and/or Loss of Habitat	Construction Operation Decommissioning Post-Decommissioning	M	RSA	LT	FF	FR	H	L	NS	M
Change in Mortality	Construction Operation Decommissioning Post-Decommissioning	L	RSA	MT	IF	FR	H	L	NS	M

[1] Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility: Fully Reversible (FR), Partially Reversible (PR), Irreversible (IR)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (U), Likely (L)
Significance: Not Significant (NS), Significant (S)
Level of Confidence: High (H), Moderate (M), Low (L)

9.3.7.4 Climate Change Considerations

Section 15.5 in Section 15 summarizes the projections for future climate conditions over the life of the Project in the area (including the Terrestrial RSA). The winters will likely be warmer and snowier, and the summers longer and hotter. There is some uncertainty around projected trends in total and extreme precipitation events which may not affect the Project (Section 15.5 in Section 15). As further described in Section 15.5 in Section 15, forest fire frequency, severity, and extent are expected to increase in all areas of the Canadian boreal forest (including the Terrestrial RSA) over the next decades (Wotton et al. 2017). Future climate change models predict that in the area around and including the Terrestrial RSA more frequent fires will occur. This prediction considers the influence of factors affecting fire occurrence, such as lightning, fuel moisture, temperature, precipitation, and vegetation (Government of Canada 2020). Rising temperatures could add damaged or dead wood to the forest fuel load (e.g., from insect outbreaks, ice storms, or high winds) and may increase the risk of fire activity. Forest fires are considered the most likely factor, under a predicted future climate change scenario, affecting terrestrial wildlife species (assessed in this EIS) through habitat effects.

While moose habitat is reasonably resilient to stress and is expected to regenerate within a few years of a forest fire (SK MOE 2019a), increased frequency and severity of fires in the boreal forest (Wang et al. 2014), may adversely affect moose habitat in the Terrestrial RSA.

While the four Furbearer KIs assessed in this EIS (i.e., wolverine, pine marten, mink, and muskrat) have evolved in the region under the current wildfire regime, predicted future increases in frequency and severity of forest fires (Wang et al. 2014) are expected to affect their habitat. Pine marten populations require mature forests (Natural Resources Canada 2020) and wolverine need vast tracts of undisturbed land to maintain viable populations (Siemens Worsely 2011). As such, these to species may be adversely affected by predicted future climate change conditions.

The past and current wildfire regime resulted in 70.6% of the vegetation within the Terrestrial RSA being comprised of post-fire regeneration (Appendix 9-B). Forest habitats experiencing such disturbances may not provide suitable woodland caribou habitat until 20 years after the disturbance ceases (Norbert et al. 2020). During engagement sessions for this Project, it was mentioned that, based on the Elders' experience, it could take up to 35 years after natural disasters for woodland caribou habitat to grow back (21-EN-ERFN-473.24). Indigenous Knowledge, provided in a 2011 study, pointed out that low woodland caribou densities in the English River Traditional Territory were caused by past forest fires which were considered the main threat to woodland caribou in the English River Traditional Territory (ERFN 2011). Most of the northern part of the English River Traditional Territory has been burned, and it was stated that caribou moved elsewhere to calve now (ERFN 2011). With increased forest fire disturbances within the Terrestrial RSA likely to occur in the future (Wang et al. 2014), it is expected that caribou habitat will be adversely affected and may limit available habitat for viable woodland caribou populations in the region.

9.3.8 Monitoring and Follow-up

As outlined in Section 5.10 in Section 5, monitoring and follow-up for this EIS are defined as follows:

- Monitoring programs are designed to meet regulatory requirements (e.g., permit or license conditions), and/or to demonstrate compliance with environmental commitments made in the EIS.
- Follow-up programs are those that are proposed to address any uncertainties identified during the EA process (e.g., to verify predictions made during the EA and to determine the effectiveness of implemented mitigation measures) and to determine if and when to implement adaptive management measures.

Monitoring Programs

Monitoring requirements will be directed by the provincial or federal regulators and as requested by Indigenous groups during the Project licensing process and are expected to include requirements related to scheduling, sampling design, frequency, and reporting. The monitoring programs may follow the same processes as described for follow-up programs (see below).

Targeted monitoring programs (described below) will be completed during the Construction, Operation, and Decommissioning phases to verify that Project design and mitigation measures (Section 9.3.5) have been appropriately applied and maintained. Following verification, the success of Project design and mitigation measures will be evaluated to assist in the determination of additional mitigation measure requirements.

An adaptive management process will be employed, after applicable consultations and approvals, where implemented mitigation measures are found to be unsuccessful. Management plans will be considered living documents, and updated when warranted to include input from consultations, monitoring results, regulatory or legislative changes, and any updated, improved, or revised BMPs and scientific methods. Project monitoring programs specific to Ungulates, Furbearers, and Woodland Caribou VCs are expected to include:

- wildlife species routinely monitored (e.g., through the Project-wide implementation of the current wildlife card system) throughout the life of the Project in accordance with the management and monitoring plans within the EMS (including implemented setback distances during sensitive time periods, if applicable); and
- progressive reclamation and revegetation of disturbed areas (i.e., transitioning into wildlife habitat) monitored in accordance with the Reclamation and Closure Plan.

Wildlife movements across the Project study areas may bring species or individuals into contact with Project components (e.g., waste ponds and pads) and activities (i.e., vehicle traffic), which can result in mortalities, wildlife-human interactions, and changes to habitat use. Project design and mitigation measures (Section 9.3.5) have been identified that are expected to minimize the likelihood of adverse Project effects. However, changes in wildlife habitat and habitat use over the life of the Project require an adaptive management process to update Project design and additional mitigation measures, if required. The potential for these changes will require appropriate monitoring for changes in wildlife mortality or encounters to determine, in a timely manner, whether changes are warranted through the adaptive management process to minimize any adverse effects on the Ungulates, Furbearers, and Woodland Caribou VCs.

Follow-up Programs

Follow-up programs are typically used to address uncertainties with the current assessment and will work towards following goals:

- quantify and qualify Project-related and cumulative effects against predictions;
- assess the effectiveness of implemented mitigation measures;
- identify unexpected environmental constraints or problems (if they should arise);

- modify existing mitigation measures or implement additional mitigation measures / adaptations in accordance with the adaptive management process to maintain valid effect predictions; and
- implement additional mitigation measures (if required) including triggers and corrective actions, in accordance with the adaptive management process.

Considering the Project planning, baseline survey results, and proposed mitigation measures, no follow-up programs are considered to be warranted at this time. The monitoring programs and environmental protection measures are expected to determine any issues that need to be addressed. If an issue is identified, then Denison's adaptive management process would be initiated and the issue, the design of the appropriate response, and the schedule to address would be completed in a timely manner.

If unforeseen adverse effects are identified during follow-up programs, Denison will, as per its ongoing adaptive management process, adjust the existing mitigation measures or, if necessary, develop new mitigation measures to address those effects. This could result in Denison refining or modifying the design and implementation of management plans (see Section 16 Assessment Summary and Conclusions), mitigation measures, and Project operations, with the final approach selected depending on the issue identified. Interested Parties, Indigenous Groups, and government agencies will be involved in developing mitigation and adaptive management measures where applicable.

9.3.9 Ungulates, Furbearer, and Woodland Caribou Summary

The terrestrial wildlife VC's (and KI's) considered in this EIS are Ungulates (moose), Furbearers (wolverine, pine marten, mink, and muskrat) and Woodland Caribou (woodland caribou). The main activities considered in the effects assessment include site preparation (i.e., clearing, grading and construction of roads, airstrip, and surface infrastructure), operation (i.e., vehicle movement, material handling), water management (i.e., withdrawal/use of surface and/or groundwater and release of effluent), waste management (i.e., temporary storage, handling, and off-site transportation), and reclamation (i.e., progressive and final reclamation of disturbed areas).

Based on the timing and nature of the interactions between the Project activities and the KI's, the following adverse effects on the Ungulates, Furbearers, and Woodland Caribou VCs have the potential to occur during the lifetime of the Project: alteration and/or loss of habitat (direct loss of wildlife habitat due to vegetation clearing and indirect alteration of wildlife habitat due to sensory disturbances); change in mortality (direct mortality due to collisions with equipment and vehicles and indirect mortality due to increased harvest and/or predation).

Mitigation measures were designed to avoid or minimize potential effects, including the following:

- The Project footprint has been reduced and is primarily within previously disturbed areas, thereby minimizing direct and indirect habitat loss and/or alteration.

- Site timing of clearing and other works that involve disturbance of vegetation and/or soil will be determined to avoid disturbance of wildlife during sensitive time periods.
- Pre-clearing wildlife surveys will be conducted to identify sensitive wildlife habitat features (i.e., dens, burrows, or lodges) or presence of species at risk (e.g., woodland caribou); further action will be determined in accordance with the EMS and federal and provincial regulations (e.g., no-disturbance setback buffers implemented).
- A Draft Caribou Mitigation Plan will be developed and will include a detailed assessment of the need for habitat offsets (see Appendix 9-E).
- Denison staff would facilitate access to undertake Aboriginal and / or Treaty Rights, provided it was safe to do so given activities in the area.
- Policies will be implemented prohibiting employees and contractors from feeding, approaching, or harassing wildlife species within the Project Are
- Appropriate road signage will be installed (e.g., speed limits, wildlife crossings) along Project roads to minimize the risk of wildlife-vehicle collisions.
- A "no littering policy" will be implemented within the Project Area.

Waste will be collected and temporarily stored in wildlife-proof containers to avoid attracting scavengers and with that increase the risk for human-wildlife interactions. The plan will also regulate the handling of hazardous materials to reduce to risk of wildlife exposure to spills of fuels and other hazardous materials. With the implementation of the above (and additional) mitigation measures, the residual effects on the Ungulates, Furbearer, and Woodland Caribou VCs were assessed as follows:

- Effects on Ungulates, related to habitat and mortality, are anticipated to be:
  - Low magnitude: up to 4.4% of available habitat within the Terrestrial RSA is predicted to be affected; the risk of mortality is expected to be within the range of natural variability.
  - Local extent of habitat effects: the direct loss of available habitat is expected to be limited to the Project Area; however, indirect alteration of habitat may extend into the Wildlife LSA.
  - Regional extent of mortality effect: the change in direct mortality is expected to occur mainly within the Project Area; however, indirect mortality may extend into the Terrestrial RSA.
  - Medium-term duration: the loss of available habitat will mainly occur during Construction; however, the alteration of habitat is expected to continue through all phases; mortality may occur during all phases of the Project, but the potential direct mortality is expected to be highest during the Construction and Operation phases.
  - Fully reversible: all habitat and mortality effects are anticipated to be fully reversible, i.e., upon completion of the Project, changes are expected to diminish to baseline conditions.

- Not significant: the residual effects of alteration and/or loss of available habitat and of change in mortality are not expected to result in a change that will alter habitat integrity to the point where it would not be able to sustain the regional ungulate populations or the integrity of the regional moose population to the point where it could not be sustained.

- Effects on Furbearers, related to habitat and mortality, are anticipated to be:
  - Low to moderate magnitude: between 1.0% to 8.2% of available habitat for wolverine, pine martin, mink, and muskrat within the Terrestrial RSA may be altered or lost; the risk of mortality is expected to be within the range of natural variability.
  - Local extent of habitat effects: the direct loss of available furbearer habitat is expected to be limited to the Project Area, and indirect effects resulting in habitat alteration are expected to be restricted to the Wildlife LSA.
  - Regional extent of mortality effects: the change in direct mortality is expected to occur within the Project Area; however, indirect furbearer mortality may extend into the Terrestrial RSA, particularly for wolverine).
  - Medium to long-term duration: the loss of available habitat for furbearers will mainly occur during Construction; however, the alteration of habitat will continue through all phases; furbearer mortality may occur during all phases of the Project, although the potential for direct mortality is expected to be highest during Construction and Operation.
  - Fully reversible: all habitat and mortality effects are anticipated to be fully reversible, i.e., upon completion of the Project, changes are expected to diminish to baseline conditions.
  - Not significant: the residual effects of alteration and/or loss of available habitat and of change in mortality are not expected to result in a change that will alter habitat integrity to the point where it would not be able to sustain the regional furbearer populations or the integrity of the regional furbearer populations to the point where they could not be sustained.
- Effects on Woodland Caribou, related to habitat and mortality, are anticipated to be:
  - Low magnitude: up to 4.3% of available woodland caribou habitat within the Terrestrial RSA are predicted to be affected by the Project; the risk of mortality is expected to be within the range of natural variability.
  - Local extent of habitat effects: the direct loss of available woodland caribou habitat is expected to be limited to the Project Area, and indirect effects resulting in habitat alteration are expected to be restricted to the Wildlife LSA.
  - Regional extent of mortality effects: the change in direct mortality is expected to occur within the Project Area; however, indirect mortality may extend into the Terrestrial RSA.
  - Medium to long-term duration: the loss of available habitat for woodland caribou is expected to mainly occur during Construction; however, the alteration of habitat may

continue through all phases and beyond project completion. It may take up to 20 years for lichen to recolonize the reclaimed forest habitats and provide woodland caribou habitat. Woodland caribou mortality may occur during all phases of the Project. The potential for direct mortality is expected to be highest during the Construction and Operation phases and the potential for indirect mortality is expected to be highest during Operation.

- Fully reversible: all habitat and mortality effects are anticipated to be fully reversible, i.e., upon completion of the Project (and after lichen recolonized the reclaimed area), changes are expected to diminish to baseline conditions.
- Not significant: the residual effects of alteration and/or loss of available habitat and of change in mortality are not expected to result in a change that will alter habitat integrity to the point where it would not be able to sustain the regional woodland caribou population or the integrity of the regional woodland caribou population to the point where they could not be sustained.

9.3.10 References

16-EN-ERFN-100.15, Community Meeting, 2016-07-27. Available from: Engagement Database.

18-EN-ERFN-5.76, Workshop, 2018-05-03. Available from: Engagement Database.

19-LK-ERFNTrap-134.24, Site Visit, 2019-10-29. Available from: Engagement Database.

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9.4 Raptors, Migratory Breeding Birds, and Bird Species at Risk

This subsection addresses potential Project-related effects on the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs and their associated KIs. In support of the assessment, this section covers the following aspects:

- scope of the assessment;
- influence of IK, LK, and engagement on the assessment;
- description of the existing environment for the VCs and associated KIs;
- identification of potential interactions between the Project and the VCs and associated KIs;
- identification and description of potential Project-related effects on the VCs and associated KIs;
- identification and description of mitigation measures to avoid or minimize the potential adverse Project-related effects on VCs;
- description and characterization of potential Project residual effects on VCs and associated KIs, including determination of significance and level of confidence in the predictions;
- identification and characterization of cumulative effects; and
- identification and description of monitoring and follow-up programs and activities.

Figure 9.4-1 is a graphic representation of the assessment process used in this EIS.

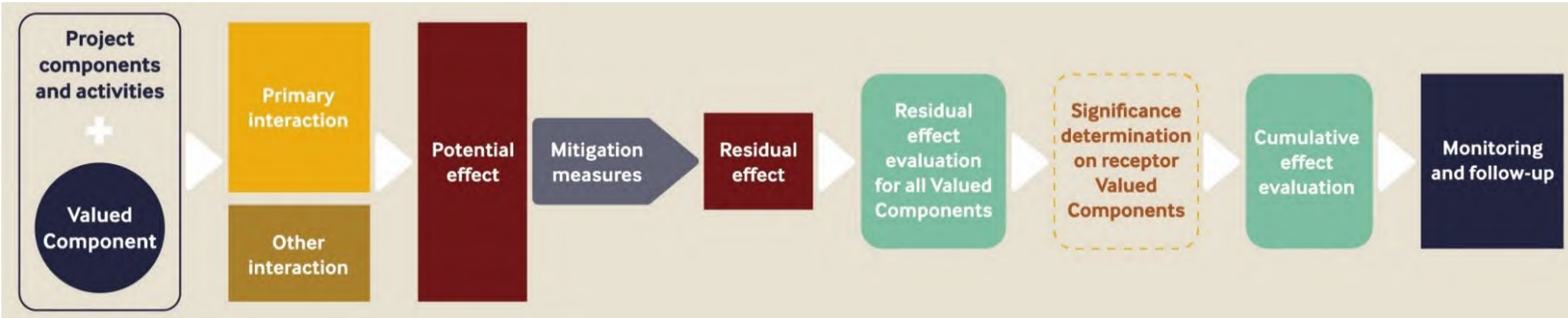

Figure 9.4-1: Environmental Assessment Process for the Wheeler River Project

9.4.1 Scope of the Assessment

9.4.1.1 Valued Component Selection

The process and rationale for selection of VCs and establishment of KIs and associated MPs is described in Section 5.3 in Section 5. Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs were selected based on their likelihood of interaction with the Project, as well as their contributing roles to biodiversity and ecosystem function. These VCs also contribute to environmental, socio-economic, and cultural values of Indigenous groups, regulators, and the public. The Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs are interrelated, to varying extents, and are linked to other VCs, including:

Atmospheric and Acoustic

- Air Quality – dust deposition and air emissions have the potential to disperse trace metals and radionuclides into the ambient air, which can subsequently be deposited into surface water and onto vegetation and affect Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs. This will be captured through the ERA (Appendix 10-A in Section 10).
- Noise – increased noise levels above ambient conditions may cause temporary disturbance to avian species, which could result in temporary avoidance of the area and other behavioural responses.

Geology and Groundwater

- Geology – alteration of geological material through terrain destabilization and accelerated erosion may affect avian species and their habitat in proximity to the Project.
- Groundwater Quality – changes in groundwater quality may affect the availability and quality of habitat for avian species.
- Groundwater Quantity – changes in groundwater quantity may affect the availability and quality of habitat for avian species.

Aquatic Environment

- Surface Water Quality – changes in surface water quality may affect the availability and quality of avian habitat and the health of avian species.
- Surface Water Quantity – changes in surface water quantity may affect the availability and quality of habitat for avian species.
- Aquatic Habitat – changes in aquatic habitats associated with the Wheeler River watershed and its sub-basins may affect avian species and their habitat.
- Sediment Quality – changes in sediment quality may affect biological functions in proximity to aquatic habitats and affect avian habitat (e.g., waterbirds and waterfowl).
- Fish Habitat – waterbirds and waterfowl may compete with fish for resources in fish habitat and changes in fish habitat may affect habitat selection by birds.

- Fish Health – changes to fish health (through chemical/radiological exposure) and increase in fish mortality may affect avian species (e.g., the Raptors and Migratory Breeding Bird VCs); avian species may prey on fish (e.g., the Raptors and Migratory Breeding Bird VCs).

Terrestrial Environment

- Terrain – changes to terrain, which interacts with vegetation communities, may affect avian species and their habitat.
- Organic Matter/Peat – changes to organic matter/peat may affect avian species and their habitat.
- Soil Quality – changes to soil quality may affect the habitat and health of avian species.
- Vegetation and Ecosystems – changes to vegetation and ecosystems may affect avian species and their habitat.
- Listed Plant Species – changes to listed plant species may affect avian species and their habitat.
- Wetlands – changes to wetlands may affect avian species and their habitat.
- Furbearers – raptors may prey on furbearer species and changes in furbearer populations may affect raptor species.

Human Health

- Human Health and Safety – some species of the Migratory Breeding Bird VC are important food sources for local land users, and, as such, are part of the exposure pathway for humans.

Land and Resource Use

- Indigenous Land and Resource Use – Raptors and Migratory Breeding Bird VCs contribute to Indigenous land and resource use, including harvest for food (birds and eggs) and collection of eagle feathers. Changes in their populations may affect Indigenous land and resource uses.
- Other Land and Resource Use – Migratory Breeding Bird VC KIs (e.g., waterbirds and waterfowl, and upland game birds) provide resource values such as resident and non-resident hunting, and tourism. Changes in their populations may affect other land and resource uses.

Economics

- Economy – the harvest of Migratory Breeding Bird VC KIs (e.g., waterfowl and upland game birds) contributes to the regional economy through supplying meat and supporting tourism. Changes in their populations may affect the local economy.

Figure 9.4-2 to Figure 9.4-4 are graphic representations of the main linkages among the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs and other VCs, illustrating the flow of assessment information into and from the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs.

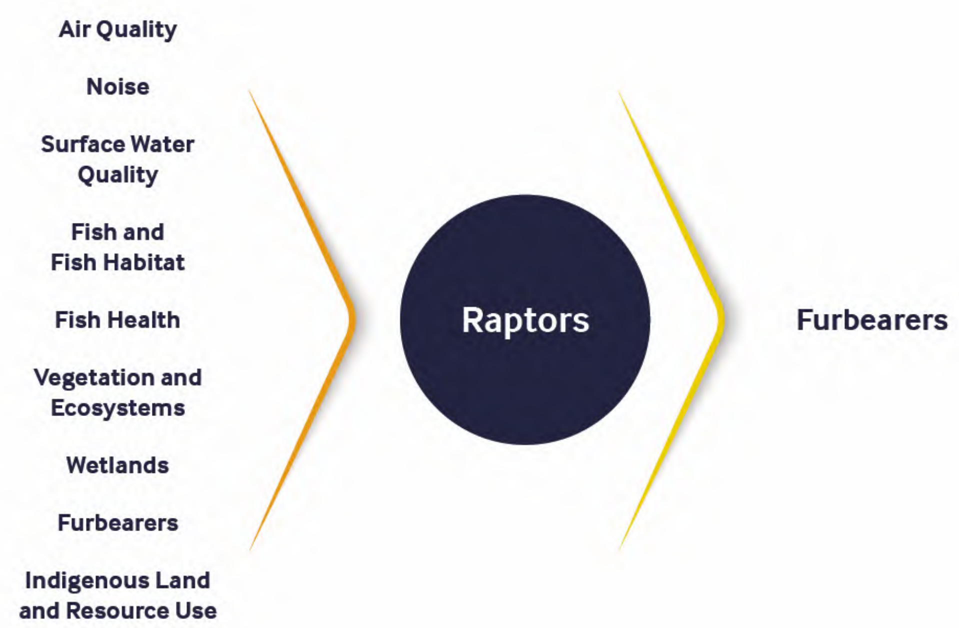

Figure 9.4-2: Integrated Assessment Approach - Key Connections between Raptors and Other Valued Components

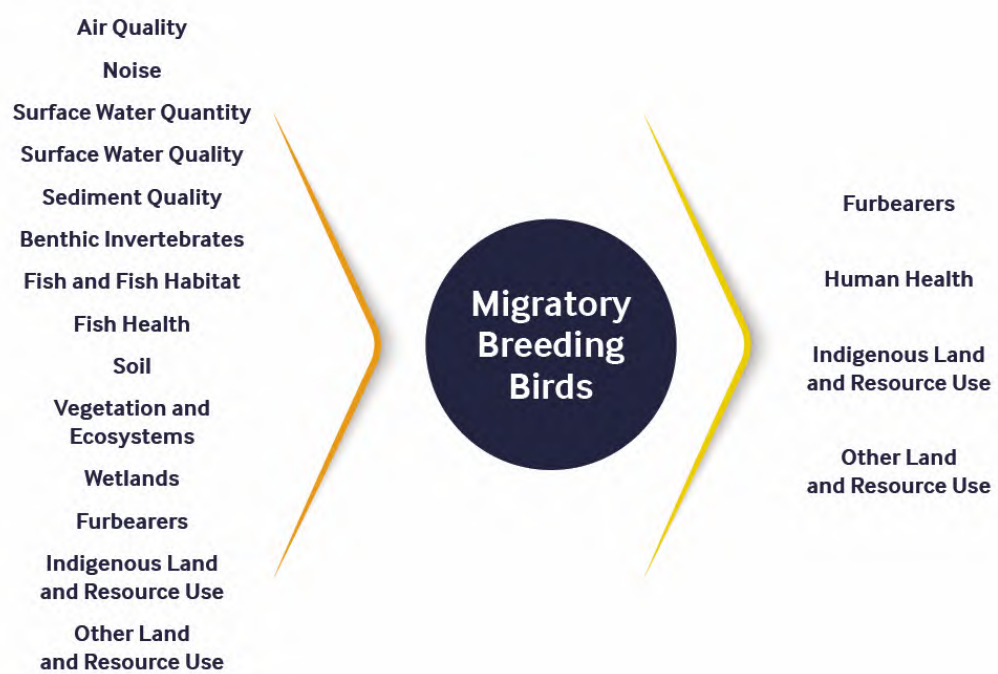

Figure 9.4-3: Integrated Assessment Approach - Key Connections between Migratory Breeding Birds and Other Valued Components

Figure 9.4-4: Integrated Assessment Approach - Key Connections between Bird Species at Risk and Other Valued Components

9.4.1.2 Key Indicators and Measurable Parameters

The KIs and associated MPs for the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs are summarized in Table 9.4-1.

Table 9.4-1: Key Indicators and Measurable Parameters for the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Raptors		
Bald Eagle (*Haliaeetus leucocephalus*)	Project activities and infrastructure may affect Bald Eagle populations (e.g., disturbance and/or destruction of eggs, young, and adults) resulting in non-compliance with regulatory requirements (e.g., Saskatchewan Activity Restriction Guidelines, *Wildlife Act* [Saskatchewan]). Eagles are sacred to Indigenous peoples and some people may carry their feathers. Bald Eagle are sensitive to noise disturbance and human activity during nesting.	Amount of habitat that may be altered or lost relative to its availability in the Terrestrial RSA. Bald Eagle mortalities directly or indirectly attributable to the Project.
Osprey (*Pandion haliaetus*)	Project activities and infrastructure may affect Osprey populations (e.g., disturbance and/or destruction of eggs, young, and adults) resulting in non-compliance with regulatory requirements (e.g., Saskatchewan Activity Restriction Guidelines, *Wildlife Act* [Saskatchewan]). Osprey are sensitive to noise disturbance and human activity during nesting. They are considered imperiled/very rare in Saskatchewan.	Amount of habitat that may be altered or lost relative to its availability in the Terrestrial RSA. Osprey mortalities directly or indirectly attributable to the Project.

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Migratory Breeding Birds		
Waterbirds and waterfowl	Project activities and infrastructure may affect waterbirds and waterfowl populations (e.g., disturbance and/or destruction of eggs, young, and adults) resulting in non-compliance with regulatory requirements (e.g., *Migratory Birds Convention Act*, Saskatchewan Activity Restriction Guidelines, *Wildlife Act* [Saskatchewan]). Some waterbird and waterfowl species are important for subsistence. Shoreline breeding habitat and important staging habitat may be affected by the Project.	Amount of habitat that may be altered or lost relative to its availability in the Terrestrial RSA. Waterbird and waterfowl mortalities directly or indirectly attributable to the Project.
Upland game birds	Project activities and infrastructure may affect upland game bird populations (e.g., disturbance and/or destruction of eggs, young, and adults) resulting in non-compliance with regulatory requirements (e.g., Saskatchewan Activity Restriction Guidelines, *Wildlife Act* [Saskatchewan]). Some upland game bird species are important for subsistence. Their breeding habitat may be affected by the Project.	Amount of habitat that may be altered or lost relative to its availability in the Terrestrial RSA. Upland game bird mortalities directly or indirectly attributable to the Project.
Migratory songbirds	Project activities and infrastructure may affect migratory songbird populations (specifically disturbance and/or destruction of eggs, young, and adults) resulting in non-compliance with regulatory requirements (e.g., *Migratory Birds Convention Act*, Saskatchewan Activity Restriction Guidelines, *Wildlife Act* [Saskatchewan]). Migratory birds are susceptible to changing environmental conditions in their breeding and overwintering habitats.	Amount of habitat that may be altered or lost relative to its availability in the Terrestrial RSA. Migratory songbird mortalities directly or indirectly attributable to the Project.
Bird Species at Risk		
Common Nighthawk (*Chordeiles minor*)	Common Nighthawk are a species at risk. Project activities and infrastructure may affect Common Nighthawk populations (e.g., disturbance and/or destruction of eggs, young, and adults) resulting in non-compliance with regulatory requirements (e.g., *Species at Risk Act* [SARA], *Migratory Birds Convention Act*, Saskatchewan Activity Restriction Guidelines, *Wildlife Act* [Saskatchewan]).	Amount of habitat that may be altered or lost relative to its availability in the Terrestrial RSA. Common Nighthawk mortalities directly or indirectly attributable to the Project.
Short-eared Owl (*Asio flammeus*)	Short-eared Owl are a species at risk. Project activities and infrastructure may affect Short-eared Owl populations (e.g., disturbance and/or destruction of eggs, young, and adults) resulting in non-compliance with regulatory requirements (e.g., SARA, *Migratory Birds Convention Act*, Saskatchewan Activity Restriction Guidelines, *Wildlife Act* [Saskatchewan]).	Amount of habitat that may be altered or lost relative to its availability in the Terrestrial RSA. Short-eared Owl mortalities directly or indirectly attributable to the Project.
Yellow Rail (*Coturnicops noveboracensis*)	Yellow Rail are a species at risk. Project activities and infrastructure may affect Yellow Rail populations (e.g., disturbance and/or destruction of eggs, young, and adults) resulting in non-compliance with regulatory requirements (e.g., SARA, *Migratory Birds Convention Act*, Saskatchewan Activity Restriction Guidelines *Wildlife Act* [Saskatchewan]).	Amount of habitat that may be altered or lost relative to its availability in the Terrestrial RSA. Yellow Rail mortalities directly or indirectly attributable to the Project.

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Rusty Blackbird (*Euphagus carolinus*)	Rusty Blackbird are a species at risk. Project activities and infrastructure may affect Rusty Blackbird populations (e.g., disturbance and/or destruction of eggs, young, and adults) resulting in non-compliance with regulatory requirements (e.g., SARA, *Migratory Birds Convention Act*, Saskatchewan Activity Restriction Guidelines *Wildlife Act* [Saskatchewan]).	Amount of habitat that may be altered or lost relative to its availability in the Terrestrial RSA. Rusty Blackbird mortalities directly or indirectly attributable to the Project.
Olive-sided Flycatcher (*Contopus cooperi*)	Olive-sided Flycatcher are a species at risk. Project activities and infrastructure may affect Olive-sided Flycatcher populations (e.g., disturbance and/or destruction of eggs, young, and adults) resulting in non-compliance with regulatory requirements (e.g., SARA, *Migratory Birds Convention Act*, Saskatchewan Activity Restriction Guidelines Wildlife Act [Saskatchewan]).	Amount of habitat that may be altered or lost relative to its availability in the Terrestrial RSA. Olive-sided Flycatcher mortalities directly or indirectly attributable to the Project.

In response to several information requests received from federal and provincial regulatory agencies, additional avian species at risk have been included as part of the assessment. Details related to life history requirements, expected Project effects, proposed mitigation measures, and anticipated residual effects on these species at risk are provided in Appendix 9-D.

9.4.1.3 Spatial and Temporal Boundaries

9.4.1.3.1 Spatial Boundaries

The spatial boundaries for the EA of the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs are depicted in Figure 9.4-5 and were defined as follows:

- **Project Area:** the area within which the Project and all components/activities are located (i.e., the Project footprint; the area of maximum physical disturbance). The Project Area covers 169.6 ha and is not VC-specific, but consistent throughout the EA.
- **Wildlife LSA:** the area established to assess the potential, direct and indirect effects of the Project on the avian VCs. It was delineated based on the area over which direct and indirect effects on VCs are most likely to occur. It is defined as the Project Area plus a 1.7 km buffer (i.e., 4,842.7 ha). The Wildlife LSA is intended to address provincially and federally mandated activity setback distances required for species at risk that may be found within the Wildlife LSA.
- **Terrestrial RSA:** the area established to assess the potential, largely indirect, effects of the Project on the terrestrial VCs in the broader, regional context. It also provides the regional context in which cumulative effects on terrestrial VCs may occur. The Terrestrial RSA is defined as a minimum of a 6.6 km buffer around the Wildlife LSA (i.e., 40,173.6 ha) and has been delineated to capture regional effects on the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs (Appendix 9-B).

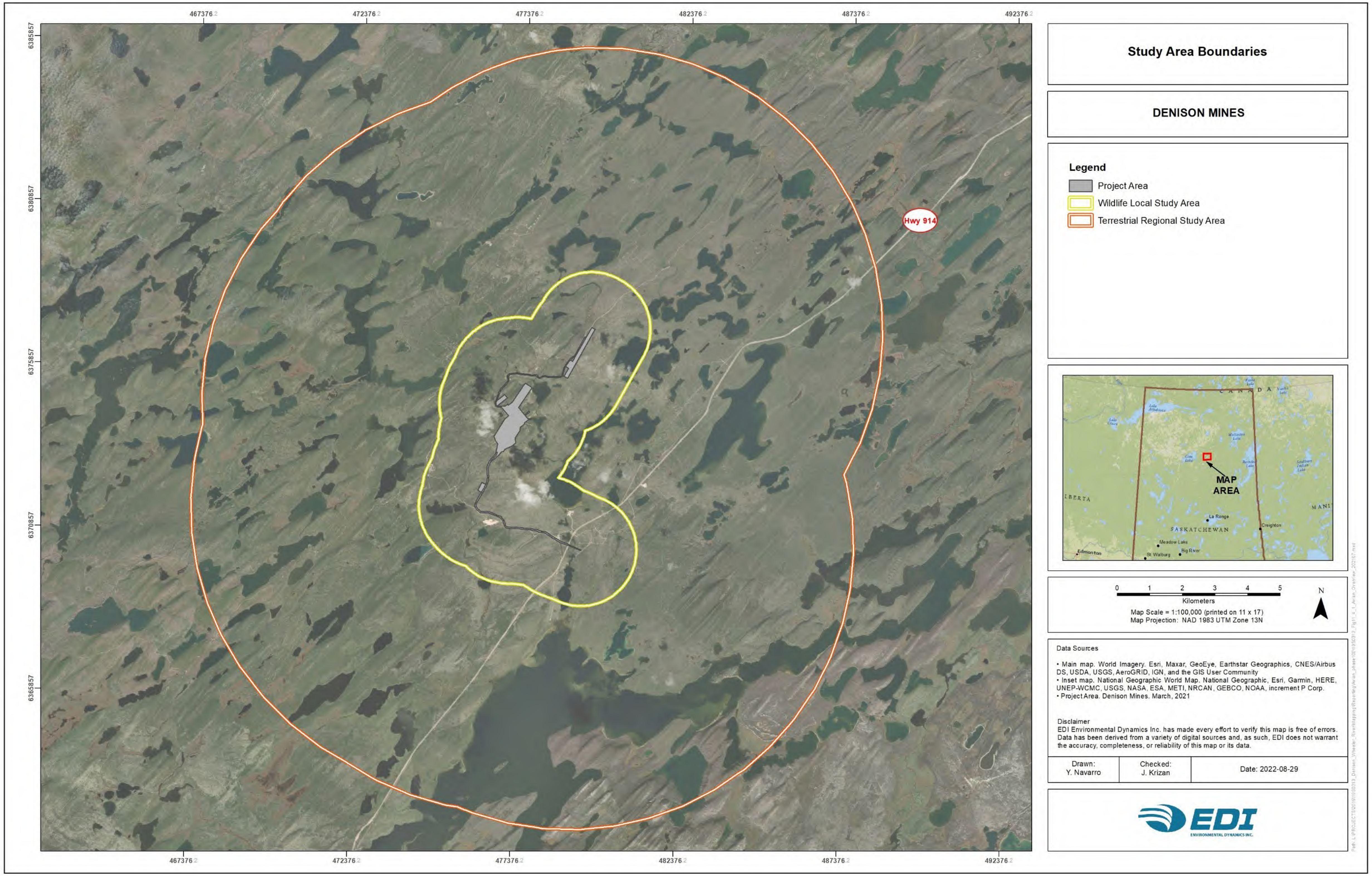

Figure 9.4-5: Study Area Boundaries for Avian Valued Components

9.4.1.3.2 *Temporal Boundaries*

The temporal boundaries for the EA of the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs represent the time frames that the Project is expected to interact with and potentially affect the VCs. Temporal boundaries are based on the different phases of the Project, as described in Table 9.4-2.

Table 9.4-2: Phases of the Project

Phase and Year	Description of Activities	
Construction Year 1 to 3	• Development of access roads and air strip • Site preparation and earthworks; clearing, leveling and grading of the project area • Power generation – generators • Installation of main substation and distribution of power around site • Wellfield and freeze hole drilling; ground freezing • Batch plant operation (concrete); crusher at borrow area • Development of surface infrastructure (camp, operations centre, plants, ponds, pads and support facilities)	• Waste management (composting, domestic and industrial landfill operation, recycling) • Water management (including treatment and site run-off) • Groundwater supply • Surface water withdrawal • Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel) • On-site and off-site operation of vehicles and transport of materials • Air transportation for workers • Regulatory site inspections • Engagement - site visit from Interested Parties
Operation Year 3 to 18	• Operation of the ISR wellfield • Wellfield and freeze wall drilling • Operation and expansion of freeze wall • Batch plant operation (grout and cement) crusher at borrow area • Expansion of pond and pads • Operation of the processing plant and production of uranium concentrate • Water withdrawal from groundwater or surface water body • Management of surface water (including seepage and site run-off) • Water treatment, both domestic and industrial • Water release to surface water body • Waste management (composting, domestic and industrial landfill operation, recycling) • Hazardous waste management (temporary storage, handling, and off-site transportation)	• Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates • On-site and off-site operation of vehicles and transport of materials • Power supply – primarily power from the grid, also generators and back-up generators • Package and transport of nuclear substances • Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel) • Air transportation for workers • Progressive decommissioning and reclamation • Regulatory site inspections • Engagement - site visit from Interested Parties
Decommissioning Year 18 to 23	• Site water management, treatment and release • Mining horizon remediation and thawing of freeze wall	• Generators • Waste management (composting and landfill operation)

Phase and Year	Description of Activities	
	• Process water treatment and release • Closure of ISR and freeze wells and related infrastructure • Decontamination of surface facilities and injection, recovery and monitoring wells • Asset removal (including site power transmission lines and electrical infrastructure) • Demolition and disposal of non-salvageable surface infrastructure and materials • Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	• Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal) • On-site and off-site operation of vehicles and transport of materials • Reclamation of disturbed areas • Regulatory site inspections • Engagement - site visit from Interested Parties
Post-Decommissioning Year 23 to 38	• Environmental monitoring	• Regulatory site inspections • Engagement - site visit from Interested Parties

9.4.2 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

Within this EIS, information obtained through IK, LK, and engagement is viewed as complementary and influential alongside information obtained through the review of western science. All sources of information are used in the following sections to gain and describe a well-rounded understanding of the existing environment of the Raptors, Migratory Breeding Birds and Bird Species at Risk VCs and the potential effects of the Project. In accordance with the methodologies provided in Sections 3, 4, and 5 of the EIS, IK, LK, and engagement have been incorporated and referenced within the assessment of the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs as available and appropriate.

Denison has recorded and stored information regarding IK, LK, and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 20-LK-LEASESUR-267.20). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment. Appendix 9-A provides a summary of unique identification numbers referenced within Section 9.4.

9.4.3 Existing Environment

9.4.3.1 Raptors

The Raptors VC is represented by two KIs: Bald Eagle and Osprey. Therefore, this subsection describes the existing environment for these two species in the Wildlife LSA and Terrestrial RSA, and the province for context.

9.4.3.1.1 *Scientific Literature Review*

Bald Eagle

Bald Eagle are listed as Not at Risk under SARA, are not listed by COSEWIC (ECCC 2021), and they have a provincial SK CDC status of S5B (Secure/Common: demonstrable secure under present conditions; widespread and abundant; low threat level) for the breeding population, while the classification for the non-breeding population is S5N (Secure/Common: demonstrably secure under present conditions; widespread and abundant; low threat level) and S4N (Apparently Secure: uncommon but not rare; some cause for long-term concern due to declines or other factors) (SK CDC 2021).

Bald Eagle Range

Bald Eagle occur in suitable habitat across Saskatchewan and are more common in northern latitudes. The breeding range for Bald Eagle extends north from the Montreal Lake area and includes the Terrestrial RSA. Breeding typically occurs around lakes with a high abundance of fish, the primary food source for Bald Eagle (Smith et al. 2019). Nests are primarily built in trees (living or dead) ranging in height from 8 to 23 m near water bodies, with Bald Eagle known to use old Osprey nests (Smith et al. 2019). Bald Eagle show a preference for coniferous trees for nesting sites, where available, and typically nest in the largest available trees (Buehler 2020).

A detailed study in the American Pacific Northwest, showed that the home ranges for 53 eagle pairs averaged 5 km^2 (ranging between 2 and 7 km^2; Watson 2002). A study in Northern Saskatchewan provided similar results: the average home range of both males and females was found to be 7 km^2 while the territory they actively defended measured on average 4 km^2 (Gerrard et al. 1992).

Little data exist on Bald Eagle distribution patterns and population size throughout Saskatchewan; the last aerial census for this species was conducted in 1974 (Smith et al. 2019). Northern populations (including those in northern Saskatchewan) return to breeding grounds when food and weather are favourable, typically between January and March (Buehler 2020). Nest building begins in September prior to fall migration and is completed in April upon return from their wintering grounds (Buehler 2020). Nesting phenology is variable, with egg laying occurring as early as May and young typically fledged by September in northern latitudes (Buehler 2020).

Population Trends

Gerrard et al. (1983) estimated a North American population of 70,000 individual Bald Eagles based on data from the 1980 Christmas Bird Count (CBC). Mougeot et al. (2013) studied Bald Eagle population trends and reproduction at Besnard Lake, Saskatchewan (approximately 220 km south-southwest of the RSA), from 1968 to 2012. The number of successful pairs identified in the study increased until approximately 1977, then remained relatively stable or slightly declined afterwards (approximately 16 successful breeding pairs per year). Density dependent factors are believed to be the primary influence on population trends and reproductive success in the Besnard Lake area and the author suggested that further studies are required to determine other factors driving population trends and reproductive success, e.g., how fluctuations in prey (i.e., fish) availability may drive population trends (Mougeot et al. 2013).

Osprey

Osprey are not listed under SARA or COSEWIC (ECCC 2021) but have a provincial SK CDC status of S2B (Imperiled/Very Rare: at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats or other factors, for the breeding population) and S2M (Imperiled/Very Rare: at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats or other factors, for the migratory population) (SK CDC 2021).

Osprey Range

Although listed as Imperiled/Very Rare by the SK CDC, Osprey are widely distributed and common over the subarctic and northern boreal forest of Saskatchewan and are less common in southern regions (Smith et al. 2019). The breeding range of Osprey extends from the South Saskatchewan River Valley northward throughout the province (Smith et al. 2019), encompassing the entirety of the Terrestrial RSA.

Breeding habitat requirements of Osprey are highly variable, ranging from the boreal forest to temperate coasts; however, presence of fish in proximity to nesting sites and predator free nest sites, such as tall trees, are good predictors of habitat (Bierregaard et al. 2020). Nests are typically built at the tops of trees, but also occur on rocky outcrops, artificial platforms, and power poles. In Saskatchewan, with the short breeding season for Osprey (typically June to August for northern populations), pairs are rarely able to build a nest and raise young in the same year and, therefore, use existing nests year after year (Smith et al. 2019). Spring migrants typically arrive between March and May and leave again between September and November (Bierregaard et al. 2020).

Unlike Bald Eagle, who are known to defend territories (see above), Osprey do not defend a home range or territory, although males may defend nesting sites. The raptors forage over a wide area and males regularly hunt up to 10 km from the nest (Mougeot et al., 2002).

Population Trends

No recent population estimates of Osprey are available for Canada. However, an estimate of 10,000 to 12,000 pairs was made during the late 1980s (Poole 1989). In North America, Osprey numbers have been increasing in recent decades and some populations formerly listed at risk in other jurisdictions are now off such lists (Bierregaard et al. 2020).

9.4.3.1.2 Information from Indigenous Knowledge, Local Knowledge, and Engagement

Engagement Database

As described in Sections 3 and 5, IK can be understood as the unique and collective knowledge of Indigenous peoples and typically includes knowledge of the environmental, cultural, economic, political, and spiritual conditions of a community or region. Indigenous Knowledge (in combination with information from LK and engagement) was collected, compiled, and made available for inclusion the EIS. No IK information, LK, or information from engagement was provided on Bald Eagle or Osprey.

Saskatchewan Indigenous Cultural Centre

The Saskatchewan Indigenous Cultural Centre has established the annual Birds of Prey Program that facilitates the distribution of eagle feathers (and other items from birds of prey) for Indigenous ceremonial and spiritual purposes (SICC 2021). Eagles are considered the most sacred of all birds and recipients of eagle feathers through this program are expected to follow a protocol to follow the care and responsibility that come with carrying an eagle feather (SICC 2021).

English River First Nation and Shared Valued Solutions: Wheeler River Project – Summary of Traditional Knowledge Study Results

English River First Nation and Shared Value Solutions (2022) compiled an IK study documenting current and past land use, knowledge of the land, and participants' perspectives on potential Project effects, as well as cumulative effects from past mining and other developments.

The ERFN IK study identified areas of bird habitat (including bald eagle and osprey) in their study area, extending beyond the Terrestrial RSA (ERFN and SVS 2022). The identified bird area is west of the Terrestrial RSA and includes Cree Lake and surrounding area.

The study also indicated that a variety of changes have occurred along the Key Lake Road where mining activity is concentrated (i.e., along the northern portion of the road, south of the RSA) and that there is concern about potential future development continuing this trend. Features of concern were identified, including the following (ERFN and SVS 2022):

- 1001-22 (changes to access through roads) - more people are accessing Cree Lake via existing winter roads and quad trails. There is a concern that more people may find out about this access and will start using it to access Cree Lake.
- 1004-17 (changes to access through roads) - more people are being given access (e.g., through recreational leases) to the land to harvest and fish, leading to more offroad vehicle and boat use in the area.
- 1006-15 (changes to access through roads) - since Key Lake Road was built in the late 1970s more people have been observed accessing the land.

9.4.3.1.3 Baseline Studies

Bald Eagle

During the aerial waterfowl and raptor stick nest survey of lakes, streams, and wetland areas in 2017, one active Bald Eagle nest was documented in the Wildlife LSA (at the border between the Wildlife LSA and the Terrestrial RSA) and two in the Terrestrial RSA (Appendix 9-B). Figure 9.4-6 depicts the locations of the active and inactive[33] nests observed during the survey.

Two adults were observed at each of two nests and two chicks were recorded at the third nest. In addition to the individuals at these nests, several Bald Eagle were observed in the Project study areas (i.e., the Project Area, the Wildlife LSA, and the Terrestrial RSA) (Appendix 9-B).

Osprey

During the aerial waterfowl and raptor stick nest survey of lakes, streams, and wetland areas in 2017, three active Osprey nests were documented in the Terrestrial RSA, and one occurred just outside the Terrestrial RSA (Appendix 9-B). Figure 9.4-6 depicts the locations of the active and inactive nests observed during the surveys. One to two adults were observed at each nest. In addition to these nests, several Osprey were observed in the Project study areas.

[33] "Inactive nests" were inactive during the time period of survey as per definition in the baseline report. Omnia (2020) assessed nests in three categories: active (currently occupied), inactive (not currently occupied), and old (dilapidated).

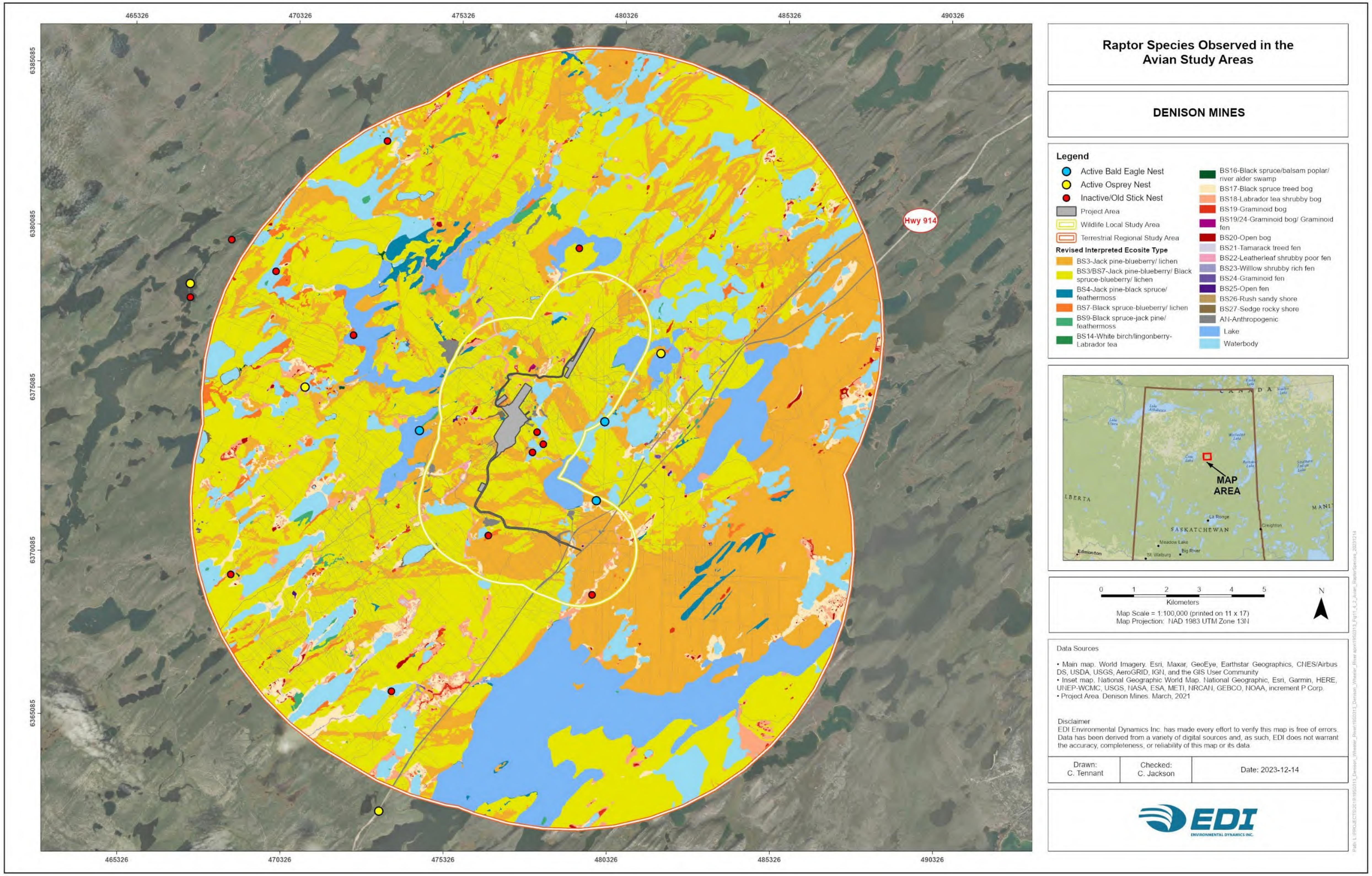

Figure 9.4-6: Nests of Raptor Species Observed in the Avian Study Areas

9.4.3.2 Migratory Breeding Birds

The Migratory Breeding Birds VC is represented by three KIs: waterbirds and waterfowl, upland game birds, and migratory songbirds. Therefore, this section describes the existing environment for these three groups in the Wildlife LSA and Terrestrial RSA.

For organizational purposes, the Migratory Breeding Birds VC was identified as an overarching group that was then divided into several guilds (i.e., the three KIs). It is acknowledged that upland game birds are not migratory but were included as one of the three KIs in this VC to reduce repetition.

9.4.3.2.1 Scientific Literature Review

Waterbirds and Waterfowl

The boreal forest of northern Saskatchewan is home to a wide diversity of waterbirds and waterfowl, including, but not limited, to Yellowlegs (*Tringa* sp.), Mallard (*Anas platyrhynchos*), Common Goldeneye (*Bucephala clangula*), and Common Merganser (*Mergus* mergansers). Waterbirds and waterfowl are defined in this EIS as bird species that are ecologically dependent on wetlands (Ramsar 1994). Waterbirds and waterfowl can be divided into three nesting guilds: upland ground nesters such as the Mallard, cavity nesters such as the Common Goldeneye, and overwater nesters such as the Greater Scaup (*Aythya marila*). The common habitat requirement for these nesting guilds are open water features for foraging opportunities and suitable upland nesting habitat for upland nesting guilds. Open water features provide foraging opportunities for all guilds and nesting opportunities for overwater nesters, and upland forested habitats provide nesting opportunities for ground and canopy nesters (Smith et al. 2019).

Population Trends

Data from the Canadian Wildlife Service Waterfowl Breeding Population and Habitat Survey shows declining trends for some waterfowl species such as the American Wigeon (*Mareca americana*) and increases for other species such as Barrow's Goldeneye (*Bucephala islandica*) (Fast et al. 2011). Population trends for ducks within the western boreal forest (including Saskatchewan) involving 10-year running averages indicated an overall decline (Prairie Habitat Joint Venture 2014). Additionally, modelling of potential changes in pair density from 1960 to 2007 predicted overall declines for all three waterfowl nesting guilds (ground, cavity, and overwater nesters) in the U.S. Fish and Wildlife Service Breeding Population and Habitat Survey area within the Boreal Plains ecozone which includes parts of southern Saskatchewan (Singer et al. 2019).

Harvest

In addition to Indigenous people practising their harvesting rights, non-Indigenous hunters can harvest waterbirds and waterfowl species, but need to have a valid Saskatchewan game bird licence and a federal Migratory Game Bird Permit while hunting migratory birds (SK MOE 2021a). Geese, Sandhill Cranes (*Antigone canadensis*), Ducks, Coots, and Snipe can be harvested across the province between September 1 and December 16. Daily limits vary between 5 and 20 birds and the possession limit (for species that have one) is set at three times the daily limit (SK MOE 2021a). Actual harvest numbers are not currently provided through the available hunter harvest surveys.

Upland Game Birds

Upland game birds that may occur in the Project study areas include Ruffed Grouse (*Bonasa umbellus*), Willow Ptarmigan (*Lagopus lagopus*), Spruce Grouse (*Falcipennis canadensis*), and Sharp-tailed Grouse (*Tympanuchus phasianellus*) (Conkin 2018). The study areas are within the year-round range for all four of these non-migratory species; however, they represent the northern and southern edge of the ranges of Ruffed Grouse and Willow Ptarmigan, respectively. Sharp-tailed Grouse are rare in this region, with their range defined as year-round scarce (Connelly et al. 2020).

Ruffed Grouse are not listed under SARA or COSEWIC (ECCC 2021) and have a provincial SK CDC status of S5 (Secure/Common: demonstrable secure under present conditions; widespread and abundant; low threat level) (SK CDC 2021). The preferred habitat of the Ruffed Grouse is aspen dominated woodlands where females build ground nests at the base of trees (Smith et al. 2019). Ruffed Grouse are uncommon in the northern boreal region, due to the dominance of conifer stands; CBC data support this with less than 1% of observations occurring in the northern boreal region (Smith et al. 2019).

Willow Ptarmigan are not listed under SARA or COSEWIC (ECCC 2021) and have a provincial SK CDC status of S5N (Secure/Common: demonstrable secure under present conditions; widespread and abundant; low threat level, for the non-breeding population) (SK CDC 2021). Willow Ptarmigan occur primarily in subarctic or subalpine zones and show a habitat preference for low, moist areas with an abundance of willow and birch shrubs. Females build nests on the ground, typically concealed from the sides by tussocks, shrubs, and herbs, and overhead by shrubs (Hannon et al. 2020).

Spruce Grouse are not listed under SARA or COSEWIC (ECCC 2021) and have a provincial SK CDC status of S5 (Secure/Common: demonstrable secure under present conditions; widespread and abundant; low threat level) (SK CDC 2021). Spruce Grouse inhabit mixed-wood and coniferous forest types and are rare or absent in deciduous forests (Smith et al. 2019). This species shows a preference for feeding on pine needles over spruce needles, and white over black spruce needles, suggesting that it may be less common in spruce bog habitats (Smith et al. 2019). Females build ground nests at the base of coniferous trees (Schroeder et al. 2020).

Sharp-tailed Grouse are not listed under SARA or COSEWIC (ECCC 2021) and have a provincial SK CDC status of S5 (Secure/Common: demonstrable secure under present conditions; widespread and abundant; low threat level) (SK CDC 2021). Sharp-tailed Grouse frequency decreases northwards of the Cypress Hills and they are widespread, but at low densities, in recent burns and dry bogs in northern regions of Saskatchewan (Smith et al. 2019). Sharp-tailed Grouse require large sections of native mixed grass and shrub habitat for breeding and nesting, and Breeding Bird Survey (BBS) data have shown average provincial population declines of 4.8% annually for the period of 1968 to 2007, attributed largely to the loss of native prairie habitat (Smith et al. 2019).

Harvest

The province manages upland game bird species in accordance with the *Saskatchewan Upland Game Bird Management Plan* (Conkin 2018). The plan outlines the three priorities in game bird management to support sustainable populations:

- monitoring bird populations annually;
- maintaining adequate habitat; and
- maintaining sustainable harvest levels.

In addition to Indigenous people practising their harvesting rights, upland game birds in Saskatchewan can be harvested by Saskatchewan residents, Canadian residents, and non-residents (SK MOE 2021a). To harvest upland game birds, non-Indigenous hunters are required to have a valid Saskatchewan game bird licence. The Terrestrial RSA is in the North Game Bird District - Game Bird Management Unit 6 (SK MOE 2021a). In Game Bird Management Unit 6, Saskatchewan residents can harvest Sharp-tailed Grouse between September 15 and December 7, with a daily limit of two and a possession limit of four birds. Both Ruffed Grouse and Spruce Grouse can be harvested between September 15 and December 31, with a daily limit of 10 and a possession limit of 20. Only Saskatchewan residents can harvest Willow Ptarmigan between November 1 and March 31, with a daily limit of 10 and a possession limit of 20 birds (SK MOE 2021a).

For Canadian residents and non-residents, the hunting season for Sharp-tailed Grouse in Saskatchewan is between September 15 and December 7 and, in addition to a daily limit of two, a season limit of four birds is regulated. Canadian residents and non-residents can harvest the same numbers of Spruce Grouse and Ruffed Grouse as allowed for Saskatchewan residents, but the time window is shorter: September 15 to December 7 (SK MOE 2021a).

Table 9.4-3 provides an overview of the estimated provincial annual game bird harvest for the three grouse species based on the annual hunter harvest surveys (SK MOE 2021b). No harvest numbers for Willow Ptarmigan were available. The harvest for Saskatchewan residents, Canadian residents, and non-residents is calculated using the number of birds harvested, the estimated number of harvesters, and the estimated number of days it took to harvest the birds (i.e., to estimate effort). Provincial annual game bird harvest numbers are available for the period from 2014 through 2020 and are combined for the entire province, i.e., the South Game Bird District and the North Game Bird District (SK MOE 2021b). Indigenous harvest is not included in these numbers as Indigenous hunting efforts are not regulated or tracked through the Saskatchewan Hunters and Trappers Guide and the associated hunter harvest survey.

Table 9.4-3: 2014 to 2020 Annual Grouse Harvest (SK MOE 2021b)

Year	Licence Type	Sharp-tailed Grouse			Ruffed Grouse			Spruce Grouse		
		Number of Hunters	Number of Birds	Number of Days	Number of Hunters	Number of Birds	Number of Days	Number of Hunters	Number of Birds	Number of Days
2020	Saskatchewan Resident	6,999	18,256	35,720	7,375	18,867	38,826	1,862	4,793	9,640
	Canadian Resident	419	793	1762	172	334	618	44	34	240
	Non-Resident	8	24	32	4	16	20	4	4	4
	Total	**7,422**	**19,073**	**37,514**	**7,554**	**19,217**	**39,464**	**1,910**	**4,831**	**9,883**
2019	Saskatchewan Resident	5,368	11,705	25,581	7,507	27,300	40,644	1,937	7,386	9,816
	Canadian Resident	397	688	2,102	242	1,017	1,321	62	50	267
	Non-Resident	707	1,175	2,314	101	569	266	37	129	119
	Total	**6,477**	**13,568**	**29,997**	**7,875**	**28,887**	**42,231**	**2,041**	**7,564**	**10,202**
2018	Saskatchewan Resident	8,199	16,307	37,249	9,612	40,751	48,166	2,289	8,957	11,819
	Canadian Resident	563	1,042	2,112	215	1,049	653	49	167	195
	Non-Resident	901	1,576	3,433	172	681	509	0	0	0
	Total	**9,663**	**18,925**	**42,794**	**9,999**	**42,482**	**49,278**	**2,338**	**9,124**	**12,013**
2017	Saskatchewan Resident	8,885	17,519	38,194	10,570	44,770	54,390	2,457	8,266	12,666
	Canadian Resident	574	1,074	2,339	197	771	629	31	68	56
	Non-Resident	670	1,301	2,357	128	441	307	6	134	34
	Total	**10,129**	**19,894**	**42,890**	**10,896**	**45,982**	**55,327**	**2,494**	**8,468**	**12,755**
2016	Saskatchewan Resident	8,951	18,362	42,077	12,563	74,189	62,360	3,702	14,484	19,154
	Canadian Resident	577	1,003	1,999	356	3,247	1,943	385	1,804	2,958
	Non-Resident	940	1,696	2,899	139	565	396	61	306	184
	Total	**10,467**	**21,061**	**46,975**	**13,058**	**78,001**	**64,700**	**4,148**	**16,594**	**21,935**
2015[1]	Total	7,076	14,761	36,371	10,799	43,782	54,993	2,683	8,338	15,001
2014	Saskatchewan Resident	6,248	6,436	19,557	8,237	22,488	36,492	4,850	10,768	19,838
	Canadian Resident	403	181	1,173	193	578	534	278	456	743
	Non-Resident	924	1,053	2,966	226	257	483	310	0	465
	Total	**7,575**	**7,670**	**23,696**	**8,656**	**23,324**	**37,509**	**5,439**	**11,232**	**21,046**

1 For 2015, estimates of total harvest numbers were provided and not further divided into licence type.

Note: Saskatchewan Resident = Canadian person whose principal residence is in Saskatchewan; Canadian Resident = a person whose principal residence is in Canada; Non-Resident = neither a Saskatchewan nor Canadian resident (SK MOE 2021a).

As shown in Table 9.4-3, Ruffed Grouse harvest was reported to be the highest of the three grouse species between 2014 and 2020, and Saskatchewan residents harvested the highest number of grouse for all species and years. Harvest numbers peaked in 2016 (with a total of 64,000 Ruffed Grouse), and then numbers declined slightly every year after. The same pattern was reported for Spruce Grouse: after the highest harvest in the reporting period occurred in 2016 (with 16,594 Spruce Grouse harvested), the harvest levels fell each year after 2016. For Sharp-tailed Grouse, the highest harvest numbers were also reported for 2016 (21,061 harvested birds), but annual harvest numbers fluctuated between the years (Table 9.4-3).

Upland game birds, and in particular the Ruffed Grouse and Spruce Grouse, exhibit population cycles of 8 to 10 years, mostly driven by quality and quantity of their habitat (Conkin 2018). This cyclicity is reflected in the annual harvest and is considered when setting harvest limits.

Migratory Songbirds

The boreal forest provides breeding and stopover habitat for a large diversity of migratory songbirds. In an analysis of niche structure of western boreal birds, Mahon et al. (2016) found that 78% of 67 species examined showed a wide niche breadth (i.e., generalist species). Of the 22% of species that showed habitat specialization, specialists showed an affinity for: old hardwood and mixed-wood forests, white spruce and balsam fir forests, burned habitats, open habitats (e.g., marshland and grassland), and lowland habitats (e.g., bogs and fens) (Mahon et al. 2016).

Species that preferred old hardwood and mixed-wood forests included Black-throated Green Warbler (*Setophaga virens*), Canada Warbler (*Cardellina canadensis*), and Ovenbird (*Seiurus aurocapilla*). Species that showed a preference for white spruce and balsam fir forests included Golden-crowned Kinglet (*Regulus satrapa*), Bay-breasted Warbler (*Setophaga castanea*), Cape May Warbler (*Setophaga tigrina*), and Western Tanager (*Piranga ludoviciana*). Species that preferred burned habitats included Black-backed Woodpecker (*Picoides arcticus*), Wilson's Warbler (*Cardellina pusilla*), and Olive-sided Flycatcher (*Contopus cooperi*). Le Conte's Sparrow (*Anthus leconeii*), Tree Swallow (*Tachycineta bicolor*), and Swamp Sparrow (*Melospiza georgiana*) showed a preference for open habitats, and Palm Warbler (*Setophaga palmarum*) showed a preference for lowland habitats (Mahon et al. 2016).

As summarized by Van Wilgenburg et al. (2015), declines in songbird numbers have been documented at both the continent-wide scale, and on local breeding grounds. While some species associated with old growth forest types showed steep population declines in their study area of the boreal transition zone, species associated with disturbances showed increases. Population trends in the northern boreal forest of Saskatchewan are unclear, as historically, bird survey data have been from the southern boreal transition zone, where the dominant disturbance is agriculture (Van Wilgenburg et al. 2015).

Currently, no reliable estimates exist of population trends for migratory songbirds in the northern boreal forest due to poor spatial coverage in this region and a lack of reliable long-term monitoring programs, resulting in poor estimates of population trends (Roy et al. 2019). While recent surveys from Environment and Climate Change Canada and the Saskatchewan Breeding Bird Atlas (Birds Canada 2021) have expanded surveys into the northern boreal forest, these data are not yet available or published to make inferences on population trends for migratory songbirds in the Terrestrial RSA. However, additional data on migratory songbird presence, acquired from the Saskatchewan Breeding Bird Atlas for the Terrestrial RSA, are provided in Appendix 9-F.

9.4.3.2.2 Information from Indigenous Knowledge, Local Knowledge, and Engagement

As described in Sections 3 and 5, IK can be understood as the unique and collective knowledge of Indigenous peoples and typically includes knowledge of the environmental, cultural, economic, political, and spiritual conditions of a community or region. Indigenous Knowledge (in combination with information from LK and engagement) was collected, compiled, and made available for inclusion into all VC sections. In the following, IK information on some species of the Migratory Breeding Bird VC in the region is provided. This information includes LK and information from engagement as well.

Knowledge holders confirmed that they observed declines in some species and increases in others. It was pointed out that less Grouse were found in recent years: "*In recent years, there are fewer … and bush chickens* [i.e., Grouse species]*"* (19-LK-ERFNTrap-134.163). It was also noted that there are less Ptarmigan observed during the winter months and fewer Canada Geese (*Branta canadensis*) and Mallards (during the summer) (19-LK-ERFNTrap-134.164). The number of Loons at Russell Lake did not appear to have declined and a growing number of Red-throated Loons were found (*Gavia Stellata*)[34].

An increase in the numbers of American White Pelican (*Pelecanus erythrorhynchos*), in particular in the Cree Lake area (outside of the Terrestrial RSA), has been observed (19-LK-ERFNTrap-134.168), while they had not been encountered here in the past: "*There are American Pelican at Cree Lake now. They were not here in the past*" (19-LK-ERFNTrap-134.239). Surf Scoter (*Melanitta perspicillata*) is another species that was reported to have increased in numbers: "*Also, way less Ptarmigan in winter. Less Mallards and Canada Geese, more Surf Scoters"* (19-LK-ERFNTrap-134.164).

It was reported that Sandhill Cranes are using an area along the Wheeler River (19-LK-ERFNTrap-134.169).

[34] 19-LK-ERFNTrap-134.166, 19-LK-ERFNTrap-134.167, 19-LK-ERFNTrap-134.238.

English River First Nation and Shared Valued Solutions: Wheeler River Project – Summary of Traditional Knowledge Study Results

English River First Nation and SVS (2022) compiled an IK study documenting current and past land use, knowledge of the land, and participants' perspectives on potential Project effects, as well as cumulative effects from past mining and other developments.

The ERFN IK study identified areas of bird habitat (including waterfowl) in their study area, extending beyond the Terrestrial RSA (ERFN and SVS 2022). The identified bird area is west of the Terrestrial RSA and includes Cree Lake and surrounding area.

The study also indicated that a variety of changes have occurred along the Key Lake Road where mining activity is concentrated (i.e., along the northern portion of the road, south of the RSA) and that there is concern about potential future development continuing this trend. Features of concern were identified, including the following (ERFN and SVS 2022):

- 1001-22 (changes to access through roads) - more people are accessing Cree Lake via existing winter roads and quad trails. There is a concern that more people may find out about this access and will start using it to access Cree Lake.
- 1004-17 (changes to access through roads) - more people are being given access (e.g., through recreational leases) to the land to harvest and fish, leading to more offroad vehicle and boat use in the area.
- 1006-15 (changes to access through roads) - since Key Lake Road was built in the late 1970s more people have been observed accessing the land.

9.4.3.2.3 Baseline Studies

Waterbirds and Waterfowl

During the 2017 aerial waterfowl surveys of lakes, streams, and wetland areas, 20 confirmed and 3 unknown species of waterbirds and waterfowl were recorded in the Wildlife LSA and Terrestrial RSA (Appendix 9-B). Higher densities and species richness were associated with smaller interconnected waterbodies, and no apparent influence of adjacent upland ecosite type on densities and species richness was identified (Appendix 9-B).

The most commonly observed waterbirds and waterfowl were: Ring-necked Duck (*Aythya collaris*, 107 observations), Common Merganser (*Mergus merganser*, 93 observations), Common Loon (*Gavia immer*, 75 observations), Mallard (*Anas Platyrhynchos*, 70 observations), unknown white-headed Gull (67 observations), Canada Goose (*Branta canadensis*, 37 observations), Lesser Scaup (*Aythya affinis*, 30 observations), Yellowlegs species (*Tring sp.,* 25 observations) and Bufflehead (*Bucephala albeola,* 23 observations).

Upland Game Birds

Of the four upland gamebird species with the potential to occur in the Terrestrial RSA, the only one observed during the 2017 baseline surveys was Spruce Grouse, with one incidental observation during the songbird survey (Appendix 9-B). The observation was recorded in the BS4 (jack pine – black spruce/feathermoss) ecosite.

During the 2017/2018 winter track count surveys, Grouse and Ptarmigan trails were pooled into one category (i.e., Grouse/Ptarmigan trails) (Appendix 9-B). Grouse/Ptarmigan trails were observed along all transects types and the highest trail densities were observed along creek transects. In 2017, the trails of Grouse/Ptarmigan were recorded in 13 of 19 (68%) ecosites. The highest trail densities were detected in the BS24 (graminoid fen), BS19 (graminoid bog), and BS18 (Labrador tea shrubby bog) ecosites. In 2018, the highest trail densities were observed in the BS23 (willow shrubby rich fen), BS16 (black spruce/balsam poplar/river alder swamp), and BS17 (black spruce treed bog) ecosites (Appendix 9-B).

During the 2017/2018 spring pellet surveys, Grouse and Ptarmigan pellets were pooled into one category (i.e., Grouse/Ptarmigan pellet groups) (Appendix 9-B). Grouse/Ptarmigan pellet groups were observed frequently in the study areas with detections in 12 ecosites. The highest densities were observed in the BS19 (graminoid bog), BS7 (black spruce/blueberry/lichen), and BS9 (black spruce – jack pine/feathermoss) ecosites. No pellet groups were observed along creek or anthropogenic disturbance transects (Appendix 9-B).

Migratory Songbirds

Thirty-six avian species were detected during the 2017 breeding songbird surveys (Appendix 9-B). The 10 most common species were: Ruby-crowned Kinglet (*Regulus calendula*, 51 observations), Dark-eyed Junco (*Junco hyemalis*, 40 observations), Canada Jay (*Perisoreus canadensis*, 34 observations), Yellow-rumped Warbler (*Setophaga coronata*, 31 observations), Swainson's Thrush (*Catharus ustulatus*, 18 observations), Hermit Thrush (*Catharus guttatus*, 18 observations), Lincoln's Sparrow (*Melospiza lincolnii*, 15 observations), Chipping Sparrow (*Spizella passerina*, 15 observations), Fox Sparrow (*Passerella iliaca*, 15 observations), and American Robin (*Turdus migratorius,* 13 observations).

Analysis of breeding songbird data included species richness and diversity, species presence, relative abundance (by species and habitat), and habitat use (Appendix 9-B). The highest species richness (i.e., the number of species within a given ecosite) was observed with 13 species in the RF1[35] (regeneration – tree dominated) ecosite, with 12 species in the BS22 (leatherleaf shrubby poor fen) ecosite, and with 11 species each in the BS17 (black spruce treed bog), BS21 (tamarack

[35] Note that for this EIS, Omnia's novel regenerating forest types RF1, RF2, and RF3 were reclassified consistent with the provincial ecosite classification of BS3 (jack pine - blueberry/lichen) and BS7 (black spruce - blueberry/lichen) when assessing residual effects of the Project (explained in Section 9.4.6).

treed fen), and RF2 (regeneration – tall shrub dominated) ecosites. The lowest species richness was observed with 1 species in the BS25 (open fen) ecosite, with 2 species in the BS19 (graminoid bog) ecosite, and with 3 species in the BS24 (graminoid fen) ecosite (Appendix 9-B).

The highest mean number of breeding songbird pairs within the study areas was detected with 5.2 pairs in the BS4 (jack pine – black spruce/feathermoss) ecosite and with 4.6 pair in the BS7 (black spruce/blueberry/lichen) ecosite. The lowest mean number of pairs were detected with 0.5 pairs in the BS5 (open fen) ecosite, with 0.8 pairs in the BS24 (graminoid fen) ecosite, and with 1 pair in the BS19 (graminoid bog) ecosite (Appendix 9-B).

The ecosites with the highest species diversity (based on the Shannon-Wiener Diversity Index [Appendix 9-B]) were the B22 (leatherleaf shrubby poor fen) ecosite with an index of 2.4, the RF1 (regeneration – tree dominated) ecosite with an index of 2.3, the BS18 (Labrador tea shrubby bog), and BS21 (tamarack treed fen) ecosites, each with an index of 2.2. The lowest species diversity was recorded in the BS25 (open fen) ecosite with an index of 0, the BS19 (graminoid bog) ecosite with an index of 0.7, and the BS24 (graminoid fen) ecosite with an index of 1 (Appendix 9-B). Ecosites with the highest evenness value (i.e., evenness calculations based on the Shannon-Wiener Diversity Index) reflecting the lowest variation in species, included: the BS19 (graminoid bog) ecosite, BS23 (willow shrubby rich fen), BS20 (open bog), BS27 (sedge rocky shore), BS18 (Labrador tea shrubby bog), BS26 (rush sandy shore), and BS22 (leatherleaf shrubby poor fen) ecosites, all with a value of 1. The ecosite with the lowest evenness value (reflecting a high degree in species variation) was BS7 (black spruce-blueberry/lichen) with a value of 0.8. All other ecosites had an evenness value of 0.9 (Appendix 9-B).

9.4.3.3 Bird Species at Risk

The Bird Species at Risk VC is represented by five KIs: Common Nighthawk, Short-eared Owl, Yellow Rail, Rusty Blackbird, and Olive-sided Flycatcher. Therefore, this section describes the existing environment for these five species in the Terrestrial RSA.

It is acknowledged that the listed Barn Swallow (*Hirundo rustica*) and Horned Grebe (*Podiceps auratus*) could potentially occur in the Terrestrial RSA. Incidental observations occurred during the baseline studies (Appendix 9-B). To focus the effects assessment on a few key species (described in the following) it was decided to use Olive-sided Flycatcher and Common Nighthawk to represent Barn Swallow as well, and to use Yellow Rail and Rusty Blackbird as a substitute for Horned Grebe. Unlike Horned Grebe, Yellow Rail and Rusty Blackbird are also listed provincially.

9.4.3.3.1 Scientific Literature Review

Common Nighthawk

Common Nighthawk are listed as Threatened under SARA's Schedule 1, as Special Concern by COSEWIC (ECCC 2021), and have a provincial SK CDC status of S4B (Apparently Secure: uncommon but not rare; some cause for long-term concern due to declines or other factors, for the breeding population) and S4M (Apparently Secure: uncommon but not rare; some cause for long-term concern due to declines or other factors, for the migratory population) (SK CDC 2021).

Common Nighthawk Range

Common Nighthawk are aerial insectivores found in a variety of habitats, including woodland clearings, burned forests, and anthropogenically cleared areas (COSEWIC 2018a). Common Nighthawk build nests on the ground, often near logs, boulders, grass clumps, and shrubs (Brigham et al. 2020). The nesting period is from late May to early August, and they arrive on their breeding grounds between early May and early June, departing for their wintering grounds between mid-August and mid-September (COSEWIC 2018a). The breeding range of the Common Nighthawk as delineated by Smith et al. (2019) encompasses the entirety of the Terrestrial RSA.

Common Nighthawk Population Trends

Common Nighthawk population estimates are incomplete as they are difficult to detect during the day and their boreal habitat is not well surveyed (COSEWIC 2018a). Population estimates from BBS data resulted in approximately 900,000 individuals in Canada, while the Boreal Avian Modelling (BAM) Project estimated a Canadian population of 270,000 adults, although the BAM value is likely an underestimate (COSEWIC 2018a). Between 1970 and 2015, a population decline of 68% was estimated in Canada, and between 2005 and 2015 the decline was estimated at 12%.

The primary threats to the Common Nighthawk are reduced abundance of aerial insects from pesticide use, changes in precipitation and temperature, and increased severe weather events (COSEWIC 2018a). Based on analysis of eBird data, the population has stabilized in recent years and Common Nighthawk are thought to be abundant in suitable boreal habitats (COSEWIC 2018a).

Short-eared Owl

Short-eared Owl are listed as Special Concern under SARA's Schedule 1, COSEWIC lists them as Threatened (ECCC 2021), and they have a provincial SK CDC status of S3B (Vulnerable/Rare to Uncommon: at moderate risk of extinction or extirpation due to a restricted range, relatively few populations, recent and widespread declines, threats, or other factors, for the breeding population), S3M (Vulnerable/Rare to Uncommon: at moderate risk of extinction or extirpation due to a restricted range, relatively few populations, recent and widespread declines, threats, or other factors, for the migratory population), and S2N (Imperiled/Very Rare: at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats or other factors, for the non-breeding population) (SK CDC 2021).

Short-eared Owl Range

Short-eared Owl habitat is closely tied to the availability of clear, open habitat with abundant small mammals, their primary food source (Smith et al. 2019). They are found in a wide variety of unforested habitats including Arctic tundra, grasslands, sand-sage, fallow pastures, cropland, marshes, and open bogs with nest sites typically in areas of dense grassland (COSEWIC 2008).

Short-eared Owls arrive in their breeding areas between March and May, with the nesting period occurring from late April to late June (COSEWIC 2008). Their breeding habitat encompasses the entirety of the Terrestrial RSA (Smith et al. 2019); however, summer records are uncommon in the boreal region of Saskatchewan (COSEWIC 2008).

Short-eared Owl Population Trends

Christmas Bird Count data estimated the Canadian Short-eared Owl population at 350,000 in 2008 and it was suggested that in the 40-year period preceding 2008, annual declines of 3 % occurred and may continue to occur (COSEWIC 2008). Destruction of prairie grasslands and coastal wintering grounds are believed to be the primary contributing factors to Short-eared Owl declines, with increased nest depredation due habitat fragmentation, declines in prey abundance, and collisions with vehicles believed to be additional factors (COSEWIC 2008).

Yellow Rail

Yellow Rail are listed as Special Concern under SARA and COSEWIC (ECCC 2021) and have a SK CDC status of S3B (Vulnerable/Rare to Uncommon: at moderate risk of extinction or extirpation due to a restricted range, relatively few populations, recent and widespread declines, threats, or other factors, for the breeding population) and S3M (Vulnerable/Rare to Uncommon: at moderate risk of extinction or extirpation due to a restricted range, relatively few populations, recent and widespread declines, threats, or other factors, for the migratory population) (SK CDC 2021).

Yellow Rail Range

Yellow Rail build their nests in emergent vegetation of shallow wetlands, preferring sedge dominated wetlands with an overlying mat of dry, dead vegetation that is used to roof their nests (Leston and Bookhout 2020). They feed on a mixture of arthropods and graminoid seeds. Yellow Rails arrive on their breeding grounds between late April and mid-May and nest from early June to early August. Timing of fall migration is poorly understood due to the cryptic behaviour of this species and lack of vocalizations outside of the breeding period; however, studies showed that at Hudson Bay (in east-central Saskatchewan near the Manitoba border), birds leave breeding grounds before early September (COSEWIC 2009). While the occurrence of Yellow Rail across much of their range is uncertain (Hedley et al. 2020), the breeding range of the species as delineated by Smith et al. (2019) encompasses the entirety of the Terrestrial RSA.

Yellow Rail Population Trends

Standardized bird survey programs, such as the BBS, CBC, and Marsh Monitoring Program, typically inadequately sample Yellow Rail populations. COSEWIC (2009) estimated that 10,000 individuals nest in Canada, and that, in the decade preceding 2008, populations declined by less than 30%.

Rusty Blackbird

Rusty Blackbird are listed as Special Concern under SARA and COSEWIC (ECCC 2021) and have a provincial SK CDC status of S3B (Vulnerable/Rare to Uncommon: at moderate risk of extinction or extirpation due to a restricted range, relatively few populations, recent and widespread declines, threats, or other factors, for the breeding population), SUN (status is uncertain in Saskatchewan because of limited or conflicting information, for the non-breeding population), and S3M (Vulnerable/Rare to Uncommon: at moderate risk of extinction or extirpation due to a restricted range, relatively few populations, recent and widespread declines, threats, or other factors, for the migratory population) (SK CDC 2021).

Rusty Blackbird Range

The breeding range of Rusty Blackbird as delineated by Smith et al. (2019) encompasses the entirety of the Terrestrial RSA. They occur across most of the northern boreal forest with their breeding range almost exclusively within the boreal forest. Typical breeding habitat is characterized by wetland habitats such as fens, bogs, muskeg, and wet forest margins along lakes and streams, with upland coniferous forests (Smith et al. 2019, Avery 2020). In their breeding range, Rusty Blackbirds feed mostly on invertebrates including arthropods, crustaceans, and molluscs, but also prey on salamanders and small fish.

Rusty Blackbird arrive at their breeding grounds between mid-March and early May with most of the spring migration happening during April. They depart for their wintering grounds between late July and September (COSEWIC 2017). The breeding season for Rusty Blackbirds occurs from mid- to late May until mid-July in the northern part of their breeding range. Nests are almost always near water and are built in living and dead trees and shrubs, typically 0.5 m to 6 m above ground in dense vegetation (Avery 2020).

Rusty Blackbird Population Trends

Canada's population of Rusty Blackbird is estimated at 4.4 million breeding individuals. Based on CBC and BBS data, Rusty Blackbird have seen a total population decline of 85 to 90% since 1970, representing one of the greatest population declines of birds in Canada (COSEWIC 2017). The largest contributing factor to Rusty Blackbird declines is thought to be loss of wintering habitat (i.e., through wetland destruction associated with agricultural activities) in the southeastern U.S. (COSEWIC 2017).

Olive-sided Flycatcher

Olive-sided Flycatcher are listed as Threatened under SARA's Schedule 1 and as Special Concern by COSEWIC (ECCC 2021) and have a provincial SK CDC status of S4B (Apparently Secure: uncommon but not rare; some cause for long-term concern due to declines or other factors, for the breeding population), and S4N (Apparently Secure: uncommon but not rare; some cause for long-term concern due to declines or other factors, for the non-breeding population) (SK CDC 2021).

Olive-sided Flycatcher Range

The preferred habitat for Olive-sided Flycatchers is coniferous and mixed-wood forest edges with tall trees and snags for perching, forest openings, and burned forests with standing trees and snags (COSEWIC 2018b). Forest edges created by wet areas, burns, and human created edges are typically used by the birds. The Olive-sided Flycatcher is an aerial insectivore (COSEWIC 2018b).

Spring migrants typically arrive between April and June with most migrants arriving in mid- to late May, departing for their wintering grounds in late July to early August. The nesting period for Olive-sided Flycatcher spans from late May to mid-August; however, these estimates are based on predictive models from data collected primarily in the southern portion of their range and may not accurately reflect trends in the northern portions of their range, including northern Saskatchewan (COSEWIC 2018b). Nests are typically constructed in coniferous trees, with a wide range of nest heights from 1.5 m to 34 m (Altman and Sallabanks 2020).

Olive-sided Flycatcher Population Trends

Breeding Bird Survey data showed a mean annual decline of 2.1% for Olive-sided Flycatchers in Canada between 2006 and 2016, a 2.8% mean annual decline between 1989 and 2016, and a 72% cumulative decline since 1970, while data from the BAM Project provided no evidence of decline between 1997 and 2013 (COSEWIC 2018b).

9.4.3.3.2 Information from Indigenous Knowledge, Local Knowledge, and Engagement

As described in Sections 3 and 5, IK can be understood as the unique and collective knowledge of Indigenous peoples and typically includes knowledge of the environmental, cultural, economic, political, and spiritual conditions of a community or region. Indigenous Knowledge (in combination with information from LK and engagement) was collected, compiled, and made available for inclusion into all VC sections.

No IK information, LK, or information from engagement was provided on Common Nighthawk, Short-eared Owl, Yellow Rail, Rusty Blackbird, or Olive-sided Flycatcher in the region. However, information on another species at risk (Whooping Crane [*Grus americana*]) was provided. Whooping Cranes are listed as Endangered on SARA's Schedule 1 and by COSEWIC (ECCC 2021); in Saskatchewan they are ranked as SXB (breeding population in the province is believed to be extinct) and S1M (Critically Imperiled/Extremely Rare: at very high risk of extinction or extirpation due to extreme rarity, very steep declines, high threat level, or other factors; for the migrant, transient population) (SCDC 2021). Knowledge providers reported that "*Whooping Cranes have been observed along the Wheeler River and probably nest along Moore Lake based on behaviour (nest defence / return to specific area after being disturbed)*" (19-LK-ERFNTrap-134.169). In addition, Whooping Crane sightings have been reported along the Cree River (outside of the Terrestrial RSA) (19-LK-ERFNTrap-134.170).

English River First Nation and Shared Valued Solutions: Wheeler River Project – Summary of Traditional Knowledge Study Results

English River First Nation and SVS (2022) compiled an IK study documenting current and past land use, knowledge of the land, and participants' perspectives on potential Project effects, as well as cumulative effects from past mining and other developments.

The ERFN IK study identified areas of species at risk (including common nighthawk) in their study area, extending beyond the Terrestrial RSA (ERFN and SVS 2022). The identified species at risk area (Feature 1018-10) is approximately 100 km south of the Terrestrial RSA.

The study also indicated that a variety of changes have occurred along the Key Lake Road where mining activity is concentrated (i.e., along the northern portion of the road, south of the RSA) and that there is concern about potential future development continuing this trend. Features of concern were identified, including the following (ERFN and SVS 2022):

- 1001-22 (changes to access through roads) - more people are accessing Cree Lake via existing winter roads and quad trails. There is a concern that more people may find out about this access and will start using it to access Cree Lake.
- 1004-17 (changes to access through roads) - more people are being given access (e.g., through recreational leases) to the land to harvest and fish, leading to more offroad vehicle and boat use in the area.
- 1006-15 (changes to access through roads) - since Key Lake Road was built in the late 1970s more people have been observed accessing the land.

9.4.3.3.3 Baseline Studies

Common Nighthawk

During the 2017 to 2019 baseline surveys, a total of 83 auditory and visual incidental Common Nighthawk observations were recorded in the Terrestrial RSA, although no specific Common Nighthawk surveys were conducted. Seven Common Nighthawks were observed in the Terrestrial RSA and 14 were observed in the Wildlife LSA (Appendix 9-B). In addition, two Common Nighthawk nests were detected in the Wildlife LSA, near the Project Area. Figure 9.4-7 depicts locations of Common Nighthawk observations.

Short-eared Owl

No Short-eared Owl were observed during the baseline surveys (Appendix 9-B).

Yellow Rail

No Yellow Rail were observed during the baseline surveys (Appendix 9-B).

Rusty Blackbird

No Rusty Blackbird were observed during the baseline surveys (Appendix 9-B).

Olive-sided Flycatcher

During the 2017 breeding songbird surveys, eight Olive-sided Flycatcher observations occurred in the Wildlife LSA and Terrestrial RSA (Appendix 9-B). These observations were in the BS17 (black spruce treed bog), BS21 (tamarack treed fen), BS22 (leatherleaf shrubby poor fen), BS23 (willow shrubby rich fen), BS24 (graminoid fen), and RF2[36] (regenerating forest – tall shrub dominated) ecosites.

Additionally, incidental Olive-sided Flycatcher observations were recorded during other baseline studies between 2017 and 2019 (Appendix 9-B). Figure 9.4-7 depicts locations of Olive-sided Flycatcher observations.

Saskatchewan Conservation Data Centre Information

Additional information regarding the avian Species of Management Concern (i.e., the Bird Species at Risk VC) was gathered from the Hunting, Angling, and Biodiversity Information of Saskatchewan (HABISask) database managed by the SK CDC.

On February 9, 2021, the HABISask database (SK MOE 2021c) was searched for Common Nighthawk, Short-eared Owl, Yellow Rail, Rusty Blackbird, and Olive-sided Flycatcher within a 10-km radius around the Project Area. Table 9.4-4 provides the results of the search.

Table 9.4-4: Additional Information for Bird Species at Risk Key Indicators (SK MOE 2021c)

Common Name	Provincial Rank	COSEWIC[1]	SARA Status[2]	Known Occurrences	Descriptions[3]
Common Nighthawk	S4B, S4M	Special concern	Threatened	Yes	Several observations of one individual per observation between 2011 and 2019.
Short-eared Owl	S3B, S2N, S3M	Threatened[4]	Special concern	No	N/A
Yellow Rail	S3B, S3M	Special concern	Special concern	No	N/A
Rusty Blackbird	S3B, SUN, S3M	Special concern	Special concern	Yes	Several observations in 2019; between one and three adults per observation.
Olive-sided Flycatcher	S4B, S4M	Special concern	Threatened	Yes	Several observations between 2016 and 2019; between one and two adults per observation.

1 Species listed by the Committee on the Status of Endangered Wildlife in Canada.
2 Species listed under the *Species at Risk Act*.
3 Observations in this database did not provide sighting locations.
4 As of the May 2021 COSEWIC Reassessment Meeting (was Special Concern before).

[36] Note that for this EIS, Omnia's novel regenerating forest types RF1, RF2, and RF3 were reclassified consistent with the provincial ecosite classification of BS3 (jack pine - blueberry/lichen) and BS7 (black spruce - blueberry/lichen) when assessing residual effects of the Project (explained in Section 9.4.6).

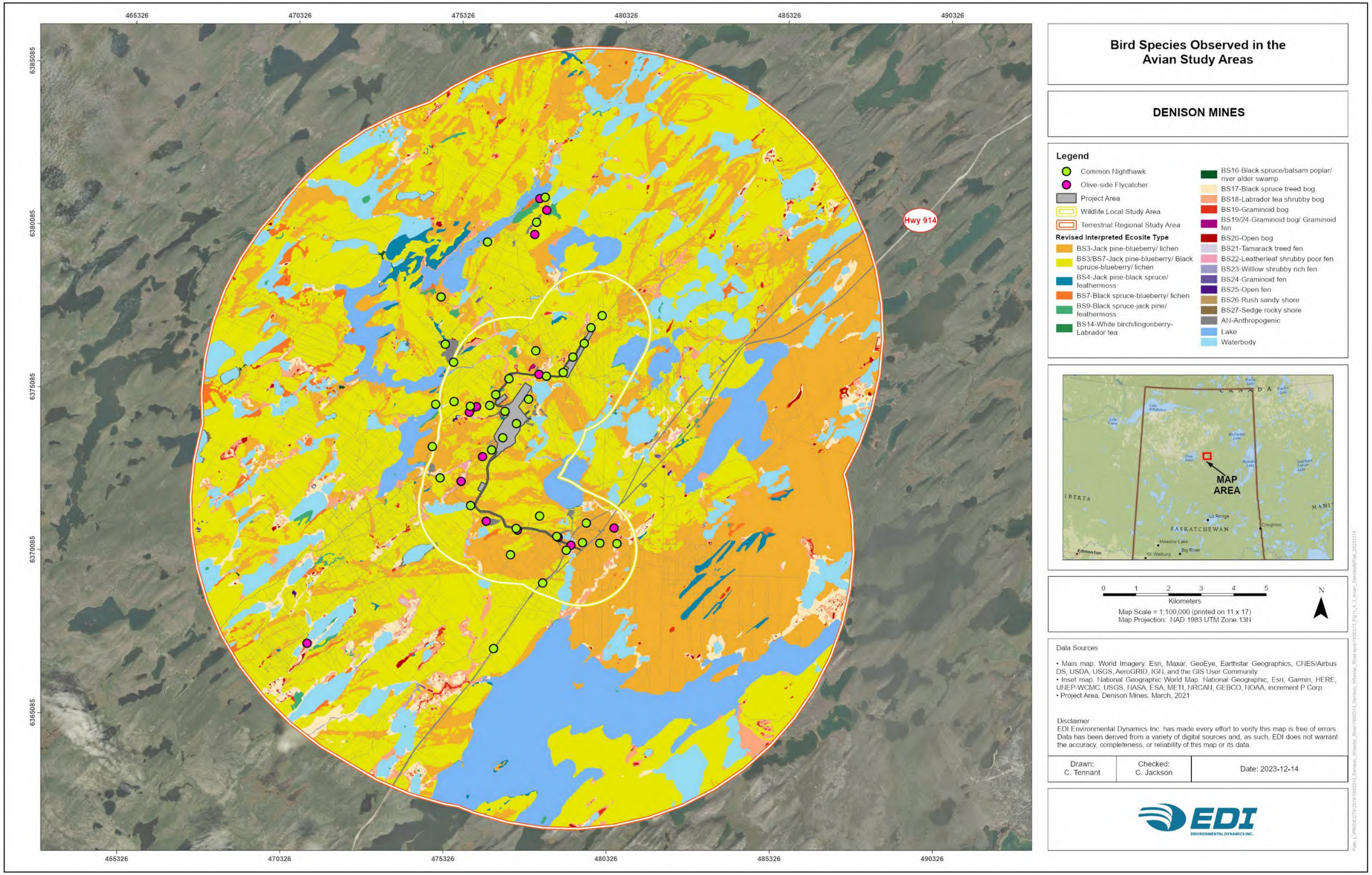

Figure 9.4-7: Bird Species at Risk Observed in the Avian Study Areas

9.4.4 Assessment of Project-related Effects

9.4.4.1 Potential Interactions Between the Project and Valued Components / Key Indicators

The Project will require the construction, operation, and decommissioning of several components (as described in Section 2). Potential interactions between these Project components and activities and the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs and their associated KIs are summarized by Project phase and activity in Table 9.4-5.

Potential interactions in Table 9.4-5 are ranked as:

- **Primary Interaction** (✓): Project activity is expected to interact with the VC / KI which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- **Other Interaction** (✓): Project activity is expected to interact with the VC / KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- **No Interaction:** Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

Table 9.4-5: Potential Project Interactions for Raptors, Migratory Breeding Birds, and Bird Species at Risk

Project Phase/Activity	Raptors		Migratory Breeding Birds			Bird Species at Risk				
	Bald Eagle	Osprey	Waterbirds and Waterfowl	Upland Game Birds	Migratory Songbirds	Common Nighthawk	Olive-sided Flycatcher	Short-eared Owl	Yellow Rail	Rusty Blackbird
Construction Activities										
Development of access roads and air strip	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Site preparation an earthworks; clearing, leveling and grading of the Project Area	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Power generation - generators	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Installation of main substation and distribution of power around site	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Wellfield and freeze hole drilling; ground freezing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Batch plant operation (concrete); crusher at borrow area	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Project Phase/Activity	Raptors		Migratory Breeding Birds			Bird Species at Risk				
	Bald Eagle	Osprey	Waterbirds and Waterfowl	Upland Game Birds	Migratory Songbirds	Common Nighthawk	Olive-sided Flycatcher	Short-eared Owl	Yellow Rail	Rusty Blackbird
Development of surface infrastructure (camp, operations centre, plants, ponds, pads and support facilities)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	✓		✓							✓
Water management (including treatment and site runoff)	✓	✓	✓						✓	✓
Groundwater supply										
Surface water withdrawal	✓	✓	✓						✓	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
On-site and off-site operation of vehicles and transport of materials	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Air transportation for workers	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Regulatory site inspection	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Engagement – site visit from Interested Parties	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
***Operation Activities*[1]**										
Operation of the ISR wellfield	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Wellfield and freeze wall drilling	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Operation and expansion of freeze wall										
Batch plant operation (grout and cement); crusher in borrow area	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Expansion of pond and pads	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Operation of the processing plant and production of uranium concentrate	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water withdrawal from groundwater or surface water body	✓	✓	✓						✓	✓
Management of surface water (including seepage and site runoff)	✓	✓	✓	✓	✓	✓	✓		✓	✓

Project Phase/Activity	Raptors		Migratory Breeding Birds			Bird Species at Risk				
	Bald Eagle	Osprey	Waterbirds and Waterfowl	Upland Game Birds	Migratory Songbirds	Common Nighthawk	Olive-sided Flycatcher	Short-eared Owl	Yellow Rail	Rusty Blackbird
Water treatment, both domestic and industrial	✓	✓	✓	✓	✓	✓	✓		✓	✓
Water release to surface water body	✓	✓	✓	✓	✓	✓	✓		✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	✓		✓							✓
Hazardous waste management (temporary storage, handling, and off-site transportation)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plan precipitates	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
On-site and off-site operation of vehicles and transport of materials	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Power supply – primarily power from the grid, also generators and back-up generators	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Package and transport of nuclear substances	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)				✓	✓		✓	✓	✓	✓
Air transportation for workers	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Progressive decommissioning and reclamation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Regulatory site inspections	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Engagement – site visit from Interested Parties	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Decommissioning Activities										
Site water management, treatment, and release	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mining horizon remediation and thawing of freeze wall				✓		✓		✓		
Process water treatment and release	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Project Phase/Activity	Raptors		Migratory Breeding Birds			Bird Species at Risk				
	Bald Eagle	Osprey	Waterbirds and Waterfowl	Upland Game Birds	Migratory Songbirds	Common Nighthawk	Olive-sided Flycatcher	Short-eared Owl	Yellow Rail	Rusty Blackbird
Closure of ISR and freeze wells and related infrastructure	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Decontamination of surface facilities and injection, recovery and monitoring wells	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Asset removal (including site power transmission lines and electrical infrastructure)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Demolition and disposal of non-salvageable surface infrastructure and materials	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Generators	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Waste management (composting and landfill operation)	✓		✓							✓
Decommissioning of landfills, hazardous waste management (temporary storage and off-site disposal	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
On-site and off-site operation of vehicles and transport of materials	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Reclamation of disturbed areas	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Regulatory site inspection	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Engagement – site visit from Interested Parties	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Post-Decommissioning Activities										
Environmental monitoring	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Regulatory site inspections	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Engagement - Site visit from interested parties	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

1 Operational activities include maintenance.

Not all activities are expected to interact with each of the three VCs, and the interaction is based on VC and KI specific habitat requirements and behaviour. The activities of ground freezing (after site clearing has been completed), groundwater supply and release, and operation of freeze wall were deemed to have no interaction and were not carried forward in the effects assessment as they are not expected to result in detectable changes in the MPs associated with the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs.

9.4.4.2 Potential Project-related Effects

Based on the timing and nature of the interactions identified in Table 9.4-5, the following adverse effects on the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs have the potential to occur during the lifetime of the Project:

- alteration and/or loss of habitat; and
- change in mortality.

The potential effects are described below for each Project phase as they may affect the VCs and associated KIs. Mitigation measures for each potential effect are described in Section 9.4.5.

In support of this EIS, an ERA was prepared with the objective to predict and assess the risk to representative human and ecological receptors resulting from exposure to radiological and non-radiological COPC expected to be released throughout all Project phases (Appendix 10-A in Section 10). The ERA used the expected sources of atmospheric and liquid releases to predict the transport of these constituents through the environment and resulting exposure and effects on ecological receptors (including representative avian species). Since the ERA assessed the effects of radiological and non-radiological emissions on representative avian species, these potential Project-related effects are not assessed in Section 9.4, and, where applicable, a reference is provided to the ERA.

9.4.4.2.1 Alteration and/or Loss of Habitat

Overview

In this assessment, alteration of habitat is defined as indirect habitat alteration where suitable habitat for the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs and their associated KIs remains physically intact but is rendered less suitable or unsuitable for their use. Sources of habitat alteration include Project-related habitat fragmentation (i.e., the breaking apart of continuous habitat into smaller, spatially distinct patches), edge effects (i.e., the influence of recently cleared areas on adjacent habitats), and sensory disturbance (e.g., the influence of noise, dust, treated effluent, artificial light, or human presence in adjacent habitats).

Habitat fragmentation occurs when continuous habitat is fragmented by natural processes (e.g., forest fires) or anthropogenic disturbances (e.g., vegetation clearing) into smaller, spatially distinct patches (Andrén 1994, Manuwal and Manuwal 2002, Crooks et al. 2017). Habitat fragmentation may affect avian species in a variety of ways, including changes in habitat connectivity (i.e., access to suitable habitat) or the creation of isolated patches of suitable habitat too small to support a species' life requisites (Villard et al. 1999, Vance et al. 2003). The subsequent potential displacement of individual birds into other, possibly less suitable areas could increase crowding and associated inter-and intra-specific competition for resources, such as breeding habitat and food (Hagan et al. 1996, Schmiegelow et al. 1997, Calizza et al. 2017). The resulting physiological stress could affect reproductive success and survival.

A minimum patch size is often required to fulfill all required life requisites (Robbins et al. 1989, Askins 1994, Vance et al. 2003, Butcher et al. 2010). When available suitable habitat is below a minimum patch size threshold, individual birds may get displaced despite the continued presence of suitable habitat. As a result, patch size at the individual and population level may have a species-specific effect on habitat use and could affect reproductive success, health, and survival (Askins 1994, Villard et al. 1999, Vance et al. 2003, Suorsa et al. 2004, Butcher et al. 2010).

Edge effects include the influence of recently cleared areas on adjacent intact habitats. Gradients of light intensity, temperature, wind, relative humidity, as well as snow accumulation and melt may occur along the border between cleared areas and intact habitats (Bannerman 1998, Kremsater and Bunnell 1999), which could alter habitat suitability for avian use. Bannerman (1998) suggested that the richness and density of generalist bird species may increase along forest edges based on the variety of vegetation and abundance of food (e.g., American Crow [*Corvus brachyrhynchos*] and Blue Jay [*Cyanocitta cristata*]). However, numbers of habitat specialist species (e.g., Red-breasted Nuthatch [*Sitta canadensis*] and Pileated Woodpecker [*Dryocopus pileatus*]) may decrease near edges because they use edge habitats less frequently or avoid them (George and Dobkin 2002). The potential influx of individuals into edge habitats, or the potential displacement of individuals into other areas, may increase crowding and subsequent inter-and intra-specific competition for breeding habitat, food, and other resources (Hagan et al. 1996, Schmiegelow et al. 1997, Bannerman 1998, George and Dobkin 2002, Calizza et al. 2017). The resulting physiological stress could affect reproductive success and survival.

Sensory disturbance includes the effects of noise, light, dust, and human presence on habitat suitability. Vegetation clearing, the construction and installation of Project components and infrastructure, and the transportation of equipment, materials, and personnel are expected to result in sensory disturbance. Avian species are typically most sensitive to sensory disturbance during the breeding season and at stopover sites during their migration (Sinnott 2000). Increased noise levels may interfere with the ability of individuals to establish or defend a territory, attract a mate, deliver distress calls, or detect prey sounds or approaching predators, which could ultimately affect reproductive success and survival (Warren et al. 2006, Gill 2007). Artificial light may attract migrating or foraging birds, which could alter movement patterns or habitat selection, or may deter individuals, resulting in reduced use or avoidance (Adams et al. 2019). Dust deposition or the release of treated effluent may alter the productivity of adjacent forests and wetlands by influencing photosynthesis, respiration, and transpiration, which could have implications for habitat suitability and feeding opportunities (Farmer 1993, Creuzer 2016). Visual stimuli (e.g., human presence) may interfere with incubation, nestling provisioning, feeding opportunities, or aggregation behaviour, which could negatively affect reproductive success and survival (Gill 2007). Sensory disturbance may also result in reduced use or avoidance of disturbed areas (Benítez-López et al. 2010). The potential displacement of individuals into other, possibly less suitable, areas could increase crowding and subsequent inter-and intra-specific competition for breeding habitat, food, and other resources (Hagan et al. 1996, Schmiegelow et al. 1997, Calizza et al. 2017). The resulting physiological stress could adversely affect reproductive success and survival.

Loss of habitat is defined as direct habitat loss where suitable habitat for the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs is physically disturbed to the extent that it is rendered functionally unsuitable for use. Sources of direct habitat loss include Project-related vegetation clearing and vegetation management, and the construction and installation of Project components and infrastructure. Loss of habitat is expected to be limited to the Project Area. Loss of habitat may affect Raptors, Migratory Breeding Birds, and Bird Species at Risk through the loss of feeding, breeding, or stopover habitats, or the loss of security or thermal cover. The potential displacement of individuals into other, possibly less suitable, areas could increase crowding and subsequent inter- and intra-specific competition for breeding habitat, food, and other resources (Hagan et al. 1996, Schmiegelow et al. 1997, Calizza et al. 2017). The resulting physiological stress could adversely affect reproductive success and survival.

Based on these considerations, Project-related alteration and/or loss of habitat may affect the distribution and/or abundance of the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs within the Terrestrial RSA.

Project Phases

Construction

Alteration and/or loss of habitat is expected to occur during all Project phases; however, most Project effects resulting in direct loss of habitat are expected to occur during Construction. Site preparation and construction during Construction will involve vegetation clearing and ground disturbance for all Project components including roads, airstrip, processing plant area, wellfield, waste pads and ponds, water treatment ponds, and support buildings, such as the camp and operations centre. Some of the areas to be cleared have already been disturbed and/or cleared from past exploration activities, which will reduce new disturbances.

The direct loss of habitat is anticipated to occur during Construction but will continue during the remaining Project phases and until Project activities decrease, Project components are removed, and disturbed habitat is revegetated and regenerates to provide suitable habitat for Raptors, Migratory Breeding Birds, and Bird Species at Risk. Vegetation clearing, soil movement, and surface water management may result in a loss of habitat or a reduction in habitat quality. Site clearing, soil salvaging, stockpiling, and grading will occur within the Project Area, resulting in the direct loss of vegetation, and potential avian habitat.

Alteration of habitat is expected to occur during Construction resulting from indirect disturbance through Project-related habitat fragmentation, edge effects, and sensory disturbance. The alteration of habitat is anticipated to begin during Construction and continue through to Post-Decommissioning; however, the alteration of habitat due to sensory disturbances is expected to decrease after Operation when Project-related activities decrease.

The activities expected to have the highest potential for alteration and/or loss of habitat during Construction are related to the development of access roads and air strip; clearing, leveling, and grading of the site; wellfield and freeze hole drilling; batch plant operation; development of surface infrastructure; waste management; water management; power generation; fuel management; operation of vehicles; transportation of materials; and air transportation for workers.

Operation

Direct habitat loss is expected to be limited during Operation; however, the alteration of habitat through sensory disturbances (e.g., vehicle traffic, aircraft traffic, dust deposition, maintaining and operating site facilities, and human presence), edge effects, fragmentation, and patch size changes are expected to continue through Operation. The potential for dust generation and deposition is expected to be highest during Operation. Fugitive dust from access roads, the airstrip and the clean waste rock pile have the potential to affect avian habitat.

Additional Project activities that may result in sensory disturbance on Raptors, Migratory Breeding Birds and Bird Species at Risk include vegetation management along Project components and infrastructure, such as access and site roads, the airstrip, pads and ponds, the processing plant, and all supporting components. The potential for dust generation and deposition is expected to be highest during Operation. Fugitive dust from access roads, the airstrip, and the clean waste rock pile have the potential to affect avian habitat.

Vegetation management may occur along Project components and infrastructure (e.g., site and access roads, power transmission line, camp, and airstrip), which may limit the progression of natural succession and could alter habitat suitability for Raptors, Migratory Breeding Birds, and Bird Species at Risk. However, progressive reclamation is expected to be positive as revegetation is initiated in reclaimed areas.

The Project activities expected to have the highest potential for alteration and/or loss of habitat during Operation are related to operation of the ISR wellfield, wellfield and freeze wall drilling, expansion of ponds and pads, operation of the ISR processing plant and production of uranium concentrate, water treatment, waste, hazardous, and contaminated waste management, nuclear substance management, storage and disposal of process waste rock and radioactive plant precipitates, operation of vehicles and transportation of materials, power supply, fuel management, and air transportation for workers.

During Operation, progressive reclamation will be completed where possible and is expected to be positive as revegetation is initiated in disturbed areas being reclaimed.

Decommissioning

Direct loss of wildlife habitat is not expected during Decommissioning; however, the alteration of habitat through Project-related habitat fragmentation, edge effects, and sensory disturbance is expected to continue during this phase. Project activities that may result in sensory disturbance on Raptors, Migratory Breeding Birds, and Bird Species at Risk include dismantling and removal of Project components and infrastructure. All permanent structures that cannot be removed from the property as an asset will require demolition. Most process equipment and non-supporting structures will be removed from buildings prior to demolition and the buildings will be demolished and disposed of appropriately. Dust production from demolition activities and associated vehicle traffic is anticipated. Progressive reclamation of the Project Area is expected to continue and result in positive effects as revegetation would occur in reclaimed areas, and, following Decommissioning, the area is expected to recover to a safe, stable, and self-sustaining condition.

Project activities expected to have the highest potential for alteration and/or loss of habitat during Decommissioning are related to remediation and closure of Project components and infrastructure, process and site water treatment and release, salvageable asset removal, demolition and disposal of infrastructure and materials, remediation of contaminated areas, power generation, waste and hazardous management, operation of vehicles, and transport of materials.

While the construction of the Project will result in loss of avian habitat in the Project Area and alteration of habitat in the Wildlife LSA, following decommissioning and reclamation, habitat is expected to recover to baseline conditions. All disturbed areas will be reclaimed during this phase, which is expected to result in positive effects on wildlife habitat.

Post-Decommissioning

The overall effect of habitat alteration and/or loss during Post-Decommissioning is expected to be minimal as regeneration of vegetation is expected to continue within reclaimed areas. While no direct loss of habitat is expected to occur during this phase, minimal sensory disturbances may occur from monitoring and inspection activities (e.g., vehicle traffic, dust deposition, or human presence). Alteration of habitat through Project-related habitat fragmentation and edge effects is expected to continue; however, fragmentation and edge effects are expected to decrease over time as vegetation regeneration and tree growth create a gradual structural transition throughout disturbed areas and along forest edges. Alteration of habitat through Project-related sensory disturbance is also expected to continue; however, Project activities are expected to be limited, resulting in isolated sensory disturbance on Raptors, Migratory Breeding Birds, and Bird Species at Risk during occasional vehicle traffic required for maintenance and monitoring activities.

Valued Components and Key Indicators

Raptors

Bald Eagle and Osprey are sensitive to human activities during their nesting season (Smith et al. 2019). Indirect effects of habitat alteration (e.g., through noise disturbance, dust deposition, treated effluent release, artificial light, and human presence) may result in raptors abandoning historic nest sites in proximity to the Project and moving to other locations further away from the Project Area. This displacement may last for the duration of the Project and raptors may re-establish historic nest sites once most Project activities cease (i.e., during and after Post-Decommissioning).

Direct habitat loss could affect these raptors through vegetation clearing primarily during Construction, if mature trees, potential nesting sites, are removed. Reclamation of disturbed areas and regeneration of vegetation during and following Decommissioning are expected to recover the Project Area to a safe, stable, and self-sustaining landscape and return potential raptor nesting habitat.

Migratory Breeding Birds

Waterbirds and waterfowl, upland game birds, and migratory songbirds are sensitive to human activity in and near their nesting and staging habitats (Singer et al. 2020).

Indirect effects of habitat alteration (e.g., through noise disturbance, dust deposition, treated effluent release, artificial light, and human presence) may result in migratory breeding birds abandoning affected habitats in proximity to the Project and moving to other habitats away from the Project Area. This displacement may last for the duration of the Project and migratory breeding birds may reoccupy habitats in and around the Project Area once most Project activities cease and regeneration of vegetation on reclaimed areas occurs (i.e., during and after Post-Decommissioning).

Direct habitat loss could affect migratory breeding birds through vegetation clearing and ground disturbance primarily during Construction. Revegetation and regeneration of reclaimed areas during and following Decommissioning is expected to recover the Project Area to a safe, stable, and self-sustaining landscape and return avian habitat.

Bird Species at Risk

Common Nighthawk, Short-eared Owl, Yellow Rail, Rusty Blackbird, and Olive-sided Flycatcher are sensitive to human activity in and near their nesting habitats (Environment Canada 2004).

Indirect effects of habitat alteration (e.g., through noise disturbance, dust deposition, treated effluent release, artificial light, and human presence) may result in bird species at risk abandoning affected habitats in proximity to the Project and moving to other habitats away from the Project Area. This displacement may last for the duration of the Project and bird species at risk may reoccupy habitats in and around the Project Area once most Project activities cease and regeneration of vegetation in reclaimed areas occurs (i.e., during and after Post-Decommissioning).

Direct habitat loss could affect bird species at risk through vegetation clearing and ground disturbance primarily during Construction. Revegetation of reclaimed areas during and following Decommissioning is expected to recover the Project Area to a safe, stable, and self-sustaining landscape and return avian habitat.

9.4.4.2.2 Change in Mortality

Overview

In this assessment, a change in mortality is defined as a change in the abundance of a Raptors, Migratory Breeding Birds, and Bird Species at Risk VC due to direct and/or indirect sources of mortality. Direct sources of mortality include incidental take (i.e., inadvertent destruction of birds and/or their nests and eggs); entrapment in Project components (e.g., buildings, pipes, vents, or other enclosed spaces); collisions with Project-related vehicles, aircraft, equipment, and Project components (e.g., buildings, windows); and collisions and/or electrocution associated with the Project power transmission line, energized equipment, and associated infrastructure (such as power poles). Indirect sources of mortality include nest failure or abandonment; disorientation of nocturnal migrating birds by artificial light; changes in predator-prey dynamics; exposure to trace metals and radionuclides in dust and/or the release of treated effluent; exposure to other hazardous materials (e.g., through spills); and contamination of avian habitat and food sources.

Incidental take is the inadvertent destruction of migratory birds and/or their nests and eggs during anthropogenic activities (Williams 2010, Canadian Wildlife Service and Environment Canada 2014). When vegetation clearing occurs during the nesting season, the risk of incidental take increases, especially if large areas of land are affected. In addition to direct mortality, Project-related sensory disturbance resulting from site clearing, the construction and installation of Project components and infrastructure, and the transportation of equipment, materials, and personnel may disrupt nesting activities in adjacent habitats, which could subsequently lead to nest failure or abandonment (Carney and Sydeman 1999, Beale and Monaghan 2004, Price 2008, Strasser and Heath 2013).

Collisions with Project-related vehicles, aircraft, mobile equipment, and components (e.g., buildings, windows) may result in direct mortality of individuals of the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs (Loss et al. 2012, 2014, 2015, Calvert et al. 2013, Machtans et al. 2013, Cabrera-Cruz et al. 2018). These types of collisions are expected to be more likely in areas of high bird density (e.g., near feeding, breeding, or staging / stopover habitats), during the nesting season, and/or during spring and fall migration (Erickson et al. 2005, Bishop and Brogan 2013). Collisions with aircraft during take-off or landing may result in direct mortality, particularly if the runway or airstrip is located near areas of suitable bird habitat (Nilsson et al. 2021, Transport Canada 2019, Bird Strike Association of Canada 2021).

Collisions with vehicles may also occur when avian scavengers (e.g., raptors) are attracted to animal carcasses along Project roads or the airstrip. Artificial light may attract and disorient nocturnal migrating birds within illuminated areas, which could lead to exhaustion and eventual collision with the ground or Project components, resulting in indirect avian mortality (Arnold and Zink 2011, Longcore et al. 2012, Machtans et al. 2013, Adams et al. 2019). Entrapment of avian species in Project components (e.g., buildings, pipes, vents, other enclosed spaces) may lead to exhaustion as the birds try to escape, and could result in dehydration, starvation, and eventual death (Loss et al. 2015, Vancouver Bird Advisory Committee 2015, University of British Columbia 2019). The increased use of Project-related access roads may facilitate increased public access, which could alter predator-prey dynamics in the Project Area and increase hunting (e.g., of waterbirds and waterfowl and upland game birds) within the Wildlife LSA and Terrestrial RSA and indirectly influence avian mortality (Francis et al. 2009, Rodewald et al. 2011, Hethcoat and Chalfoun 2015).

Mortality could result from collisions and/or electrocutions associated with the Project power transmission line/energized equipment and associated infrastructure (such as power poles). In Canada, annual avian mortality due to electrocution is not consistently recorded (Rioux et al. 2013). It is estimated that the effects are greater on large-bodied species, such as raptors and some waterbird and waterfowl species, than on smaller species. The construction of transmission lines and their maintenance are also recorded to affect nests (Rioux et al. 2013). However, Rioux et al. (2013) suggest that avian mortality related to the construction and maintenance of transmission and distribution power lines is likely too small to affect any species at the population level.

Release of Project-related treated effluent or the deposition of contaminated dust (e.g., with trace metal and radionuclides) from traffic and uranium stockpiling and transportation processes may result in contamination of individual birds, avian habitats and food sources, which could indirectly affect mortality. This risk is assessed in the ERA (Appendix 10-A in Section 10).

Limited potential exists for spills of fuels and other hazardous materials, which may affect individual birds, avian habitats, and food sources (Erickson et al. 2005); however, this is expected to be a minor contributor to the effect (i.e., an expected interaction, but not a primary interaction, see Section 9.4.4.1). The risks for possible major accidents and malfunctions are addressed in Section 14.

Based on these considerations, a Project-related change in mortality through direct and/or indirect sources may affect the abundance of the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs within the Terrestrial RSA.

Project Phases

Construction

The effect of a change in mortality through direct and/or indirect effects is expected to begin during Construction when activities begin and continue through to Post-Decommissioning. In particular, Project-related site clearing (i.e., the removal of vegetation) may result in a change in mortality of Raptors, Migratory Breeding Birds and Bird Species at Risk through incidental take. The activities expected to have the highest potential for a change in mortality during Construction are related to the development of access roads and the air strip; clearing, leveling and grading of the site; wellfield and freeze hole drilling; batch plant operation; development of surface infrastructure; waste management; water management; power transmission line construction and power generation; fuel management; operation of vehicles; transport of materials; and air transportation for workers.

Operation

A change in mortality through direct and indirect effects is expected to continue during Operation. Project-related site clearing is expected to be limited; however, vegetation management may occur along the access and site roads, the power transmission line, the airstrip, and other Project components, which may result in direct mortality via incidental take. Sensory disturbance caused by vegetation management and additional Project activities may disrupt nesting activities in adjacent habitats, which could lead to nest failure or abandonment.

Sources of direct Project-related mortality of Raptors, Migratory Breeding Birds, and Bird Species at Risk during Operation include possible entrapment in Project components (e.g., buildings, pipes, vents, or other enclosed spaces), collisions with vehicles, aircraft, mobile equipment, and Project components (e.g., buildings, windows), and collisions and/or electrocutions associated with the power transmission line, energized equipment, and associated electric infrastructure (such as power poles).

Exposure to hazardous materials (e.g., through contact with contaminated waste ponds, release of treated effluent, trace metal and radionuclide depositions) could affect avian health and contribute to mortality (Appendix 10-A in Section 10). Spills or leaks of fuels and other hazardous materials may affect individual birds, avian habitats and food sources; however, this is expected to be a minor contributor to the effect. The risks for possible major accidents and malfunctions are addressed in Section 14.

The activities expected to have the highest potential for change in direct and/or indirect mortality during Operation are related to operation of the ISR wellfield, wellfield and freeze wall drilling, expansion of pond and pads, operation of the ISR processing plant and production of uranium concentrate, water treatment, waste, hazardous, and contaminated waste management, nuclear substance management, storage and disposal of process waste rock and radioactive plant precipitates, operation of vehicles and transport of materials, power supply, fuel management, and air transportation for workers.

Decommissioning

Changes in direct and/or indirect mortality are expected to continue during Decommissioning as Project activities cease and Project components are removed or demolished. While vegetation clearing activities (and the associated potential for incidental take) are not anticipated, collisions with Project vehicles, aircraft, mobile equipment, and Project components may result in direct morality of Raptors, Migratory Breeding Birds, and Bird Species at Risk. Dust production and deposition (including trace metals and radionuclides) during Decommissioning may result in contamination of avian habitat and indirectly affect a change in mortality (Appendix 10-A in Section 10). Spills of fuels and other hazardous materials may contribute to the effect on avian VCs, however, the risks for possible major accidents and malfunctions are addressed in Section 14**.** Sensory disturbance of Raptors, Migratory Breeding Birds, and Bird Species at Risk could result from dismantling and removal of Project components and infrastructure, equipment and materials; reclamation and closure of all infrastructure (such as roads, airstrip, and power transmission line infrastructure).

Project activities expected to have the highest potential for a change in direct and/or indirect mortality during Decommissioning are related to remediation and closure of project components and infrastructure, process and site water treatment and release, salvageable asset removal, demolition and disposal of infrastructure and materials, remediation of contaminated areas, power generation, waste and hazardous management, operation of vehicles, and transportation of materials. All disturbed areas will be reclaimed during this phase, which is expected to result in positive effects on avian habitat.

Post-Decommissioning

The effect of change in mortality during Post-Decommissioning is expected to be minimal as habitat regeneration is expected to continue within reclaimed areas. Change in mortality through direct and indirect effects is expected to continue; however, Project activities on site are expected to be limited, resulting in isolated sensory disturbance or collision risk to avian species during occasional vehicle traffic and maintenance and monitoring activities. The risk of Project-related spills or leaks occurring is expected to be limited. All Project components will have been removed, resulting in a reduced risk of vehicle collisions with wildlife, exposure to trace metals and radionuclides, hazardous materials (e.g., spills), and risk of entrapment.

Valued Components and Key Indicators

Raptors

Raptors (i.e., Bald Eagle and Osprey) may experience Project-related changes in mortality through direct and/or indirect sources. Direct raptor mortality sources include incidental take (i.e., inadvertent destruction of birds and/or their nests and eggs); collisions with Project-related vehicles, aircraft, and mobile equipment; and collisions and/or electrocution associated with the Project power transmission line, energized equipment, and associated electric infrastructure (such as power poles). Raptors may also be attracted to carcasses on access and site roads or at other Project components, which may increase their mortality risk through collisions with Project vehicles and equipment. Indirect sources of mortality include nest failure or abandonment due to sensory disturbance. The effects of direct and indirect mortality are expected to continue from Construction to Post-Decommissioning when most Project activities cease, Project components are decommissioned, and habitat regeneration within reclaimed areas continues to return the Project Area to baseline conditions.

Migratory Breeding Birds

Waterbirds and waterfowl, upland game birds, and migratory songbirds may experience Project-related changes in mortality through direct and/or indirect sources. Direct migratory breeding bird mortality sources include incidental take (i.e., inadvertent destruction of birds and/or their nests and eggs); entrapment in Project components (e.g., buildings, pipes, vents, or other enclosed spaces); collisions with Project-related vehicles, aircraft, and mobile equipment, and Project components (e.g., buildings, windows); and collisions and/or electrocution associated with the Project power transmission line/energized equipment and associated electric infrastructure (such as power poles).

Indirect sources of mortality include nest failure or abandonment due to sensory disturbance; disorientation of nocturnal migrating birds by artificial light; and changes in predator-prey dynamics.

The effects of direct and indirect mortality are expected to continue from Construction to the Post-Decommissioning when most Project activities cease, Project components are decommissioned, and habitat regeneration within reclaimed areas continues to return the Project Area to baseline conditions.

Bird Species at Risk

Common Nighthawk, Short-eared Owl, Yellow Rail, Rusty Blackbird, and Olive-sided Flycatcher may experience Project-related changes in mortality through direct and/or indirect sources. Direct migratory breeding bird mortality sources include incidental take (i.e., inadvertent destruction of birds and/or their nests and eggs); entrapment in Project components (e.g., buildings, pipes, vents, or other enclosed spaces); collisions with Project-related vehicles, aircraft, and mobile equipment, and Project components (e.g., buildings, windows); and collisions and/or electrocution associated with the Project power transmission line, energized equipment, and associated electric infrastructure (such as power poles).

Indirect sources of mortality include nest failure or abandonment due to sensory disturbance; disorientation of nocturnal migrating birds by artificial light; changes in predator-prey dynamics.

The effects of direct and indirect mortality are expected to continue from Construction to Post-Decommissioning when most Project activities cease, Project components are decommissioned, and habitat regeneration within reclaimed areas continues to return the Project Area to baseline conditions.

9.4.5 Mitigation Measures

Mitigation in this EIS is defined as the elimination, reduction, or control of potential adverse effects of the Project on the environment throughout all Project phases. Project-specific mitigation measures include: Project design; implementation of BMPs; development of management plans; implementation of emergency response programs; and provision of training, education and awareness (Denison 2020).

In addition to implementing mitigation measures, the ISR mining process is acknowledged for minimal adverse environmental effects as it is associated with low noise levels, minimal dust and air emissions, low water consumption levels, minimal treated effluent discharge volumes, and minimal waste rock generation (Denison 2020). The following subsections summarize mitigation measures that will be implemented to avoid or minimize adverse effects on the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs.

9.4.5.1 Project Design Measures

Potential adverse effects on Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs will be avoided or minimized to the extent practical through Project design:

- The Project Area (i.e., the area of maximum physical disturbance) has been reduced to the extent practicable resulting in reduced habitat disturbance and noise propagation.
- Much of the proposed footprint will be developed within previously disturbed areas, including roads currently used for exploration activities, thereby minimizing additional habitat disturbance.
- The powerline to the main substation at the site is relatively short (i.e., approximately 7 km) and will be constructed from the existing provincial power line adjacent to Highway 914.
- During Operation, progressive reclamation activities will be completed where possible, and the progress and success of these activities will be assessed annually.
- Cleared brush will be stockpiled when possible, to be used in progressive reclamation.
- Ongoing decommissioning of Project components will be completed when possible.

- Dust deposition on vegetation and waterbodies (including potential deposition of trace metals and radionuclides) will be reduced by:
  - directing processing plant exhaust from drying and packaging areas through a stack prior to release outside of the building;
  - designing the stack height based on results of air dispersion modelling to be an appropriate height for optimal dispersion;
  - controlling access to the property with both a north and south security gate (the north gate is on a decommissioned road and the south gate is manned);
  - making a wash bay available to clean items, equipment and vehicles that may have been in contact with potentially contaminated materials. Contaminated water from the wash bay will be collected in a sump tank and routed to the water treatment plant for treatment and discharge;
  - conducting radiological clearance scanning as required for any items, equipment, and vehicles leaving the Project Area; and.
  - watering and traffic controls on roads.
- Battery-powered light vehicles and mobile equipment, and an AC powered dual rotary drill for ISR wellfield development instead of a traditional diesel-powered unit, will be employed, where practical, to reduce air emissions and noise levels and improve energy efficiency.
- The main sources of noise will be related to transport of people and goods, drilling of holes for the freeze wall and wellfield, operation of the batch plant, operation of the processing plant, and operation of the pumphouses. The use of high-quality, low sound emission equipment and regular maintenance will reduce noise associated with Project activities.
- Bulk storage tanks for processing chemicals such as sulphuric and/or hydrochloric acid, sodium hydroxide, and hydrogen peroxide will sit inside appropriately designed and sized secondary containment basins, physically separated from the containment basins for other chemical systems.
- Surface pipelines will be designed to have secondary containment or catchment and have leak detection systems in place at key locations.
- A freeze wall will be established around the uranium deposit to reduce groundwater disturbance.
- Mining solution and process water will be reused throughout the mining process, reducing water use requirements to the extent feasible and reducing the volume of treated effluent requiring discharge. Make-up water will be preferentially sourced from site runoff where possible.
- Double-walled HDPE or equivalent piping will be used in the wellfields and will be freeze protected and secured to minimize pipe movement.

- Contaminated wastes (e.g., mineralized drill cuttings, solid impurities removed from mining solution, dewatered reject solids) will be properly contained on a double lined waste pad with leak detection capabilities and an associated monitoring program. An adjacent pond will be used to collect runoff from the pad and water in the waste pond will be piped to the water treatment plant. Such waste will be disposed of either on site or off site at an approved facility.
- The ISR wellfield and processing plant will be designed to re-use most of the solutions inside each circuit; any excess water will be released to a surface water body once acceptable water quality is achieved. All treated effluent released to surface water will meet federal and provincial regulatory discharge limits.
- All contaminated areas, such as waste ponds and pads, and the domestic landfill will be fenced to avoid contact with workers and wildlife. Fences will be monitored and maintained.

As not all effects on Raptors, Migratory Breeding Birds, and Bird Species at Risk can be addressed through Project design, additional avian-specific mitigation measures will be implemented, as described in the following sections.

9.4.5.2 Additional Avian Species-specific Mitigation Measures

Additional mitigation measures specific to the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs, in accordance with the *Migratory Birds Convention Act,* and tailored to Project features will be incorporated into various Project management and monitoring plans such as the, erosion and sediment controls, soil and vegetation monitoring, wildlife monitoring, the Decommissioning Plan, air quality monitoring, Spill Response Plan, Radiation Protection Plan, surface water and effluent monitoring, and Waste Management Plan.

The management plans within the EMS will address specific mitigation measures based on proven and accepted mitigation measures following standard industry guidelines and BMPs. The EMS will provide guidance to avoid or minimize potential adverse effects of the Project on avian species and their habitat, including monitoring and follow-up programs, as appropriate. It will be in place during all phases of the Project and will be subject to ongoing review and revision as required. If monitoring identifies a need for additional or revised mitigation measures, a process of adaptive management (as described in the plan) will be triggered. The Project management plans provide direction on monitoring and adaptive management so that responses are timely and effective.

Mitigation measures specific to the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs, summarized in the following paragraphs, are applicable during all Project phases and expected to be effective immediately following implementation.

9.4.5.2.1 Work Timing Windows and Habitat Disturbance

- Site clearing and other works that involve disturbance of vegetation and/or soil will be conducted outside of the nesting season, whenever practicable. The nesting season for the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs in Saskatchewan spans a period from March 15 to August 31; however, the dates differ for certain species. The nesting season for raptors is generally longer (SK MOE 2017). The management plans within the EMS will provide details on nesting windows for avian species occurring in the Terrestrial RSA based on the Saskatchewan Activity Restriction Guidelines for Sensitive Species (SARGSS), which were established to support the avoidance of sensitive species' habitats during sensitive periods (SK MOE 2017).

- Prior to commencing any site clearing (i.e., vegetation clearing and/or soil disturbance) during the nesting season, pre-clearing nest surveys will be conducted at that location within the Project Area.
- Active nests and suspected nest locations will be protected with a no-disturbance setback buffer consistent with regulatory guidelines (e.g., the 2017 SARGSS [SK MOE 2017]) in accordance with the level of the disturbance and species until the young have successfully fledged, the nest is confirmed as no longer active (e.g., abandoned or depredated), or the nesting window has passed (for suspected nest locations). If guidelines cannot be met, due to safety or operational concerns, SK MOE will be contacted for advice on the appropriate response to the situation.

9.4.5.2.2 Avian Education

- Employees and contractors will be provided with wildlife education and awareness training, including education about potential avian issues on site and training on the mitigation measures to avoid or minimize potential adverse Project effects on avian species and their habitat.
- Employees and contractors will be educated on waste management policies that limit human-avian interactions.
- Designated employees will be trained in appropriate avian deterrent techniques to minimize avian interactions with the Project.
- Employees and contractors will be requested to report avian observations on site, injured or dead birds (which will be reported to SK MOE). Avian encounters and outcomes will be monitored, and logbooks will be used to record observations. Logbooks and reports will be available to employees.

9.4.5.2.3 Avian Species and Habitat Protection

- Personal firearms will be prohibited for employees and contractors within the Project Area to prevent hunting activities.
- If any individual were seeking access around the Project area to undertake Aboriginal and/or Treaty Rights, Denison staff would facilitate this, provided it were safe to do so given activities in the area.

- Policies will be implemented prohibiting employees and contractors from feeding, approaching, or harassing avian species within the Project Area.
- To support avian habitat regeneration, progressive reclamation and ecosystem-based revegetation will be conducted on disturbed areas as soon as practicable in accordance with the Reclamation and Closure Plan.

9.4.5.2.4 Avian Deterrence and Prevention of Entrapment

- Deflectors will be used on Project power transmission lines leading to the Project components, if appropriate. Measures will be taken to discourage birds, particularly raptors, from nesting on utility poles.
- Buildings and other Project infrastructure will be designed and maintained to exclude birds (e.g., Barn Swallows) and bats as much as possible. This may include installing solid barriers (e.g., corner slope panels or wooden panels) or flexible barriers (e.g., netting, tarps, or geotextiles) under roof eaves or other exterior surfaces. Physical, visual, and/or auditory deterrents will be used to discourage avian use of buildings and other Project infrastructure for refuge, shelter, or nesting, and to deter birds from potentially becoming entrapped.
- Physical, visual, and/or auditory deterrents and exclusion measures will be employed around hazardous materials to discourage avian use as required.

9.4.5.2.5 Sensory Disturbance

- Noise emitting Project activities will be managed to minimize sensory disturbance of avian species, especially during sensitive time periods (i.e., nesting).
- Low sound emission equipment, regular maintenance of equipment, and the use of silencers or mufflers (whenever practical) will be used to reduce noise associated with Project activities, to the extent practical.
- To minimize sensory disturbance on the avian VCs, directed lighting, light shielding, low lighting, and/or task lighting (e.g., downturned shaded fixtures to prevent sky-lighting or bird disorientation), rather than broad lighting, will be implemented, and lighting will be focused on work sites and not surrounding areas. In addition, building lighting will be put on sensors or timers, and a higher lumen/watt ratio may be used on all new buildings or building expansions.
- Dust generation and subsequent deposition on vegetation and in waterbodies (including potential deposition of trace metals and radionuclides) will be limited through dust suppression techniques such as road watering and traffic management.

9.4.5.2.6 Road and Traffic Management

- Vegetation management, such as mowing and brush cutting, will be implemented along Project roads to reduce site attractiveness for avian species.
- Traffic and access control measures will be implemented will include reducing traffic volume by scheduling truck convoys, using high-volume haul trucks, and restricting public access to the

Project site and roads (e.g., private vehicles, snowmobiles, all-terrain vehicles, and foot traffic). It is important to note that if any individual were seeking access around the Project area to undertake Aboriginal and / or Treaty Rights, Denison staff would facilitate this, provided it were safe to do so given activities in the area.

- Appropriate road signage will be installed (e.g., speed limits) along Project roads to raise awareness and minimize the potential for wildlife-vehicle collisions.
- Speed limits will be implemented for a variety of reasons, including to reduce the potential for avian-vehicle collisions.
- Employees and contractors will report and communicate the location and circumstances of any roadkill observed on or alongside Project roads. Large-bodied wildlife carcasses found will be reported to SK MOE and disposed of as directed to discourage avian scavengers.
- Ditches and culverts along Project roads will be designed and maintained to minimize pooling of water. Roadside pools that form may attract avian species.

9.4.5.2.7 Waste and Hazardous Materials Management

- A "no littering policy" for employees and contractors will be implemented within the Project Area.
- Vegetation management will be incorporated in the vicinity of waste ponds to discourage avian use of potentially affected vegetation.
- In accordance with a Waste Management Plan, waste will be collected and temporarily stored in wildlife-proof containers to avoid attracting avian scavengers.
- The wildlife-proof containers will be inspected regularly for evidence of avian presence (e.g., gull species) or access to waste disposal facilities. If evidence of avian presence or access to waste disposal facilities is detected, modified systems will be implemented and/or off-site waste disposal frequencies will be increased.
- Hazardous materials will be handled, stored, and disposed of appropriately and in accordance with a Waste Management Plan to avoid attracting avian scavengers (e.g., wildlife-proof containers).
- Appropriate hazardous materials management practices will be implemented in accordance with industry guidelines and a Waste Management Plan to minimize the risk of accidental spills or leakage.
- Appropriate spill response kits will be positioned adjacent to areas where hazardous materials are stored in accordance with the Spill Response Plan.
- A minimum 100 m distance from any waterbody will be maintained for fuel storage, refueling activities, or equipment servicing in accordance with the Spill Response Plan.

- Appropriate fuel, chemical, and materials management practices will be followed in accordance with the Spill Response Plan to minimize the risk of accidental spills or leakage of diesel fuel, other hydrocarbons, and other hazardous materials.
- Air emissions will be reduced to the extent practical through implementation of an air quality monitoring plan within the EMS.
- All vehicles and equipment will be equipped with industry-standard emission control systems; unnecessary idling of vehicles will be prohibited.
- Vehicles and equipment will be maintained in good working condition (e.g., no leaks) and furnished with industry-standard spill response kits.
- Mitigation measures to reduce the potential for dispersion of radiological contaminants of potential concern to vegetation will be implemented in accordance with the Radiation Protection Plan.
- Education on and enforcement of proper waste and hazardous materials management practices will be provided to employees and contractors.

9.4.5.2.8 Sediment and Erosion Control

Erosion control measures that are designed to prevent sediment from entering waters frequented by avian species at risk include (but are not limited to):

- the installation of silt fence, straw wattles, and/or erosion control blankets to prevent erosion and limit sediment transport; and
- the maintenance of vegetated barriers between Project components and wetland features, as much as practical.
- Information on erosion and sediment control measures will be provided in applicable management plans, which will be developed to support Project permitting and licensing.
- Routine inspections and management will be completed to document the effectiveness of erosion control measures, and any required /replacement of these structures will be completed as required.

9.4.6 Residual Effects Evaluation

This section describes the likely residual effects of the Project on the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs. Residual effects are effects that remain after the implementation of mitigation measures and management strategies and are the expected consequences of the Project.

The approach to assessing residual Project effects on the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs follows the methodology outlined in Section 5.8 in Section 5. For each VC and associated KI, each residual effect is assessed in the context of the Project activities that will occur within each Project phase. Each residual effect is then characterized based on the combined predicted residual effect for all phases.

For the residual effects evaluation for the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs, Omnia's (2020; see Appendix 9-B) original interpreted ecosite mapping product (referred to in Section 9.4.3) was updated to reflect provincial ecosite classifications used in Section 9.2 of this EIS. These updates relate to the novel regenerating forest types, as explained in the following paragraphs.

Novel regenerating forest types characterized within the original interpreted ecosite mapping product by Omnia (2020; see Appendix 9-B) included three upland types and two wetland types. The three novel upland regenerating coniferous forest types (RF1-C, RF2-C, RF3-C) were exclusively referred to as regenerating forest types RF1, RF2, and RF3 in the Terrestrial Baseline Report (Appendix 9-B). They describe structural categories along a natural successional trajectory from a low shrub stage characteristic of recent fire disturbance (RF3) toward a young forest stage (RF1; Appendix 9-B). The two novel regenerating bog types (RF2-B and RF3-B) were introduced but not used in the baseline report (Appendix 9-B).

As described in detail in the Terrestrial Baseline Report (EDI 2021 in Appendix 9-C), vegetation plots within all three novel upland regenerating forest types indicate a dominance of jack pine within the tallest vegetation layer (sometimes co-dominant with black spruce), with blueberry and reindeer lichen dominating the low shrub layer and ground cover, respectively. Vegetation community observations for the three novel upland regenerating forest types are consistent with the provincial ecosite classifications of BS3 (jack pine - blueberry / lichen) and BS7 (black spruce - blueberry / lichen). For consistency, these provincial ecosite classifications are used instead of RF1, RF2, and RF3 when describing habitat types in the following sections.

9.4.6.1 Definitions for Residual Effects Characterization and Significance

9.4.6.1.1 Residual Effects Characterization

General definitions of the residual effects characteristics are provided in Table 5.8-1 in Section 5. Residual effects characteristics pertaining to the two residual effects specific to the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs are defined in Table 9.4-6.

Table 9.4-6: Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs– Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Negative effect or effect is not desirable. **Positive** – Beneficial effect or effect is desirable.
Magnitude	The amount of change in a measurable parameter	**Low**

Residual Effect Characteristic	Definition	Rating
	relative to baseline conditions.	Alteration and/or Loss of Habitat effect occurs that might be detectable but is expected to be within the range of baseline values, or within the range of natural variability (0 to 5%). Change in Mortality effects occur that might be detectable but are expected to be within the range of baseline values, or within the range of natural variability. **Moderate** Alteration and/or Loss of Habitat effect is expected to be at or to slightly exceed the limits of baseline values (by greater than 5 to 15%); it is clearly an effect and may become a management concern. Change in Mortality effects are expected to be at or to slightly exceed the limits of baseline values; it is clearly an effect and may become a management concern. **High** Alteration and/or Loss of Habitat effect is expected to exceed the limits of baseline values (by greater than 15%). It can pose a serious risk and represents a management concern. Change in Mortality effects are expected to exceed the limits of baseline values. It can pose a serious risk and represents a management concern.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the Wildlife LSA. **Regional** – Effect extends beyond the Wildlife LSA into the Terrestrial RSA. **Beyond Regional** – Effect extends beyond Terrestrial RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions. **Partially Reversible** – A residual effect that partially diminishes to baseline conditions. **Irreversible** – A residual effect that will not diminish to baseline conditions.
Context	The extent to which the VC or KI has been affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its ability to recover from that effect (i.e., resilience)	**Low** – VC/KI has high resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or a lack of historic and ongoing anthropogenic or natural disturbance. No species at risk present. **Moderate** – VC/KI has moderate resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or an intermediate level of historic or ongoing anthropogenic or natural disturbance with the capacity to assimilate more change. Presence of species at risk. **High** – VC/KI has weak resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or

Residual Effect Characteristic	Definition	Rating
		ecosystem, and/or a high level of historic or ongoing anthropogenic or natural disturbance. Presence of *SARA*-listed species.
Likelihood	Likelihood that the residual effect will occur including consideration of the likelihood that the mitigation will be successful.	**Likely** – Moderate to high probability that the residual effect will occur. **Unlikely** – Low probability that the residual effect will occur.

9.4.6.1.2 Significance and Confidence

The characterization of residual effects is based on the review of existing conditions (Section 9.4.3), the assessment of Project-related effects and proposed mitigation measures and management strategies, other relevant scientific information, IK, and the professional judgment of the EA team. All residual effects (independent of their significance rating) are carried forward to the CEA.

The significance of the residual effect is rated as **not significant** or **significant**, based on the following:

Not significant – a residual effect that is not expected to result in a change to a VC/KI that would alter its population viability or persistence beyond an acceptable level (e.g., where it is not sustainable or is unavailable to contribute to biodiversity and ecosystem function).

Significant – a residual effect that is expected to result in a change to a VC/KI that would alter its population viability or persistence beyond an acceptable level (e.g., where it is not sustainable or is unavailable to contribute to biodiversity and ecosystem functions).

Limitations of existing data and uncertainty associated with the assessment were also characterized by assigning a level of confidence for the assessment predictions made for each residual effect. Confidence levels were considered in relation to:

- scientific certainty relative to the quantification of the effect, including the quality and/or quantity of data and the understanding of effect mechanisms;
- scientific certainty relative to the effectiveness of the proposed mitigation measures; and
- professional judgment based on prior experience in predicting effects and the known effectiveness of proven mitigation measures.

Therefore, a low level of confidence is assigned when the VC/KI and/or the Project interaction is not well understood, and/or the mitigation measures have not been proven effective. A moderate level of confidence is assigned where the VC/KI is understood in similar ecosystems and effects have been documented in the larger regional area or in the literature, and/or the mitigation measures have been proven effective elsewhere. A high level of confidence is assigned when the

VC/KI and Project interactions are well understood, and the mitigation measures have been proven effective.

9.4.6.2 Residual Effects Evaluation for Raptors

The Raptors VC is represented by two KIs—Bald Eagle and Osprey. The residual effects evaluation, therefore, assesses Project-related effects on these two species.

9.4.6.2.1 Alteration and/or Loss of Habitat

The assessment of the alteration and/or loss of habitat residual effect considers the direct loss of habitat and the indirect alteration of habitat during all Project phases. Both raptor species are known to use the habitat within the Wildlife LSA and Terrestrial RSA, as observed during baseline studies (Appendix 9-B).

During the baseline studies, one active Bald Eagle nest was documented in the Wildlife LSA and two in the Terrestrial RSA. In addition, several Bald Eagle observations occurred in the Project study areas (Appendix 9-B). During the surveys, three active Osprey nests were documented in the Terrestrial RSA, and one was noted just outside the Terrestrial RSA. Several Osprey observations also occurred in the Project study areas (Appendix 9-B).

While the observations recorded during the baseline surveys were not associated with specific habitat types, available Bald Eagle and Osprey habitat was identified in the study areas based on the raptors' documented habitat requirements (Smith et al. 2019): 0.01%, 8.5% and 20.9% of the Project Area, Wildlife LSA, and Terrestrial RSA, respectively, are classified as waterbodies and lakes, providing foraging opportunities for the birds. Waterbody classifications in this assessment include wetland habitat, delineated as lakes (described in Section 9.2.3.3). Both raptor species typically fly several kilometres between their nest site and their foraging site (Section 9.4.3.1.1). Forested upland habitats that provide nesting opportunities are represented in 85.1% of the Project Area, 82.6% of the Wildlife LSA, and 71.2% of the Terrestrial RSA (Table 9.4-7). However, not all forested cover is expected to provide suitable nesting habitat for Bald Eagle or Osprey; therefore, these calculations are conservative estimates. Figure 9.4-8 depicts available raptor habitat in the project study areas.

Table 9.4-7 provides a summary of available Bald Eagle and Osprey habitat in the Project Area, Wildlife LSA and Terrestrial RSA. Ecosite codes and descriptions are adopted from Table 9.2-5.

Table 9.4-7: Summary of Available Bald Eagle and Osprey Habitat in the Project Study Areas

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS3 (mature forest)	Jack pine - blueberry / lichen	31.1	18.3	1,693.7	35.0	1,0374.8	25.8
BS3 and BS7 (regenerating forest types)	Jack pine - blueberry / Black spruce - blueberry / lichen	110.2	64.9	2,268	46.8	17,494.0	43.5

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS4	Jack pine - black spruce / feathermoss	2.9	1.7	18.4	0.2	332.8	0.8
BS7 (mature)	Black spruce - blueberry / lichen	0.04	0.02	9.8	0.2	281.0	0.7
BS9	Black spruce - jack pine / feathermoss	0.3	0.2	12.3	0.3	148.5	0.4
BS14	White birch / lingonberry - Labrador tea	-	-	0.03	0.0006	1.8	0.005
BS16	Black spruce/ balsam poplar / river alder swamp	-	-	-	-	8.8	0.02
Waterbody and Lakes	Waterbody	0.02	0.01	412.2	8.5	8,381.6	20.9
Total		**144.6**[1]	**84.9**	**4,414.4**[2]	**91.1**	**37,023.3**[3]	**92.1**

1, 2, 3 These areas represent the total area of available Bald Eagle and Osprey habitat within each study area; the percentages are the amount of available habitat relative to the Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha).

The characterization of the alteration and/or loss of habitat residual effect considers the Project effects on available Bald Eagle and Osprey habitat within the Wildlife LSA and Terrestrial RSA. As outlined in Table 9.4-7, 84.9% of the Project Area, 91.1% of the Wildlife LSA, and 92.1% of the Terrestrial RSA provide habitat types that are potentially available to the two species.

Based on studies summarized in Section 9.4.3.1, and the SARGSS, which were established to support the avoidance of sensitive species' habitats during sensitive periods (SK MOE 2017), alteration of available habitat for the Raptor VC is quantified by applying a buffer of 1,000 m around the Project Area in which Project effects in the form of sensory disturbance are assumed to affect available habitat and make it functionally unavailable for use (Figure 9.4-8). The SARGSS specify a setback distance from a Bald Eagle nest site of 750 m and 1,000 m for medium and high disturbance categories[37] (between March 15 and July 15), respectively; and a set back distance of 1,000 m for both disturbance categories from Osprey nest sites (between May 1 and August 15) (SK MOE 2017).

Progressive reclamation is anticipated to begin during Construction. However, a conservative approach is used, with raptor habitat in the Project Area considered to be unavailable for the

[37] Medium disturbance categories are defined as vehicles >1 ton, plough-in pipeline, operating compressor station or battery, small vehicles, and off-road vehicles. High disturbance categories are defined as road, battery or compressor station construction, seismic, drilling rigs, trench-in pipeline, blasting, mines, gravel pit, quarries, rock crushing, asphalt batching, and renewable energy projects (SK MOE 2017).

duration of the Project, only becoming available as habitat following Post-Decommissioning (i.e., during the regeneration of vegetation following Decommissioning).

Direct habitat loss is calculated as the area of available Bald Eagle and Osprey habitat lost due to site clearing within the Project Area. Direct habitat loss has been mitigated by reducing the size of the Project Area to the extent practicable during Project design; however, available habitat is still predicted to be cleared during the Construction Phase. In the Project Area, 144.6 ha or 100% of available habitat is assumed to be removed and will not be available to the two raptor species for the duration of the Project, which represents a loss of 3.3% of available raptor habitat in the Wildlife LSA and 0.4% in the Terrestrial RSA (Table 9.4-8).

An additional 2,403.9 ha (54.5%) of available Bald Eagle and Osprey habitat in the Wildlife LSA may experience habitat alteration as a result of indirect Project effects, such as sensory disturbance (Table 9.4-8). This habitat alteration relates to 6.5% of available raptor habitat in the Terrestrial RSA (Table 9.4-8). Mitigation measures outlined in Section 9.4.5 are anticipated to reduce the effects of alteration and/or loss of habitat on the two raptor species, but not eliminate them.

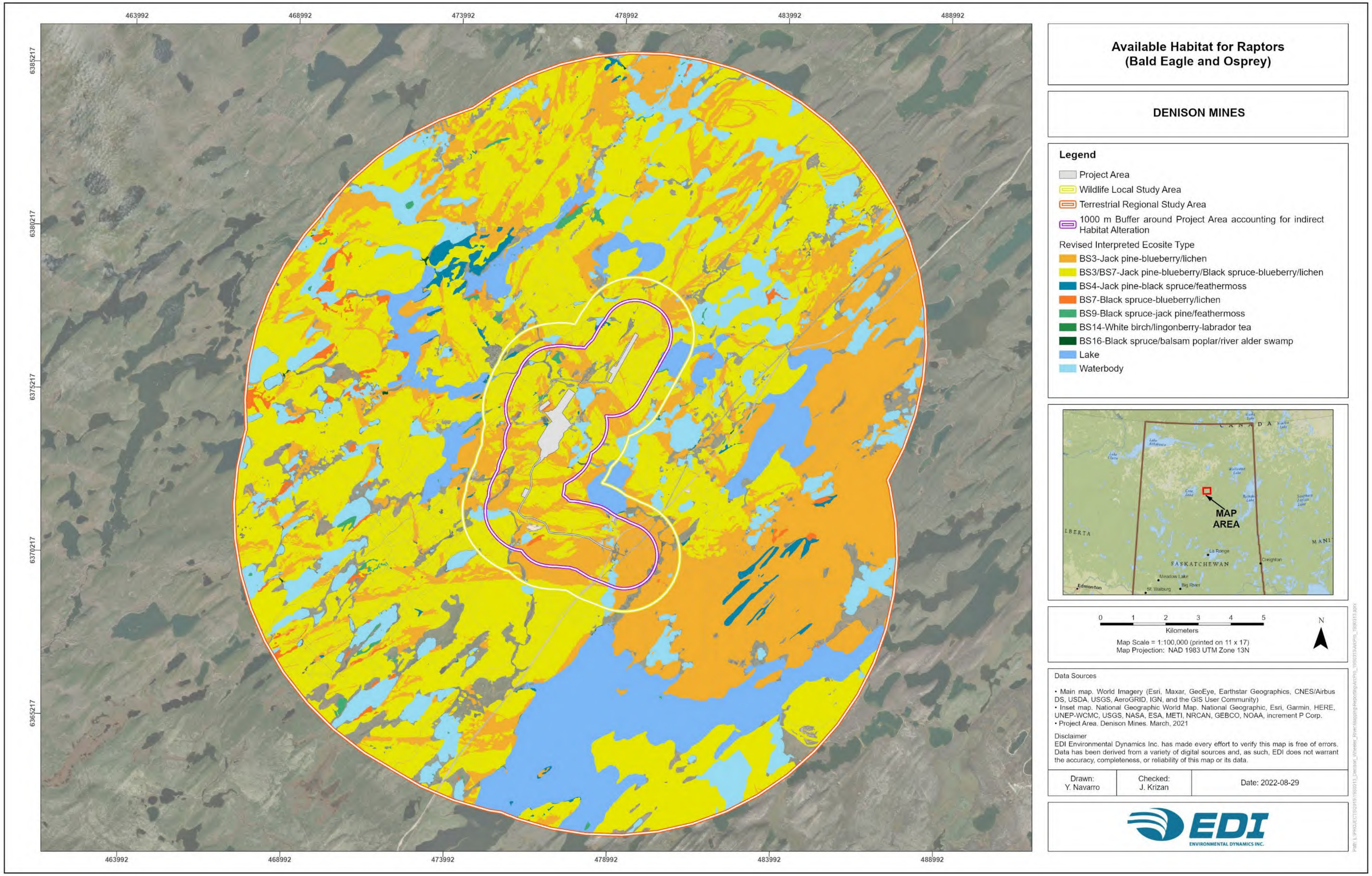

Figure 9.4-8: Available Habitat for Raptors (Bald Eagle and Osprey)

Table 9.4-8: Summary of Available Bald Eagle and Osprey Habitat, Direct Habitat Loss, and Habitat Alteration in the Study Areas

Study Area	Ecosite Description	Amount of Available Raptor Habitat (ha)	Percent of Available Raptor Habitat (%)	Amount of Available Raptor Habitat Loss (ha)	Percent of Available Raptor Habitat Loss (%)	Amount of Available Raptor Habitat Altered (ha)[1]	Percent of Available Raptor Habitat Altered (%)
Project Area	BS3 (mature forest) Jack pine - blueberry / lichen	31.1	18.3	31.1	100	N/A	N/A
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry / lichen and black spruce - blueberry / lichen	110.2	64.9	110.2	100	N/A	N/A
	BS4 (Jack pine - black spruce / feathermoss)	2.9	1.7	2.9	100	N/A	N/A
	BS7 (mature forest) Black spruce - blueberry / lichen	0.04	0.03	0.04	100	N/A	N/A
	BS9 (Black spruce - jack pine / feathermoss)	2.9	1.7	2.9	100	N/A	N/A
	BS14 (White birch / lingonberry - Labrador tea)	-	-	-	-	-	-
	BS16 Black spruce / balsam poplar / river alder swamp	-	-	-	-	-	-
	Waterbody	0.02	0.01	0.02	100	N/A	N/A
	Total	**144.6**[2]	**84.9**	**144.6**	**100**	**N/A**	**N/A**
Wildlife LSA	BS3 (mature forest) Jack pine - blueberry / lichen	1,693.7	35.0	31.1	1.8	928.0	54.8
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry / lichen and black spruce - blueberry / lichen	2,268	46.8	110.2	4.9	1,322.6	58.3

Study Area	Ecosite Description	Amount of Available Raptor Habitat (ha)	Percent of Available Raptor Habitat (%)	Amount of Available Raptor Habitat Loss (ha)	Percent of Available Raptor Habitat Loss (%)	Amount of Available Raptor Habitat Altered (ha)[1]	Percent of Available Raptor Habitat Altered (%)
	BS4 (Jack pine - black spruce / feathermoss)	18.4	0.2	2.9	15.7	6.7	36.9
	BS7 (mature forest) Black spruce - blueberry / lichen	9.8	0.2	0.04	0.5	8.9	90.3
	BS9 (Black spruce - jack pine / feathermoss)	12.3	0.3	0.3	2.3	9.6	77.8
	BS14 (White birch / lingonberry - Labrador tea)	0.03	0.0006	-	-	-	-
	BS16 Black spruce / balsam poplar / river alder swamp	-	-	-	-	-	-
	Waterbody	412.2	8.5	0.02	0.004	128.1	31.1
	Total	**4,414.2**[3]	**91.1**	**144.6**	**3.3**	**2,403.9**	**54.5**
Terrestrial RSA	BS3 (mature forest) Jack pine - blueberry / lichen	1,0374.8	25.8	31.1	0.3	928.0	9.0
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry / lichen and black spruce - blueberry / lichen	17,494.0	43.5	110.2	0.6	1,322.6	7.6
	BS4 (Jack pine - black spruce / feathermoss)	332.8	0.8	2.9	0.9	6.7	2.0
	BS7 (mature forest) Black spruce - blueberry / lichen	281.0	0.7	0.04	0.02	8.9	3.2
	BS9 (Black spruce - jack pine / feathermoss)	148.5	0.4	0.3	0.2	9.6	6.5
	BS14 (White birch / lingonberry - Labrador tea)	1.8	0.005	-	-	-	-

Study Area	Ecosite Description	Amount of Available Raptor Habitat (ha)	Percent of Available Raptor Habitat (%)	Amount of Available Raptor Habitat Loss (ha)	Percent of Available Raptor Habitat Loss (%)	Amount of Available Raptor Habitat Altered (ha)[1]	Percent of Available Raptor Habitat Altered (%)
	BS16 Black spruce / balsam poplar / river alder swamp	8.8	0.02 (%)	-	-	-	-
	Waterbody	8,381.6	20.9	0.02	0.0002	128.1	1.5
	Total	**37,023.3[4]**	**92.1**	**144.6**	**0.4**	**2,403.9**	**6.5**

1 Based on a 1,000 m buffer around the Project Area.

2, 3, 4 This area does not reflect the entire Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha) but represents the total area of available Bald Eagle and Osprey habitat in each study area.

N/A = Not Applicable

Residual Effects Characteristics

The residual effects characterization for the alteration and/or loss of available Bald Eagle and Osprey habitat is provided in Table 9.4-9.

The direction of the residual effect is predicted to be adverse. The Project is expected to affect available Bald Eagle and Osprey habitat directly (through habitat loss) and indirectly (through habitat alteration).

The magnitude of the residual effect is predicted to be moderate. Up to 6.9% of available Bald Eagle and Osprey habitat within the Terrestrial RSA is anticipated to be altered or lost as a result of the Project: 0.4% of available habitat within the Terrestrial RSA will be cleared within the Project Area during the Construction Phase, and an additional 6.5% of available raptor habitat within the Terrestrial RSA may be altered through indirect effects (such as sensory disturbance through noise and dust deposition) during all Project phases.

The residual effect is predicted to be local in geographic extent. While the direct loss of available Bald Eagle and Osprey habitat is expected to be limited to the Project Area during Construction, indirect Project effects are expected to occur within the Wildlife LSA within a 1,000 m area around the Project Area during all Project phases.

The residual effect is predicted to occur over the long-term (i.e., longer than 38 years) because of the time required for available raptor habitat to regenerate following disturbance. Differences may exist between habitat types depending on the areas and types of reclamation and the time frame for regeneration of vegetation within reclaimed areas. Progressive reclamation is anticipated to begin in some parts of the Project Area following Construction; however, the revegetation within most of the Project Area will occur as part of reclamation activities during Decommissioning, up to

23 years after clearing during Construction. The Project Area is expected to support areas of suitable upland forest habitat after revegetation following Project completion and vegetation has re-established and matured within reclaimed areas. Regeneration of disturbed areas to mature forests is expected to extend beyond Post-Decommissioning (i.e., long-term).

The frequency of the residual effect is predicted to be frequent. While loss of available habitat resulting from vegetation clearing during Construction will occur only initially, additional clearing for maintenance and safety purposes may happen throughout Operation. Alteration of available raptor habitat within the Wildlife LSA through indirect Project effects is anticipated to be frequent throughout the Construction, Operation, and Decommissioning phases, and infrequent during Post-Decommissioning.

The residual effect is predicted to be fully reversible. Through progressive and final reclamation, disturbed areas within the Project Area will be revegetated with a focus on achieving the creation of a safe, stable, and self-sustaining landscape. Both raptor species prefer tall mature trees within upland forest habitat near waterbodies, and revegetated areas are anticipated to become available to raptors after Post-Decommissioning when mature trees offer potential nesting habitat. Progressive reclamation may occur in some parts of the Project Area prior to Post-Decommissioning; however, most revegetation is anticipated to occur following the end of Operation. The alteration of available raptor habitat is expected to be reversed within a similar time frame as sensory disturbances diminish, with the ceasing of Project Operation and subsequent Decommissioning.

The context of the residual effect is predicted to be high. Available raptor habitat that is altered or cleared will remain so until Post-Decommissioning when final reclamation and revegetation will occur. Raptors have been exposed to historic and ongoing anthropogenic and natural disturbances throughout their ranges, including within the Terrestrial RSA (i.e., 1.5% of the Terrestrial RSA has currently experienced anthropogenic disturbances). Bald Eagle populations in Saskatchewan are considered secure; however, Osprey have been assigned the status of S2B (Imperiled/Very Rare: at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats or other factors, for the breeding population) and S2M (Imperiled/Very Rare: at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats or other factors, for the migratory population) (SK CDC 2021).

The residual effect is predicted to be likely. Available habitat is expected to be lost during site clearing and the construction and installation of Project components, and available habitat within a 1,000 m buffer around the Project Area is expected to be indirectly affected.

Project mitigation measures identified in Section 9.4.5 are expected to limit the residual effect on raptors. Although Project activities may result in raptor habitat alteration and/or loss within the Wildlife LSA, with the implementation of mitigation measures, the residual effect is not expected to result in a change to their populations.

Table 9.4-9: Summary of the Characteristics Ratings for Alteration and/or Loss of Available Bald Eagle and Osprey Habitat

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project is expected to affect available raptor habitat directly and indirectly.
Magnitude	Moderate	Up to 6.9% of available raptor habitat within the Terrestrial RSA is predicted to be affected by the Project. This includes 0.4% habitat loss and 6.5% of habitat alteration.
Geographic Extent	Local	The direct loss of available raptor habitat is expected to be limited to the Project Area during Construction, and indirect effects resulting in habitat alteration are expected to be restricted to the Wildlife LSA during all Project phases.
Duration	Long-term	The loss of available raptor habitat will mainly occur during Construction; however, the alteration of habitat will continue through all phases. The reclamation and revegetation of the Project Area will not be complete until after revegetation following Project completion and vegetation has re-established and matured within reclaimed areas.
Frequency	Frequent	Loss of available raptor habitat will occur initially during Project Construction, and alteration of available habitat through indirect Project effects is anticipated to be frequent until Post-Decommissioning.
Reversibility	Fully Reversible	Disturbed habitat within the Project Area will be revegetated and mature trees will likely become available to raptors after Project completion. The alteration of available raptor habitat is expected to be reversed as sensory disturbances diminish, with the ceasing of Project Operation and subsequent Decommissioning of Project components.
Context	High	Disturbed habitat within the Project Area will be revegetated and mature trees will likely become available to raptors after Project completion. While Bald Eagle populations in Saskatchewan are considered secure, Osprey have been assigned the status of S2B (Imperiled/Very Rare: at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats or other factors, for the breeding population) and S2M (Imperiled/Very Rare: at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats or other factors, for the migratory population) (SK CDC 2021).
Likelihood	Likely	Available raptor habitat is expected to be cleared in the Project Area during Construction and to be indirectly affected in the Wildlife LSA during all phases of the Project.

Significance and Confidence

The residual effect of alteration and/or loss of available Bald Eagle and Osprey habitat is not expected to result in a change that will alter their habitat integrity to the point where it would not be able to sustain the regional raptor population. Therefore, the effect is assessed as **not significant**.

The level of confidence of this prediction is moderate. The effects of habitat loss and alteration on raptor species are well known, and proven, effective mitigation measures will be implemented. However, some level of uncertainty exists related to the available background and baseline information used to identify available raptor habitat in this assessment.

9.4.6.2.2 Change in Mortality

Change in mortality is assessed qualitatively by considering the residual effect of the Project on the abundance of Bald Eagle and Osprey. The assessment includes considerations of direct mortality from Project activities and interactions with Project components, and indirect mortality as a result of the Project.

Potential sources of direct mortality on the Raptors VC include incidental take during Project-related site clearing and vegetation management; collisions with Project-related vehicles, equipment, aircraft, and components (e.g., buildings or windows), and collisions with power transmission lines, as well as electrocution caused by contact with energized equipment.

Both Raptor VC KIs are not as susceptible as ground-breeding species to incidental take during Project-related site clearing and vegetation management due to their preference for nesting sites in tall trees or on power poles (Bierregaard et al. 2020). Raptors are also considered to be less susceptible to collisions with Project-related vehicles, equipment, and buildings/windows (Erickson et al. 2005). However, several studies have documented raptor collisions with vehicles and buildings/windows (Deem et al. 1998, Wendell et al. 2002, Hager 2009, Neese et al. 2010, Molina-López et al. 2011, Smith et al. 2018).

During take-off and landings of aircrafts, a risk occurs for birds colliding with planes or being sucked into engines or propellers (Nilsson et al. 2021). Canadian airports have reporting requirements in place to document bird-airplane collisions (also called bird strikes) to support the analysis and associated risk assessment of bird strike events (Transport Canada 2019). While large-bodied flocking species (such as Swans, Geese, and Ducks) face the greatest risk of a bird strike, the risk for solitary large-bodied species (including Bald Eagle and Osprey) is also considered high (Bird Strike Association of Canada 2021). This risk is amplified if the airport is close to suitable habitat that supports these species (Nilsson et al. 2021). Due to minimal anticipated aircraft traffic at the Project airstrip (approximately five flights per week during Operation) and the absence of observed active raptor nests in the Project Area, the risks of raptor collisions with Project aircraft are considered low.

Raptors are strong fliers and can quickly maneuver in flight, making them less vulnerable to collisions with power transmission lines compared to other avian species (e.g., Ducks, Geese, and Swans). However, inexperienced juvenile raptors or raptors distracted by territorial, or courtship displays or aerial hunting activities, may be at greater risk of collision with power lines (Avian Power Line Interaction Committee 2006, 2012; Rioux et al. 2013). Raptors are susceptible to electrocution caused by contact with power line infrastructure because their large wingspan can cover the distance between energized equipment (Erickson et al. 2005, Avian Power Line Interaction Committee 2006). The use of utility poles for nesting, hunting, feeding, or resting may increase collision and/or electrocution risk for raptors or affect their nests (Rioux et al. 2013). Low-flying movements between nesting and feeding habitats may also increase collision and/or electrocution risk for raptors.

Potential sources of indirect mortality on Raptors include nest failure or abandonment caused by sensory disturbance from Project activities; changes in predator-prey dynamics caused by Project-related edge effects or use of the Project Area and adjacent habitats by people.

Compared to other bird groups, raptors are typically more sensitive to sensory disturbance, particularly during the nesting season (Sinnott 2000). The SARGSS suggest that Bald Eagle and Osprey have a lower tolerance to anthropogenic disturbance near nest sites and recommend a setback distance for Bald Eagle of 750 m and 1,000 m for medium and high disturbance categories (between March 15 and July 15), respectively; and a set back distance of 1,000 m for both disturbance categories for Osprey (between May 1 and August 15) (SK MOE 2017). The effects of sensory disturbance on these raptors (e.g., elevated stress levels; interference with communication; interference with incubation or nestling provisioning) may lead to nest failure or abandonment, which could have implications for reproductive success and survival.

Project-related edge effects or the increased use of Project-related access roads facilitating increased public access may alter prey availability and predator-prey dynamics within the Project Area and adjacent habitats, which could indirectly influence Bald Eagle mortality (Francis et al. 2009, Rodewald et al. 2011, Bishop and Brogan 2013, Hethcoat and Chalfoun 2015).

Project mitigation measures identified in Section 9.4.5 are expected to limit interactions between raptors and potential sources of direct and indirect mortality, thereby minimizing the residual effect of change in mortality. Although Project activities may result in a change of direct and/or indirect mortality of raptors within the Terrestrial RSA, with the implementation of mitigation measures, the residual effect is not expected to result in a change to their populations.

Residual Effect Characteristics

The residual effect characteristics for change in mortality on the Raptors VC are summarized below and provided in Table 9.4-10.

The direction of the residual effect is predicted to be adverse. While it is expected that the risk for Project-related raptor mortalities is limited (due to effective mitigation measures), any additional mortality may affect the Bald Eagle and Osprey populations.

The magnitude is predicted to be low. Mitigation measures are expected to limit the potential for interactions between raptors and potential sources of direct and indirect mortality. Changes to habitat available for raptors because of the Project are expected (Table 9.4-8), which suggests that a limited number of individuals are expected to interact with the Project and potentially be affected by direct and/or indirect sources of mortality. Individuals displaced by the Project are expected to relocate to areas of available habitat within the Wildlife LSA and Terrestrial RSA, thereby limiting the potential for further interactions with the Project. Available habitat is not considered to be a limiting factor within the study areas (i.e., the available habitat is expected to be able to support the low numbers of displaced individuals).

The geographic extent is predicted to be regional. While most direct mortality is expected to be limited to the Project Area, effects from power transmission lines and indirect mortality related to sensory disturbance, increased access, and exposure to hazardous materials is expected to extend into adjacent habitats within the Wildlife LSA and may affect raptors in the Terrestrial RSA.

The duration is predicted to occur over the medium-term. Sources of direct mortality and most sources of indirect mortality are expected to occur during Construction and Operation and the residual effects are expected to persist until Project activities cease and Project components are removed at the end of Decommissioning. Indirect sources of mortality related to sensory disturbance are also expected to occur during the Construction and Operation phases; however, the residual effects are expected to persist until Project components are decommissioned and disturbed areas are reclaimed at the end of Post-Decommissioning.

The frequency is predicted to be infrequent. Although direct and/or indirect mortality could occur sporadically through all Project phases, occurrences are expected to be isolated and infrequent events given the implementation of mitigation measures identified in Section 9.4.5.

The residual effect is predicted to be fully reversible once Project activities cease, Project components are removed, disturbed habitats are reclaimed, and vegetation has re-established and regenerated to maturity within reclaimed areas.

The context is predicted to be high. Raptors have been exposed to historic and ongoing anthropogenic and natural disturbances throughout their ranges, including within the Terrestrial RSA (i.e., 1.5% of the Terrestrial RSA has currently experienced anthropogenic disturbances). While Bald Eagle populations in Saskatchewan are considered secure, Osprey have been assigned the status of S2B (Imperiled/Very Rare: at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats or other factors, for the breeding population) and S2M (Imperiled/Very Rare: at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats or other factors, for the migratory population) (SK CDC 2021). Although the Project is expected to interact with a limited number of individuals that may be affected by direct and/or indirect sources of mortality, raptor (particularly Osprey) populations may be less resilient to changes in mortality.

The residual effect is predicted to be likely. Observations of Bald Eagle and Osprey, as well as active nest sites for both species, have been recorded within the Project study areas (Appendix 9-B); therefore, it is possible that Project activities may interact with raptors and result in direct and/or indirect mortality.

Project mitigation measures identified in Section 9.4.5 are expected to limit interactions between raptors and potential sources of direct and indirect mortality, thereby minimizing the residual effect of change in mortality. Although Project activities may result in a change of direct and/or indirect raptor mortality within the Terrestrial RSA, with the implementation of mitigation measures, the residual effect is not expected to result in a change to their populations.

Table 9.4-10: Summary of the Characteristics Ratings for Change in Mortality of Raptors

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project is expected to affect a change in mortality of raptors.
Magnitude	Low	Mitigation measures are anticipated to be effective at reducing the potential for a change in direct and indirect mortality, and the risk of mortality is expected to be within the range of natural variability.
Geographic Extent	Regional	The change in direct mortality is expected to occur mainly within the Project Area; however, indirect raptor mortality may extend into the Wildlife LSA and the Terrestrial RSA.
Duration	Medium-term	Raptor mortality may occur during all phases of the Project. The potential for a change in direct mortality is expected to be highest during the Construction and Operation phases and the potential for indirect mortality is expected to be highest during Operation, decreasing during Decommissioning, and limited during Post-Decommissioning.
Frequency	Infrequent	The potential for a change in direct and indirect raptor mortality is expected to be limited, but the residual effect may occur sporadically throughout the life of the Project.
Reversibility	Fully Reversible	The change in mortality of raptors is anticipated to decline during Decommissioning following the removal of Project components and a reduction in Project activities and diminish to baseline conditions following Post-Decommissioning.
Context	High	Bald Eagle populations in Saskatchewan are considered secure; however, Osprey are listed provincially as S2B (Imperiled/Very Rare: at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats or other factors, for the breeding population) and S2M (Imperiled/Very Rare: at high risk of extinction or extirpation due to a very restricted range, very few populations, steep declines, threats or other factors, for the migratory population) (SK CDC 2021). Osprey populations may be less resilient to changes in mortality.
Likelihood	Likely	Mitigation measures are expected to reduce, but not fully eliminate the residual effect on raptors.

<u>**Significance and Confidence**</u>

The residual effect of change in mortality is not expected to result in a change in raptor mortality that will alter the integrity of the Bald Eagle and Osprey populations to the point where the regional populations could not be sustained. Therefore, the effect is assessed as **not significant**.

The level of confidence of this prediction is moderate. The risks of increased mortality are well known, and proven, effective mitigation measures will be implemented. They are anticipated to reduce the change in direct and indirect mortality of raptors to levels within the range of natural variability. However, some level of uncertainty exists regarding the status of the regional Bald Eagle and Osprey populations and, with that, their ability to assimilate limited additional mortality.

9.4.6.3 Residual Effects Evaluation for Migratory Breeding Birds

The Migratory Breeding Birds VC is represented by three KIs—waterbirds and waterfowl, upland game birds, and migratory songbirds. In a 2016 paper assessing the niche characteristics of western boreal birds the authors state "*Our results suggest that most boreal bird species have adopted generalist strategies in order to persist within the heterogeneous and unstable environments typical of northern boreal forests*" (Mahon et al. 2016). As such, we have taken a broad niche-based approach to split the migratory songbirds KI for more informative effects assessment, while recognizing that niche specificity of boreal birds is typically broad. The residual effects evaluation, therefore, assesses Project-related effects on these three groups (and niches within the migratory songbirds group), and provides an indicator species for each of these three groups, with indicator species in the migratory songbirds group assigned for each of the identified niches.

9.4.6.3.1 Alteration and/or Loss of Habitat

The assessment of the alteration and/or loss of habitat residual effect considers the direct loss of habitat and the indirect alteration (e.g., sensory disturbances, habitat fragmentation, and edge effects) of habitat during all Project phases.

Waterbirds and Waterfowl

The Common Merganser has been chosen as an indicator species for the Waterbirds and Waterfowl KI to represent anticipated impacts to this KI.

During the 2017 aerial waterfowl surveys of lakes, streams and wetland areas, 20 confirmed and 3 unknown species of waterbirds and waterfowl were recorded in the Wildlife LSA and Terrestrial RSA. Higher densities and species richness were associated with smaller interconnected waterbodies, and no apparent influence of adjacent upland ecosite type on densities and species richness was identified (Appendix 9-B).

While the waterbird and waterfowl sightings were not associated with specific habitat types, based on baseline observations (Appendix 9-B), waterbodies and shorelines are considered available habitat for waterbirds and waterfowl. Waterbody classifications in this assessment include wetland habitat, delineated as lakes (described in Section 9.2.3.3). Bogs and fens are not included in waterbird and waterfowl habitat because these ecosites do not contain open water suitable for waterbird and waterfowl use (Smith et al. 2019).

The Project Area includes little available habitat for waterbirds and waterfowl (0.01%), while the Wildlife LSA and Terrestrial RSA provide 8.6% and 21.0% of available habitat, respectively (Table 9.4-11).

Table 9.4-11 provides a summary of available waterbird and waterfowl habitat in the Project Area, Wildlife LSA and Terrestrial RSA. Ecosite codes and descriptions are adopted from Table 9.2-5. Figure 9.4-9 depicts available waterbird and waterfowl habitat in the Project study areas.

Table 9.4-11: Summary of Available Habitat for Waterbirds and Waterfowl in the Project Study Areas

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS26	Rush sandy shore	-	-	0.8	0.02	15.1	0.04
BS27	Sedge rocky shore	-	-	4.2	0.09	29.3	0.1
Waterbody and Lakes	Waterbody	0.02	0.01	412.2	8.5	8,381.6	20.9
Total		**0.02**[1]	**0.01**	**417.2**[2]	**8.6**	**8,426.0**[3]	**21.0**

1, 2, 3 These areas represent the total area of available habitat for waterbirds and waterfowl within each study area; the percentages are the amount of available habitat relative to the Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha).

The characterization of the alteration and/or loss of habitat residual effect considers the Project effects on available habitat for waterbirds and waterfowl within the Wildlife LSA and Terrestrial RSA. As outlined in Table 9.4-11, the study areas provide limited habitat types that are potentially available to these avian species.

Based on studies summarized in Section 9.4.3.2.1, and the SARGSS, which support the avoidance of sensitive species' habitats during sensitive periods (SK MOE 2017), alteration of available habitat for waterbirds and waterfowl is quantified by applying a buffer of 1,000 m around the Project Area in which Project effects in the form of sensory disturbance are assumed to affect available habitat and make it functionally unavailable for use. The SARGSS specify setback distances between 150 m and 1000 m for several waterbird and waterfowl species for medium and high disturbance categories between April 1/May 15 and July 15/July 31 around nesting birds or colonies (SK MOE 2017). The species in the SARGSS list that may occur in the Terrestrial RSA include Loons (*Gavia spp.*), colonial nesting Grebes, American Bittern (*Botaurus lentiginosus*), colonial nesting birds (including American White Pelican, which have been reported in increased numbers in the region [19-LK-ERFNTrap-134.239]), Plovers (*Charadrius spp*.), as well as some Gulls and Terns (Laridae family) (SK MOE 2017).

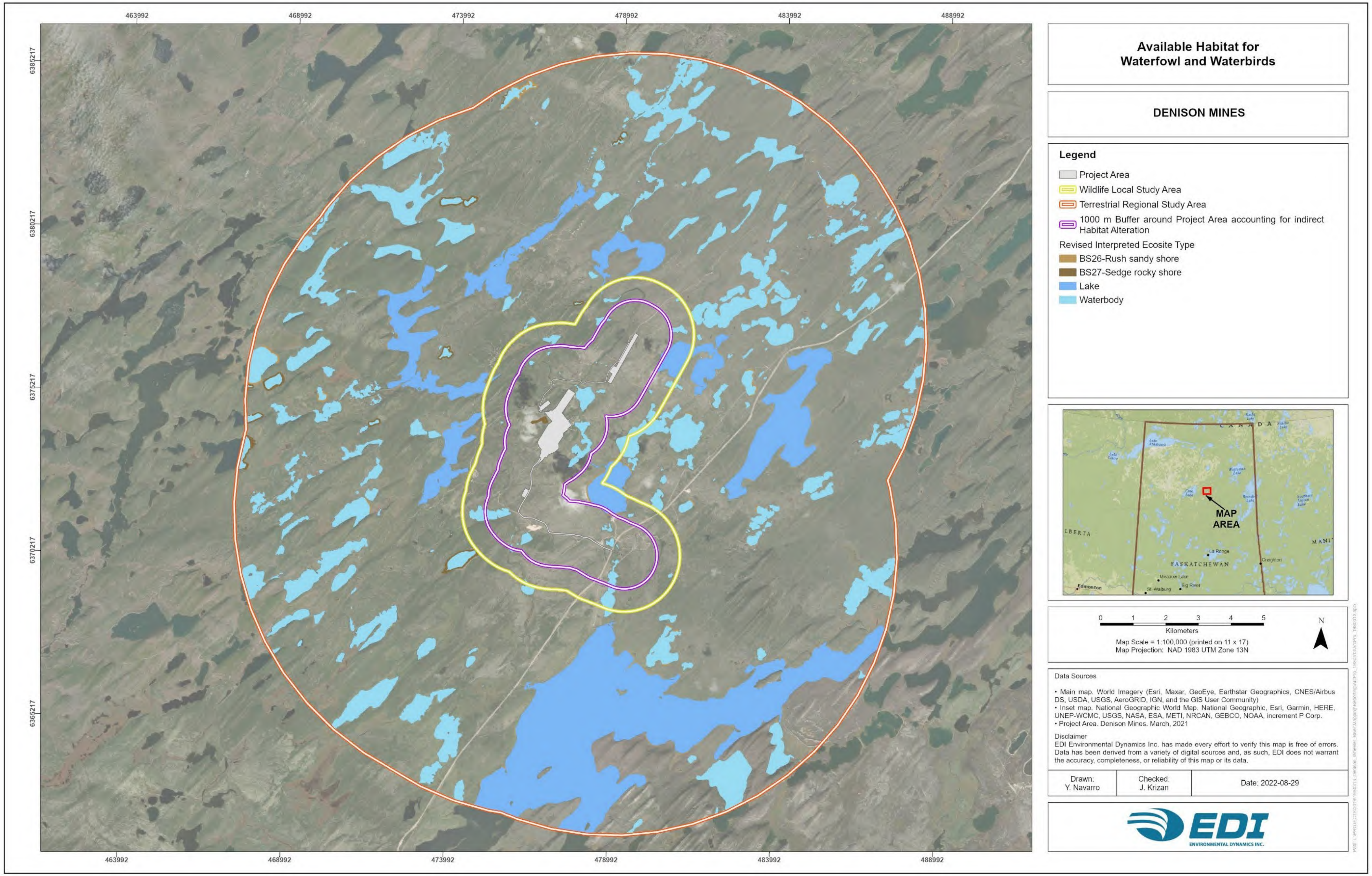

Figure 9.4-9: Available Habitat for Waterfowl and Waterbirds

Progressive reclamation is anticipated to begin during Construction. However, a conservative approach is used with waterbird and waterfowl habitat in the Project Area considered to be unavailable for the duration of the Project, only becoming available as habitat following Post-Decommissioning (i.e., during the regeneration of vegetation following Decommissioning).

Direct habitat loss is calculated as the area of available habitat lost for waterbirds and waterfowl due to site clearing within the Project Area. Direct habitat loss has been mitigated by reducing the size of the Project Area to the extent practicable during Project design; however, available habitat is still predicted to be cleared during Construction. In the Project Area, 0.02 ha or 100% of available habitat is assumed to be removed and will not be available to the waterbird and waterfowl species for the duration of the Project, which represents a removal of 0.004% of available waterbird and waterfowl habitat in the Wildlife LSA and 0.0002% in the Terrestrial RSA (Table 9.4-12).

An additional 132.3 ha (31.7%) of available habitat for waterbirds and waterfowl in the Wildlife LSA may experience habitat alteration resulting from indirect Project effects, such as sensory disturbance. This area of potential habitat alteration represents 1.6% of available habitat within the Terrestrial RSA (Table 9.4-12). Mitigation measures outlined in Section 9.4.5 are anticipated to reduce the effects of alteration and/or loss of habitat on waterbirds and waterfowl, but not eliminate them.

Table 9.4-12: Summary of Available Habitat for Waterbirds and Waterfowl, Direct Habitat Loss, and Habitat Alteration in the Study Areas

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
Project Area	BS26 (Rush sandy shore)	-	-	-	-	-	-
	BS27 (Sedge rocky shore)	-	-	-	-	-	-
	Waterbody	0.02	0.01	0.02	100	N/A	N/A
	Total	0.02[2]	**0.01**	**0.02**	**100**	**N/A**	**N/A**
Wildlife LSA	BS26 (Rush sandy shore)	0.8	0.02	-	-	0.1	8.1
	BS27 (Sedge rocky shore)	4.2	0.09	-	-	4.1	99.2
	Waterbody	412.2	8.5	0.02	0.004	128.1	31.1
	Total	**417.2**[3]	**8.6**	0.02	**0.004**	**132.3**	**31.7**
Terrestrial RSA	BS26 (Rush sandy shore)	15.1	0.04	-	-	0.1	0.5
	BS27 (Sedge rocky shore)	29.3	0.1	-	-	4.1	14.2

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
	Waterbody	8,381.6	20.9	0.02	0.0002	128.1	1.5
	Total	**8,426.0**[4]	**21.0**	**0.02**	**0.0002**	**132.3**	**1.6**

1 Based on a 1,000 m buffer around the Project Area.

2, 3, 4 This area does not reflect the entire Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha) but represents the total area of available waterbird and waterfowl habitat in each study area.

N/A = Not Applicable

Upland Game Birds

The Spruce Grouse has been chosen as an indicator species for the Upland Game Birds KI to represent anticipated impacts to this KI.

During their 2017 survey, one pair of Spruce Grouse was recorded in the BS4 (jack pine – black spruce/feathermoss) ecosite (Appendix 9-B). During the 2017/2018 winter track surveys, Grouse/Ptarmigan trails were observed at the highest trail densities in the BS24 (graminoid fen), BS19 (graminoid bog), BS18 (Labrador tea shrubby bog), BS23 (willow shrubby rich fen), BS16 (black spruce/balsam poplar/river alder swamp), and BS17 (black spruce treed bog) ecosites (Appendix 9-B). Grouse/Ptarmigan pellet groups were observed at highest densities in the BS19 (graminoid bog), BS7 (black spruce/blueberry/lichen), and BS9 (black spruce – jack pine/feathermoss) ecosites (Appendix 9-B).

Considering the baseline data (Appendix 9-B), upland breeding bird habitat is described in the following paragraphs without seasonal or species-specific differentiation and referred to as available habitat for the four upland game bird species potentially occurring in the Terrestrial RSA (i.e., Sharp-tailed Grouse, Ruffed Grouse, Spruce Grouse and Willow Ptarmigan). However, many coniferous ecosites in the study areas are predominantly considered habitat for Spruce Grouse. Habitat for Willow Ptarmigan is likely comprised of several shrub dominated ecosites in the study areas, while available habitat for Ruffed Grouse and Sharp-tailed Grouse is assumed to be limited or not present due to a lack of deciduous dominated forest ecosites and the absence of dry grassy ecosite types, respectively, in the study areas (Conkin 2018, Connelly et al. 2020). Based on these considerations, 85.4%, 87.9%, and 77.4% of the Project Area, Wildlife LSA, and Terrestrial RSA, respectively, are assumed to provide available habitat for upland game birds (Table 9.4-13).

Table 9.4-13 provides a summary of available habitat for upland game birds in the Project Area, Wildlife LSA and Terrestrial RSA. Ecosite codes and descriptions are adopted from Table 9.2-5. Figure 9.4-10 depicts available habitat for upland game birds in the Project study areas.

Table 9.4-13: Summary of Available Habitat for Upland Game Birds in the Project Study Areas

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS3 (mature forest)	Jack pine - blueberry / lichen	31.1	18.3	1,693.7	35.0	10,374.8	25.8
BS4	Jack pine - black spruce / feathermoss	2.9	1.7	18.2	0.4	332.8	0.8
BS3 and BS7 (regenerating forest types)	Jack pine - blueberry / lichen and black spruce - blueberry / lichen	110.2	64.9	2,268	46.8	17,494.0	43.5
BS7 (mature forest)	Black spruce - blueberry / lichen	0.04	0.03	9.8	0.2	281.0	0.7
BS9	Black spruce - jack pine / feathermoss	0.3	0.2	12.3	0.3	148.5	0.4
BS14	White birch / lingonberry - Labrador tea	-	-	0.03	0.0006	1.8	0.005
BS16	Black spruce / balsam poplar / river alder swamp	-	-	-	-	8.8	0.02
BS17	Black spruce treed bog	0.4	0.2	98.8	2.0	1,157.1	2.9
BS18	Labrador tea shrubby bog	0.003	0.002	105.1	2.2	990.0	2.5
BS19	Graminoid bog	-	-	10.0	0.2	160.5	0.4
BS19 / BS24	Graminoid bog / Graminoid fen	-	-	2.4	0.05	2.4	0.006
BS21	Tamarack treed fen	-	-	15.6	0.3	66.5	0.2
BS22	Leatherleaf shrubby poor fen	-	-	13.2	0.3	28.5	0.1
BS23	Willow shrubby rich fen	0.1	0.04	3.2	0.1	20.9	0.05
BS24	Graminoid fen	-	-	-	-	9.0	0.02
Total		**145.0[1]**	**85.4**	**4,250.3[2]**	**87.9**	**31,076.6[3]**	**77.4**

1, 2, 3 This area does not reflect the entire Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha) but represents the total area of available upland gamebird habitat in each study area.

The characterization of the alteration and/or loss of habitat residual effect considers the Project effects on available habitat for upland game birds within the Wildlife LSA and Terrestrial RSA. As outlined in Table 9.4-13, the study areas provide several habitat types that are potentially available to these year-round resident avian species.

Based on studies summarized in Section 9.4.3.2.1, and the SARGSS, which support the avoidance of sensitive species' habitats during sensitive periods (SK MOE 2017), alteration of available habitat for upland game birds is quantified by applying a buffer of 500 m around the Project Area in which Project effects, in the form of sensory disturbance, are assumed to affect available habitat for upland game birds and make it functionally unavailable for use. The SARGSS specify setback distances of 400 m from Sharp-tailed Grouse leks for medium and high disturbance categories between March 15 and May 15 (SK MOE 2017). No setback distances are recommended for the other three upland game bird species.

Progressive reclamation is anticipated to begin during Construction. However, a conservative approach is used with upland game bird habitat in the Project Area considered to be unavailable for the duration of the Project, only becoming available as habitat following Post-Decommissioning (i.e., during the regeneration of vegetation following Decommissioning).

Direct habitat loss is calculated as the area of available habitat for upland game birds lost due to site clearing within the Project Area. Direct habitat loss has been mitigated by reducing the size of the Project Area to the extent practicable during Project design; however, available habitat is still predicted to be cleared during the Construction Phase. In the Project Area, 145.0 ha or 100% of available habitat is assumed to be removed and will not be available to the upland game bird species for the duration of the Project, which relates to a removal of 3.4% of available upland game bird habitat in the Wildlife LSA and 0.5% in the Terrestrial RSA (Table 9.4-14).

An additional 1,173.9 ha (27.6 %) of available habitat for upland game birds in the Wildlife LSA may experience habitat alteration resulting from indirect Project effects, such as sensory disturbance. This area of potential habitat alteration represents 3.8 % of available habitat within the Terrestrial RSA (Table 9.4-14). Mitigation measures outlined in Section 9.4.5 are anticipated to reduce the effects of alteration and/or loss of habitat on upland game birds, but not eliminate them.

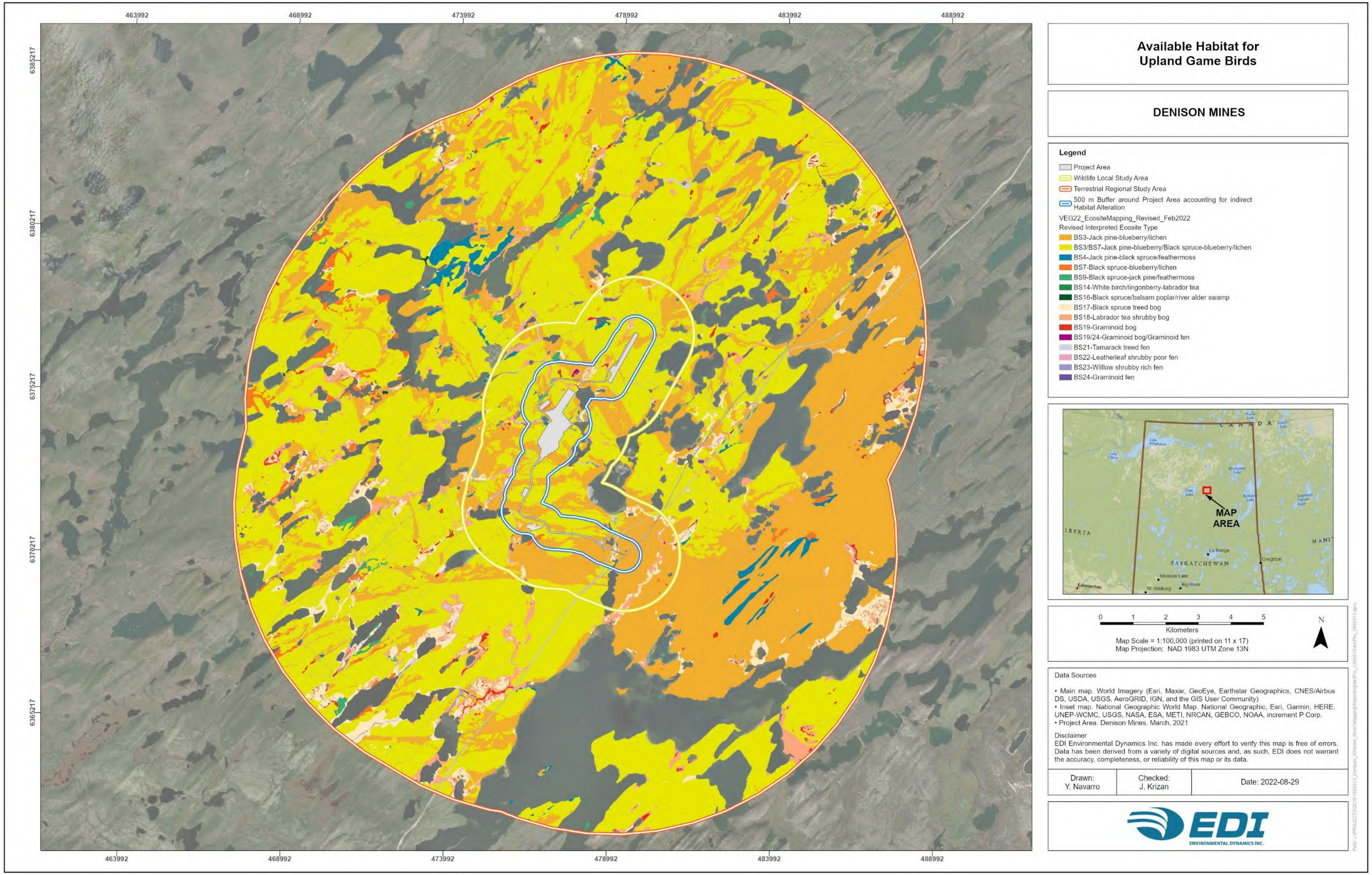

Figure 9.4-10: Available Habitat for Upland Game Birds

Table 9.4-14: Summary of Available Habitat for Upland Game Birds, Direct Habitat Loss, and Habitat Alteration in the Study Areas

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
Project Area	BS3 (mature forest) Jack pine - blueberry / lichen	31.1	18.3	31.1	100	N/A	N/A
	BS4 Jack pine - black spruce / feathermoss	2.9	1.7	2.9	100	N/A	N/A
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry / lichen and black spruce - blueberry / lichen	110.2	64.9	110.2	100	N/A	N/A
	BS7 (mature forest) Black spruce - blueberry / lichen	0.04	0.03	0.04	100	N/A	N/A
	BS9 Black spruce - jack pine / feathermoss	0.3	0.2	0.3	100	N/A	N/A
	BS14 White birch / lingonberry - Labrador tea	-	-	-	-	-	-
	BS16 Black spruce / balsam poplar / river alder swamp	-	-	-	-	-	-
	BS17 Black spruce treed bog	0.4	0.2	0.4	100	N/A	N/A
	BS18 Labrador tea shrubby bog	0.003	0.002	0.003	100	N/A	N/A
	BS19 Graminoid bog	-	-	-	-	-	-
	BS19 / BS24 Graminoid bog / Graminoid fen	-	-	-	-	-	-
	BS21 Tamarack treed fen	-	-	-	-	-	-
	BS22 Leatherleaf shrubby poor fen	-	-	-	-	-	-
	BS23 Willow shrubby rich fen	0.1	0.04	0.1	100	N/A	N/A

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
	BS24 Graminoid fen	-	-	-	-	-	-
	Total	**145.0[2]**	**85.4**	**145.0**	**100**	**N/A**	**N/A**
Wildlife LSA	BS3 (mature forest) Jack pine - blueberry / lichen	1,693.7	35.0	31.1	1.8	445.1	26.3
	BS4 Jack pine - black spruce / feathermoss	18.2	0.4	2.9	15.7	3.4	18.5
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry / lichen and black spruce - blueberry / lichen	2,268	46.8	110.2	4.9	656.5	29.0
	BS7 (mature forest) Black spruce - blueberry / lichen	9.8	0.2	0.04	0.5	5.3	53.9
	BS9 Black spruce - jack pine / feathermoss	12.3	0.3	0.3	0.3	3.5	28.3
	BS14 White birch / lingonberry - Labrador tea	0.03	0.0006	-	-	-	-
	BS16 Black spruce / balsam poplar / river alder swamp	-	-	-	-	-	-
	BS17 Black spruce treed bog	98.8	2.0	0.4	0.4	22.0	22.3
	BS18 Labrador tea shrubby bog	105.1	2.2	0.003	0.003	30.0	28.6
	BS19 Graminoid bog	10.0	0.2	-	-	2.8	28.5
	BS19 / BS24 Graminoid bog / Graminoid fen	2.4	0.05	-	-	2.4	100
	BS21 Tamarack treed fen	15.6	0.3	-	-	2.2	14.2
	BS22 Leatherleaf shrubby poor fen	13.2	0.3	-	-	-	-
	BS23 Willow shrubby rich fen	3.2	0.1	0.1	2.2	0.7	21.3

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
	BS24 Graminoid fen	-	-	-	-	-	-
	Total	**4,250.3**[3]	**87.9**	**145.0**	**3.4**	**1,173.9**	**27.6**
Terrestrial RSA	BS3 (mature forest) Jack pine - blueberry / lichen	10,374.8	25.8	31.1	0.3	445.1	4.3
	BS4 Jack pine - black spruce / feathermoss	332.8	0.8	2.9	0.9	3.4	1.0
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry / lichen and black spruce - blueberry / lichen	17,494.0	43.5	110.2	0.6	656.5	3.8
	BS7 (mature forest) Black spruce - blueberry / lichen	281.0	0.7	0.04	0.02	5.3	1.9
	BS9 Black spruce - jack pine / feathermoss	148.5	0.4	0.3	0.2	3.5	2.4
	BS14 White birch / lingonberry - Labrador tea	1.8	0.005	-	-	-	-
	BS16 Black spruce / balsam poplar / river alder swamp	8.8	0.02	-	-	-	-
	BS17 Black spruce treed bog	1,157.1	2.9	0.4	0.03	22.0	1.9
	BS18 Labrador tea shrubby bog	990.0	2.5	0.003	0.0003	30.0	3.0
	BS19 Graminoid bog	160.5	0.4	-	-	2.8	1.8
	BS19 / BS24 Graminoid bog / Graminoid fen	2.4	0.006	-	-	2.4	100
	BS21 Tamarack treed fen	66.5	0.2	-	-	2.2	3.3
	BS22 Leatherleaf shrubby poor fen	28.5	0.1	-	-	-	-
	BS23 Willow shrubby rich fen	20.9	0.05	0.1	0.3	0.7	3.3

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
	BS24 Graminoid fen	9.0	0.02	-	-	-	-
	Total	**31,192.2**[4]	**77.7**	**145.0**	**0.5**	**1,173.9**	**3.8**

1 Based on a 500 m buffer around the Project Area.

2, 3, 4 This area does not reflect the entire Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha) but represents the total area of available upland game bird habitat in each study area.

N/A = Not Applicable

Migratory Songbirds

The Migratory Songbirds KI has been divided into three broad niche groups based on ecological similarities and the results of a study characterizing niche preference of western boreal birds (Mahon et al. 2016): forest birds, open habitat (e.g., marshland and grassland) birds and lowland habitat (e.g., bogs and fens) birds. Indicator species have been chosen for each of these niche groups to represent anticipated impacts to these niche groups within the Migratory Songbirds KI and are based on habitat affinities identified by Mahon et al. (2016) and their documented presence in the Wildlife LSA. Ruby-crowned Kinglet was chosen to represent the forest birds niche group, Wilson's Warbler was chosen to represent the open habitat niche group, and Dark-eyed Junco was chosen to represent the lowland habitat birds group.

Thirty-six migratory songbird species were detected during the 2017 breeding songbird surveys (Appendix 9-B). The highest species richness was observed in the regenerating forest types BS3 and BS7 (jack pine - blueberry/lichen and black spruce - blueberry/lichen), BS22 (leatherleaf shrubby poor fen), BS17 (black spruce treed bog), and BS21 (tamarack treed fen) ecosites. The lowest species richness was observed in the BS25 (open fen), BS19 (graminoid bog), and BS24 (graminoid fen) ecosites (Appendix 9-B). The highest mean number of breeding songbird pairs within the study areas was detected in the BS4 (jack pine – black spruce/feathermoss) and BS7 (black spruce/blueberry/lichen) ecosites. The lowest mean number of pairs was detected in the BS25 (open fen), BS24 (graminoid fen), and BS19 (graminoid bog) ecosites (Appendix 9-B). The ecosites with the highest species diversity were B22 (leatherleaf shrubby poor fen), regenerating forest types BS3 and BS7 (jack pine - blueberry/lichen and black spruce - blueberry/lichen), BS18 (Labrador tea shrubby bog), and BS21 (tamarack treed fen). The lowest species diversity was recorded in the BS25 (open fen), BS19 (graminoid bog), and BS24 (graminoid fen) ecosites (Appendix 9-B).

Considering the baseline data (Appendix 9-B), migratory songbird habitat is described in the following text without species-specific differentiation and referred to as available habitat for migratory songbirds. For the purposes of this assessment, all habitat types within the RSA could potentially be used by migratory songbirds for foraging or breeding opportunities.

Table 9.4-15 provides a summary of available habitat for migratory songbirds in the Project Area, Wildlife LSA and Terrestrial RSA. Ecosite codes and descriptions are adopted from Table 9.2-5. Figure 9.4-11 depicts available habitat for migratory songbirds in the Project study areas.

Table 9.4-15: Summary of Available Habitat for Migratory Songbirds in the Project Study Areas

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
AN	Anthropogenic disturbance	24.8	14.6	168.0	3.5	599.0	1.5
BS3	Jack pine - blueberry / lichen	31.1	18.3	1,693.7	35.0	10,374.8	25.8
BS4	Jack pine - black spruce / feathermoss	2.9	1.7	18.2	0.4	332.8	0.8
BS3 and BS7 (regenerating forest types)	Jack pine - blueberry / lichen and black spruce - blueberry / lichen	110.2	64.9	2,268.0	46.8	17,494.0	43.5
BS9	Black spruce - jack pine / feathermoss	0.3	0.2	12.3	0.3	148.5	0.4
BS14	White birch / lingonberry - Labrador tea	-	-	0.03	0.001	1.8	0.00
BS16	Black spruce/ balsam poplar / river alder swamp	-	-	-	-	8.8	0.02
BS17	Black spruce treed bog	0.4	0.2	98.8	2.0	1,157.1	2.9
BS18	Labrador tea shrubby bog	0.003	0.002	105.1	2.2	967.6	2.4
BS18 (regenerating bog types)	Labrador tea shrubby bog	-	-	-	-	22.3	0.1
BS19	Graminoid bog	-	-	10.0	0.2	160.5	0.4
BS19/24	Graminoid bog / Graminoid fen	-	-	2.4	0.05	2.4	0.01
BS20	Open bog	-	-	4.8	0.1	65.5	0.2
BS21	Tamarack treed fen	-	-	15.6	0.3	66.5	0.2
BS22	Leatherleaf shrubby poor fen	-	-	13.2	0.3	28.5	0.1
BS23	Willow shrubby rich fen	0.1	0.04	3.2	0.1	20.9	0.1

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS24	Graminoid fen	-	-	-	-	9.0	0.02
BS25	Open fen	-	-	2.1	0.04	5.7	0.01
BS26	Rush sandy shore	-	-	0.8	0.02	15.1	0.04
BS27	Sedge rocky shore	-	-	4.2	0.1	29.3	0.1
Waterbody	Lake	-	-	181.3	3.7	4,314.1	10.7
Waterbody	Waterbody	0.02	0.01	230.8	4.8	4,067.5	10.1
Total		**169.6**[1]	**100.0**	**4,842.7**[2]	**100.0**	**40,173.6**[3]	**100.0**

1, 2, 3 These areas represent the total area of available migratory songbird habitat within each study area; the percentages are the amount of available habitat relative to the Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha).

The characterization of the alteration and/or loss of habitat residual effect considers the Project effects on available habitat for migratory songbirds within the Wildlife LSA and Terrestrial RSA. As outlined in Table 9.4-15, the study areas provide habitat types that are potentially available to these avian species. While loss of habitat types is anticipated to affect migratory songbirds, due to the generalist strategy of most boreal bird species (Mahon et al. 2016) the loss of different habitats may affect bird groups differently. Loss of forested habitat is anticipated to have the most pronounced effect on the forest birds group, while loss of open habitat and lowland (bog and fen) habitat is anticipated to have the most pronounced effect on the open habitat birds group and the lowland habitat birds group, respectively.

Based on studies summarized in Section 9.4.3.2.1, and the SARGSS, which support the avoidance of sensitive species' habitats during sensitive periods (SK MOE 2017), alteration of available habitat for migratory songbirds is quantified by applying a buffer of 500 m around the Project Area in which Project effects in the form of sensory disturbance are assumed to affect available habitat and make it functionally unavailable for use. The SARGSS specify setback distances for several migratory songbird species between 100 m and 300 m from observed breeding birds for medium and high disturbance categories between April 21/May1 and July 31/August 31 (SK MOE 2017).

Progressive reclamation is anticipated to begin during Construction. However, a conservative approach is used, with migratory songbird habitat in the Project Area considered to be unavailable for the duration of the Project, only becoming available as habitat following Post-Decommissioning (i.e., during the regeneration of vegetation following Decommissioning).

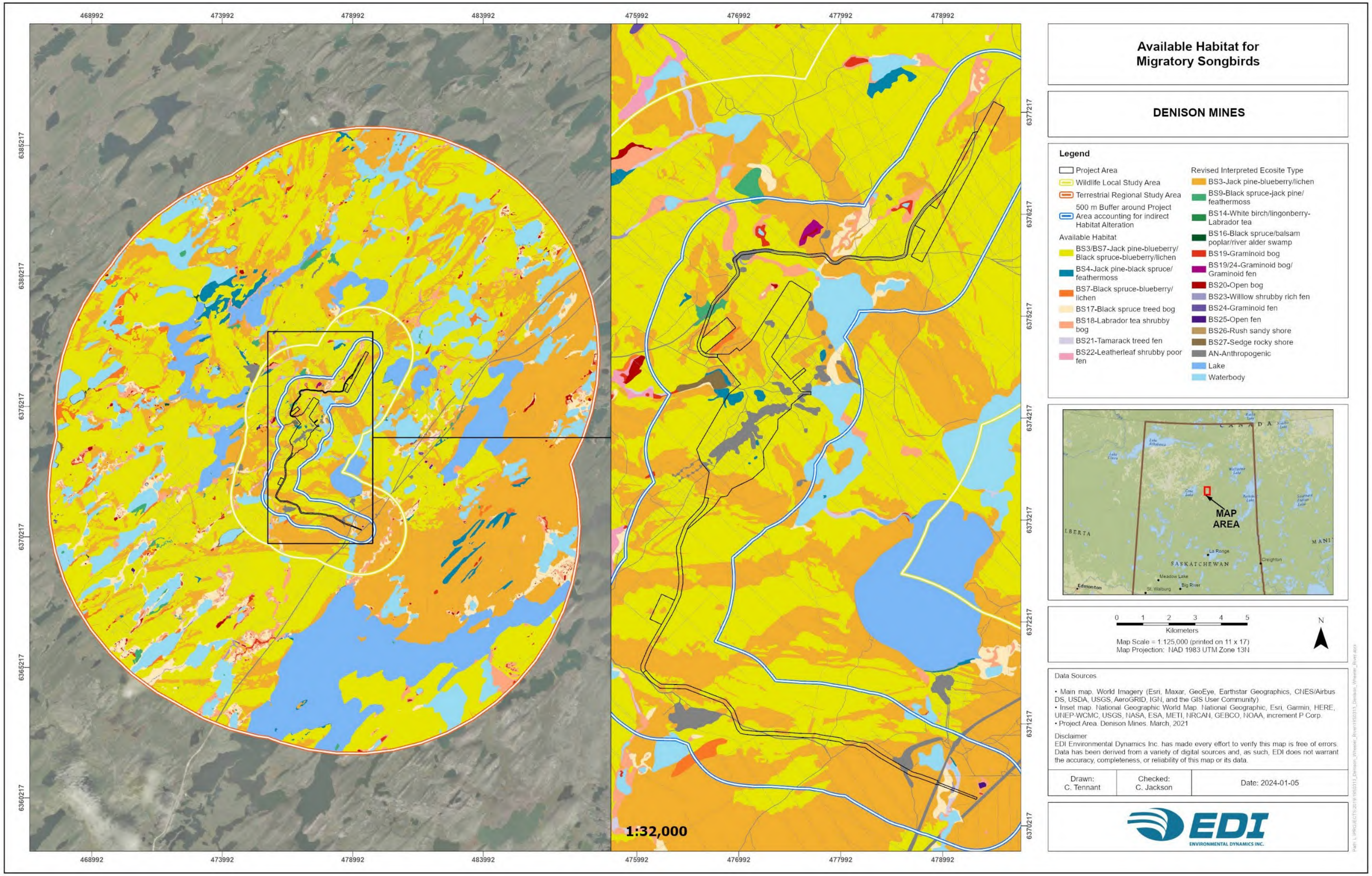

Figure 9.4-11: Available Habitat for Migratory Songbirds

Direct habitat loss is calculated as the area of available habitat for migratory songbirds lost due to site clearing within the Project Area. Direct habitat loss has been mitigated by reducing the size of the Project Area to the extent practicable during Project design; however, available habitat is still predicted to be cleared during the Construction Phase. In the Project Area, 169.6 ha or 100% of available habitat is assumed to be removed and will not be available to the migratory songbird species for the duration of the Project. The represents the removal of 3.5% of available habitat within the Wildlife LSA and of 0.4% within the Terrestrial RSA (Table 9.4-16).

An additional 30.1% (1,460.7 ha) of available habitat for migratory songbirds in the Wildlife LSA may experience habitat alteration resulting from indirect Project effects, such as sensory disturbance. In the Terrestrial RSA, 3.6% of available habitat may experience habitat alteration (Table 9.4-16). Mitigation measures outlined in Section 9.4.5 are anticipated to reduce the effects of alteration and/or loss of habitat on migratory songbirds, but not eliminate them.

Table 9.4-16: Summary of Available Habitat for Migratory Songbirds, Direct Habitat Loss, and Habitat Alteration in the Study Areas

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
Project Area	Anthropogenic disturbance	24.77	14.61	24.77	100	N/A	N/A
	BS3 Jack pine - blueberry / lichen	31.06	18.31	31.06	100	N/A	N/A
	BS4 Jack pine - black spruce / feathermoss	2.85	1.68	2.85	100	N/A	N/A
	BS7 Black spruce - blueberry / lichen	0.04	0.03	0.04	100	N/A	N/A
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry / lichen and black spruce - blueberry / lichen	110.16	64.95	110.16	100	N/A	N/A
	BS9 Black spruce - jack pine / feathermoss	0.29	0.17	0.29	100	N/A	N/A
	BS17 Black spruce treed bog	0.37	0.22	0.37	100	N/A	N/A
	BS18 Labrador tea shrubby bog	0.003	0.002	0.003	100	N/A	N/A
	BS23 Willow shrubby rich fen	0.07	0.04	0.07	100	N/A	N/A

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
	Waterbodies	0.02	0.01	0.02	100	N/A	N/A
	Total	**169.6**[2]	**100.0**	**169.6**	**100**	**N/A**	**N/A**
Wildlife LSA	Anthropogenic disturbance	168.33	3.48	24.77	14.72	79.91	47.47
	BS3 Jack pine - blueberry / lichen	1,693.69	34.97	31.06	1.83	476.16	28.11
	BS4 Jack pine - black spruce / feathermoss	18.16	0.38	2.85	15.71	6.22	34.25
	BS7 Black spruce - blueberry / lichen	9.82	0.20	0.04	0.45	5.34	54.33
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry / lichen and black spruce - blueberry / lichen	2,267.98	46.83	110.16	4.86	766.69	33.80
	BS9 Black spruce - jack pine / feathermoss	12.34	0.25	0.29	2.33	3.78	30.60
	BS14 White birch / lingonberry - Labrador tea	0.03	0.00	-	-	-	-
	BS17 Black spruce treed bog	98.76	2.04	0.37	0.37	22.37	22.66
	BS18 Labrador tea shrubby bog	105.06	2.17	0.003	0.003	30.01	28.56
	BS19 Graminoid bog	9.95	0.21	-	-	2.84	28.50
	BS19/24 Graminoid bog / Graminoid fen	2.39	0.05	-	-	2.39	100.00
	BS20 Open bog	4.82	0.10	-	-	0.56	11.58
	BS21 Tamarack treed fen	15.58	0.32	-	-	2.21	14.18
	BS22 Leatherleaf shrubby poor fen	13.21	0.27	-	-	-	-
	BS23 Willow shrubby rich fen	3.23	0.07	0.07	2.22	0.76	23.48
	BS25 Open fen	2.13	0.04	-	-	0.36	16.69

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
	BS26 Rush sandy shore	0.83	0.02	-	-	-	-
	BS27 Sedge rocky shore	4.19	0.09	-	-	4.15	99.21
	Waterbody – Lake	181.33	3.74	-	-	-	-
	Waterbody - Waterbody	230.85	4.77	0.02	0.01	56.97	24.68
	Total	**4,842.7**[3]	**100.0**	**169.6**	**3.50**	**1,460.7**	**30.16**
Wildlife RSA	Anthropogenic disturbance	600.07	1.49	24.77	4.13	79.91	13.32
	BS3 Jack pine - blueberry / lichen	10,374.79	25.82	31.06	0.30	476.16	4.59
	BS4 Jack pine - black spruce / feathermoss	332.76	0.83	2.85	0.86	6.22	1.87
	BS7 Black spruce - blueberry / lichen	280.99	0.70	0.04	0.02	5.34	1.90
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry / lichen and black spruce - blueberry / lichen	17,494.00	43.55	110.16	0.63	766.69	4.38
	BS9 Black spruce - jack pine / feathermoss	148.47	0.37	0.29	0.19	3.78	2.54
	BS14 White birch / lingonberry - Labrador tea	1.84	0.00	-	-	-	-
	BS16 Black spruce/ balsam poplar / river alder swamp	8.77	0.02	-	-	-	-
	BS17 Black spruce treed bog	1,157.07	2.88	0.37	0.03	22.37	1.93
	BS18 Labrador tea shrubby bog	967.57	2.41	0.00	0.00	30.01	3.10
	BS19 Graminoid bog	160.48	0.40	-	-	2.84	1.77
	BS19/24 Graminoid bog / Graminoid fen	2.39	0.01	-	-	2.39	100.00
	BS20 Open bog	65.45	0.16	-	-	0.56	0.85

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
	BS21 Tamarack treed fen	66.48	0.17	-	-	2.21	3.32
	BS22 Leatherleaf shrubby poor fen	28.49	0.07	-	-	-	-
	BS23 Willow shrubby rich fen	20.86	0.05	0.07	0.34	0.76	3.64
	BS24 Graminoid fen	9.04	0.02	-	-	-	-
	BS25 Open fen	5.72	0.01	-	-	0.36	6.21
	BS26 Rush sandy shore	15.10	0.04	-	-	-	-
	BS27 Sedge rocky shore	29.30	0.07	-	-	4.15	14.18
	Waterbody – Lake	4,314.13	10.74	-	-	-	-
	Waterbody – Waterbody	4,067.48	10.12	0.02	0.00	56.97	1.40
	Total	**40,173.6[4]**	**100.0**	**169.6**	**0.42**	**1,460.7**	**3.64**

1 Based on a 500 m buffer around the Project Area.

2, 3, 4 This area does not reflect the entire Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha) but represents the total area of available migratory songbird habitat in each study area.

N/A = Not Applicable

Residual Effects Characteristics for Migratory Breeding Birds

The residual effects characterization for the alteration and/or loss of available habitat for the Migratory Breeding Bird VC and its three KIs (waterbirds and waterfowl, upland gamebirds, migratory songbirds) is provided in Table 9.4-17.

The direction of the residual effect is predicted to be adverse. The Project is expected to affect available habitat directly (through habitat loss) and indirectly (through habitat alteration).

The magnitude is predicted to be low. Up to 1.6% of available habitat for waterbirds and waterfowl within the Terrestrial RSA is anticipated to be altered or lost as a result of the Project: 0.0002% of available habitat will be lost (localized to the Project Area) during Construction, and an additional 1.6% of available waterbird and waterfowl habitat may be altered through indirect effects during all Project phases (Table 9.4-12). For upland game birds (Table 9.4-14), 4.3% of available habitat within the Terrestrial RSA may be altered or lost as a result of the Project: 0.5% of available habitat will be lost within the Project Area during the Construction Phase, and an additional 3.8% of available habitat for upland game birds may be altered through indirect effects during all Project phases. Migratory songbirds may experience habitat loss and/or alteration affecting 4.1% of their available habitat within the Terrestrial RSA (Table 9.4-16): 0.6% of available habitat is expected to be lost during Construction, and an additional 3.5% of available habitat may be altered through indirect effects during all Project phases.

The residual effect is predicted to be local in geographic extent. While the direct loss of available habitat is expected to be limited to the Project Area during Construction and Operation, indirect Project effects are expected to occur in the Wildlife LSA, within a 500 to 1,000 m buffer around the Project Area during all Project phases.

The residual effect is predicted to occur over the long-term (i.e., longer than 38 years) because of the time required for available habitat to regenerate following disturbance. Differences may exist between habitat types depending on the areas and types of reclamation and the time frame for regeneration of vegetation within the reclaimed areas. Progressive reclamation is anticipated to begin in some parts of the Project Area following Construction; however, the revegetation within most of the Project Area will occur as part of reclamation activities during Decommissioning, up to 23 years after clearing during Construction. The Project Area is expected to support areas of suitable upland forest habitat after revegetation following Project completion and vegetation re-establishment within reclaimed areas. While avian species that prefer regenerating vegetation types would have suitable habitat available for their use earlier (i.e., medium-term), regeneration of disturbed areas into mature forests is expected to extend beyond Post-Decommissioning (i.e., long-term).

The frequency of the residual effect is predicted to be frequent. While loss of available habitat resulting from vegetation clearing during Construction will occur only initially, additional clearing for maintenance and safety purposes may happen throughout Operation. Alteration of available habitat within the Wildlife LSA through indirect Project effects is anticipated to be frequent throughout the Construction, Operation, and Decommissioning phases, and infrequent during Post-Decommissioning.

The residual effect is predicted to be fully reversible. Through progressive and final reclamation, disturbed areas within the Project Area will be revegetated with a focus on achieving the creation of a safe, stable, and self-sustaining landscape. Revegetated areas are anticipated to become available for avian species after Post-Decommissioning. Progressive reclamation may occur in some parts of the Project Area prior to Post-Decommissioning; however, most revegetation is anticipated to occur following the end of Operation and become available habitat following Post-Decommissioning. In addition, the alteration of available migratory breeding habitat is expected to be reversed within a similar time frame as sensory disturbances diminish with the ceasing of Project Operation and subsequent Decommissioning.

The context of the residual effect is predicted to be moderate. Migratory breeding birds have been exposed to historic and ongoing anthropogenic and natural disturbances throughout their ranges, including within the Terrestrial RSA (i.e., 1.5% of the Terrestrial RSA has currently experienced anthropogenic disturbances). Available habitat that is altered or cleared will remain so until Post-Decommissioning when final reclamation and revegetation will occur. Revegetated areas are expected to become available habitat within a few years of revegetation for some migratory breeding bird species that prefer habitat following disturbance at an early seral stage. While 36 species of migratory breeding birds were observed in the Terrestrial RSA (Appendix 9-B), data from the Canadian Wildlife Service Waterfowl Breeding Population and Habitat Survey showed declining trends for some waterbird and waterfowl species in their range, including Saskatchewan (Prairie Habitat Joint Venture 2014). In addition, songbird declines have been documented across North America. However, population trends in the northern boreal forest of Saskatchewan are not well documented (Van Wilgenburg 2015). Indigenous Knowledge reported declines in some species: *"In recent years, there are fewer … and bush chickens [i.e., Grouse species]"* (19-LK-ERFNTrap-134.163). It was also noted that less Ptarmigan, Canada Geese, Loons (in in the Cree Lake area outside of the Terrestrial RSA), and Mallards were observed (19-LK-ERFNTrap-134.164, 19-LK-ERFNTrap-134.166).

The residual effect of alteration and/or loss of available habitat for migratory breeding birds is predicted to be likely. Available habitat is expected to be lost during site clearing and the construction and installation of Project components and available habitat around the Project Area is expected to be indirectly affected.

Project mitigation measures identified in Section 9.4.5 are expected to limit the residual effect on migratory breeding birds. Although Project activities may result in migratory breeding bird habitat alteration and/or loss within the Wildlife LSA, with the implementation of mitigation measures, the residual effect is not expected to result in a change to their populations.

Table 9.4-17: Summary of the Characteristics Ratings for Alteration and/or Loss of Available Habitat for Migratory Breeding Birds

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project is expected to directly and indirectly affect available habitat for migratory breeding birds.
Magnitude	Low	<u>Waterbirds and waterfowl (Low):</u> 1.6% of available habitat for waterbirds and waterfowl within the Terrestrial RSA may be altered or lost: 0.0002% will be cleared during Construction, and an additional 1.6% may be altered through indirect effects during all Project phases. <u>Upland game birds (Low):</u> 4.3% of available habitat for upland game birds within the Terrestrial RSA may be altered or lost: 0.5% will be cleared during Construction, and an additional 3.8% may be altered through indirect effects during all Project phases. <u>Migratory songbirds (Low):</u> 4.1% of available habitat for migratory songbirds within the Terrestrial RSA may be altered or lost: 0.6 % will be cleared during Construction, and an additional 3.5% may be altered through indirect effects during all Project phases.

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Geographic Extent	Local	The direct loss of available habitat for migratory breeding birds is expected to be limited to the Project Area during Construction, and indirect effects resulting in habitat alteration are expected to be restricted to the Wildlife LSA during all Project phases.
Duration	Long-term	The loss of available habitat for migratory breeding birds will mainly occur during Construction; however, the alteration of habitat will continue through all phases. The reclamation and revegetation of the Project Area will not be complete until after completion of Post-Decommissioning at which time revegetated areas will become available habitat for migratory breeding birds that prefer mature forests.
Frequency	Frequent	Loss of available habitat for migratory breeding birds will occur initially during construction, and alteration of available habitat through indirect Project effects is anticipated to be frequent throughout all Project phases until Post-Decommissioning.
Reversibility	Fully Reversible	Disturbed habitat within the Project Area will be revegetated and will likely become available to migratory breeding birds after Post-Decommissioning. The alteration of available habitat for migratory breeding birds is expected to be reversed as sensory disturbances diminish with the ceasing of Project Operation and subsequent Decommissioning
Context	Moderate	Revegetated areas are expected to become available habitat for migratory breeding birds after areas are revegetated upon completion of the Project. Declining trends across North America have been recorded for some waterbird and waterfowl species as well as some migratory songbird species (Prairie Habitat Joint Venture 2014, Van Wilgenburg 2015). Indigenous Knowledge reported declines in Grouse, Ptarmigan, Canada Geese, Loons (outside the Terrestrial RSA), and Mallards (19-LK-ERFNTrap-134.163, 19-LK-ERFNTrap-134.164, 19-LK-ERFNTrap-134.166).
Likelihood	Likely	Available habitat for migratory breeding birds is expected to be cleared in the Project Area during Construction and to be indirectly affected in the Wildlife LSA during all phases of the Project.

Significance and Confidence

The residual effect of alteration and/or loss of available habitat for migratory breeding bird is not expected to result in a change that will alter their habitat integrity to the point where it would not be able to sustain the regional migratory breeding bird populations. Therefore, the effect is assessed as **not significant**.

The level of confidence of this prediction is moderate. The effects of habitat loss and alteration on migratory breeding bird species are well known, and proven, effective mitigation measures will be implemented. However, some level of uncertainty exists related to the available background and baseline information used to identify available habitat for the Migratory Breeding Bird VC and its three KIs in this assessment.

9.4.6.3.2 Change in Mortality

Change in mortality is assessed qualitatively by considering the residual effect of the Project on the abundance of the Migratory Breeding Bird VC, as represented by the three KIs (i.e., waterbirds and waterfowl, upland game birds, and migratory songbirds). The assessment includes considerations of direct mortality from Project activities and interactions with Project components, and indirect mortality as a result of the Project.

Given the diversity of migratory breeding bird species known to occur within the Terrestrial RSA, and considering their respective life requisites and behaviours, several sources of direct and indirect mortality were considered for the assessment of change in mortality on migratory breeding birds.

Potential sources of direct mortality include incidental take during Project-related site clearing and vegetation management; entrapment in Project components (e.g., buildings, pipes, vents, other enclosed spaces); collisions with Project-related vehicles, equipment, and components (e.g., buildings, windows), collisions with Project aircraft, and collisions with/electrocution caused by power transmission lines/energized equipment.

All migratory bird species are vulnerable to incidental take during Project-related site clearing and vegetation management, particularly those that build inconspicuous nests (e.g., ground-nesting species) or nest on buildings and other structures (e.g., Swallows) that require routine maintenance. Species that are more tolerant of anthropogenic activities and/or nest on buildings and other structures (e.g., swallows) may be more susceptible to entrapment in Project components. Entrapment may lead to exhaustion as the birds try to escape, and could result in dehydration, starvation, and eventual death (Loss et al. 2015, Vancouver Bird Advisory Committee 2015, University of British Columbia 2019). Species that use roadside habitats for nesting, feeding, and/or roosting (e.g., passerines that prefer early seral habitats) may be more susceptible to collisions with Project-related vehicles and mobile equipment. The low-flying daily movements of passerines and other migratory birds may increase their vulnerability to collisions with Project-related vehicles, mobile equipment, and components (e.g., buildings, windows). Waterbirds and waterfowl are generally less susceptible to these types of collisions (Erickson et al. 2005, Bishop and Brogan 2013, Machtans et al. 2013).

Large-bodied flocking birds (such as Swans, Geese, and Ducks) are considered at highest risk of bird strikes, but other groups, such as passerines, are also known to collide (less frequently) with aircraft at Canadian airports (Bird Strike Association of Canada 2021, Transport Canada 2019). The bird strike risk is amplified if the airport is close to suitable habitat that supports these species. Due to minimal aircraft traffic at the Project airstrip (approximately five flights per week during Operation) and the limited presence of waterbodies in the Project Area (i.e., habitat for waterbirds and waterfowl), the risk of collisions with migratory breeding birds with Project aircraft is considered low.

Larger-bodied birds (e.g., Swans, Geese, and Ducks) may be more susceptible to collisions with power transmission lines because they tend to be weaker fliers and/or lack the ability to quickly maneuver in flight (Avian Power Line Interaction Committee 2006, 2012, Loss et al. 2015). Larger birds may also be more susceptible to electrocution caused by contact with power transmission lines because their size can span the distance between energized equipment (Avian Power Line Interaction Committee 2006). Flocking species, inexperienced juvenile birds, or birds distracted by territorial or courtship displays, or aerial hunting activities may be at greater risk of collision and/or electrocution. Low-flying daily movements between nesting, feeding, and stopover habitats (e.g., movement of waterbirds between nearby wetlands) may also increase collision and electrocution risk with power transmission lines/energized equipment (Rioux et a. 2013).

Potential sources of indirect mortality for KIs of the Migratory Breeding Birds VC include nest failure or abandonment caused by sensory disturbance from Project activities; exhaustion and eventual collision with the ground or Project components caused by disorientation of nocturnal migrating birds by artificial light; and changes in hunting pressure and predator-prey dynamics caused by increased public access or Project-related edge effects.

Avian species are typically more sensitive to sensory disturbance during the breeding season (Sinnott 2000), with the degree of sensitivity varying depending on the species, individual, and type, level, frequency, and timing of disturbance. The effects of sensory disturbance on avian species (e.g., elevated stress levels; interference with communication or predator detection; interference with incubation or nestling provisioning) may lead to nest failure or abandonment, which could have implications for reproductive success and survival. The use of broad area artificial lighting (i.e., not focused or directed on specific areas with shielding to prevent stray light upwards) during spring and fall migrations could attract and disorient migrating birds within illuminated areas, which could lead to exhaustion and eventual collision with the ground or Project components. Species most susceptible to disorientation by artificial light include nocturnal migrants (e.g., passerines, waterbirds and waterfowl) (Arnold and Zink 2011, Longcore et al. 2012, Cabrera-Cruz et al. 2018).

Project-related edge effects or the increased use of access roads may increase hunter access (ERFN and SVS 2022) and, with that, the harvest of waterbirds and waterfowl and upland game birds. They could also alter prey availability and predator-prey dynamics within the Project Area and adjacent habitats, which could indirectly affect avian mortality (Francis et al. 2009, Rodewald et al. 2011, Bishop and Brogan 2013, Hethcoat and Chalfoun 2015). Species that use roadsides for nesting, feeding, and/or roosting (e.g., passerines that prefer early seral habitats) may be more susceptible to vegetation management practices, such as vegetation mowing or brush cutting.

Project mitigation measures identified in Section 9.4.5 are expected to limit interactions between migratory breeding birds and potential sources of direct and indirect mortality, thereby minimizing the residual effect of change in mortality. Although Project activities may result in a change of direct and/or indirect mortality of migratory breeding birds within the Terrestrial RSA, with the implementation of mitigation measures, the residual effect is not expected to result in a change to their populations.

Residual Effect Characteristics

The residual effect characteristics for change in mortality on the Migratory Breeding Birds VC are summarized below and provided in Table 9.4-18.

The direction of the residual effect of change in mortality is predicted to be adverse. While it is expected that the risks for Project-related migratory breeding bird mortalities is limited (due to effective mitigation measures), any additional mortality may affect the avian populations.

The magnitude is predicted to be low. Mitigation measures are expected to limit the potential for interactions between the Migratory Breeding Birds VC and potential sources of direct and/or indirect mortality. Loss and alteration of available habitat for migratory breeding birds are expected as a result of the Project (Table 9.4-12, Table 9.4-14, and Table 9.4-16), resulting in a limited number of individuals to likely interact with the Project and experiencing direct and/or indirect sources of mortality. Individuals displaced by the Project are expected to relocate to areas of available habitat within the Wildlife LSA and Terrestrial RSA, thereby limiting the potential for further interactions with the Project. Available habitat is not considered to be a limiting factor within the Wildlife LSA and Terrestrial RSA (i.e., the available habitat is expected to be able to support the low numbers of displaced individuals).

The geographic extent is predicted to be regional. While most direct mortality is expected to be limited to the Project Area, effects from power transmission lines, indirect mortality related to edge effects, sensory disturbance, increased public access, and exposure to hazardous materials are expected to extend into adjacent habitats within the Wildlife LSA and may affect migratory breeding birds in the Terrestrial RSA.

The duration is predicted to occur over the long-term (i.e., longer than 38 years). Sources of direct mortality and most sources of indirect mortality are expected to occur during the Construction and Operation phases and the residual effects are expected to persist until Project activities cease, Project components are removed during Decommissioning, and disturbed areas are reclaimed at the end of Post-Decommissioning (i.e., medium-term). Indirect sources of mortality related to edge effects are expected to occur during Construction; however, the residual effects are expected to persist until disturbed areas are reclaimed, and vegetation has re-established within reclaimed areas, which may include a time frame that differs between avian species. Regeneration of disturbed areas to mature forest habitat, preferred by some species, is expected to extend beyond Post-Decommissioning (i.e., long-term).

The frequency is predicted to be infrequent. Direct and/or indirect mortality could occur sporadically through all Project phases and occurrences of mortality are expected to be isolated and infrequent events given the implementation of mitigation measures.

The residual effect is predicted to be fully reversible once Project activities cease, Project components are removed, disturbed habitats are reclaimed, and vegetation has re-established within reclaimed areas.

The context is predicted to be moderate. Migratory breeding birds have been exposed to historic and ongoing anthropogenic and natural disturbances throughout their ranges, including within the Terrestrial RSA (i.e., 1.5% of the Terrestrial RSA has currently experienced anthropogenic disturbances). The Project is expected to interact with a limited number of individuals that may be affected by direct and/or indirect sources of mortality. While waterbirds and waterfowl, upland game birds, and migratory songbirds are generally considered secure in Saskatchewan, declining trends for some waterbird and waterfowl species in their range, including Saskatchewan, have been reported (Prairie Habitat Joint Venture 2014). Declines in songbird populations have been documented across North America; however, population trends in the northern boreal forest of Saskatchewan are not well documented (Van Wilgenburg 2015). Indigenous Knowledge reported declines in some species: *"In recent years, there are fewer … and bush chickens [i.e., Grouse species]"* (19-LK-ERFNTrap-134.163). It was also noted that less Ptarmigan, Canada Geese, Loons (in some lakes outside the Terrestrial RSA), and Mallards were observed (19-LK-ERFNTrap-134.164, 19-LK-ERFNTrap-134.166).

The residual effect is predicted to be likely. Several species of the Migratory Breeding Bird VC were observed during baseline studies (Appendix 9-B) and available habitat for the three KIs is present within the Project study areas; therefore, it is possible that Project activities may interact with migratory breeding birds and result in direct and/or indirect mortality.

Project mitigation measures identified in Section 9.4.5 are expected to limit interactions between migratory breeding birds and potential sources of direct and indirect mortality, thereby minimizing the residual effect of change in mortality. Although Project activities may result in a change of direct and/or indirect mortality of migratory breeding birds within the Terrestrial RSA, with the implementation of mitigation measures, the residual effect is not expected to result in a change to their populations.

Table 9.4-18: Summary of the Characteristics Ratings for Change in Mortality of Migratory Breeding Birds

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project is expected to affect a change in mortality of migratory breeding birds.
Magnitude	Low	Mitigation measures are anticipated to be effective at reducing the potential for a change in direct and indirect mortality, and the risk of mortality is expected to be within the range of natural variability.
Geographic Extent	Regional	The change in direct mortality is expected to occur mainly within the Project Area; however, indirect migratory breeding bird mortality may extend into the Wildlife LSA and the Terrestrial RSA.

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Duration	Long-term	Migratory breeding bird mortality may occur during all phases of the Project. The potential for a change in direct mortality is expected to be highest during Construction and Operation and the potential for indirect mortality is expected to be highest during Operation, decreasing during Decommissioning, and limited during Post-Decommissioning. Regeneration of disturbed areas to mature forest habitat, preferred by some avian species, is expected to extend beyond Post-Decommissioning.
Frequency	Infrequent	The potential for a change in direct and indirect migratory breeding bird mortality is expected to be limited, but the residual effect may occur sporadically throughout the life of the Project.
Reversibility	Fully Reversible	The change in mortality of migratory breeding birds is anticipated to decline during Decommissioning following the removal of Project components and a reduction in Project activities and diminish to baseline conditions following Post-Decommissioning.
Context	Moderate	The Project is expected to interact with a limited number of migratory breeding birds that may be affected by direct and/or indirect sources of mortality. While waterbirds and waterfowl, upland game birds, and migratory songbirds are generally considered secure in Saskatchewan, declining trends for some waterbird and waterfowl species in their range have been reported (Prairie Habitat Joint Venture 2014) and songbird declines have been documented across North America (Van Wilgenburg 2015). Indigenous Knowledge reported declines Grouse, Ptarmigan, Canada Geese, Loons (in some lakes), and Mallards (19-LK-ERFNTrap-134.163, 19-LK-ERFNTrap-134.164, 19-LK-ERFNTrap-134.166).
Likelihood	Likely	Mitigation measures are expected to reduce, but not fully eliminate the residual effect on migratory breeding birds.

Significance and Confidence

The residual effect of change in mortality is not expected to result in a change in mortality that will alter the integrity of the migratory breeding bird populations to the point where the regional populations could not be sustained. Therefore, the effect is assessed as **not significant**.

The level of confidence of this prediction is moderate. The risks of increased mortality are well known, and proven, effective mitigation measures will be implemented. Mitigation is anticipated to reduce the change in direct and indirect mortality of the migratory breeding bird species to levels within the range of natural variability. However, some level of uncertainty exists regarding the status of the regional populations and, with that, their ability to assimilate limited additional mortality.

9.4.6.4 Residual Effects Evaluation for Bird Species at Risk

The Bird Species at Risk VC is represented by five KIs – Common Nighthawk, Short-eared Owl, Yellow Rail, Rusty Blackbird, and Olive-sided Flycatcher. The residual effects evaluation, therefore, assesses Project-related effects on these five species.

9.4.6.4.1 Alteration and/or Loss of Habitat

The assessment of the alteration and/or loss of habitat residual effect considers the direct loss of habitat and the indirect alteration (e.g., sensory disturbances, habitat fragmentation, and edge effects) of habitat during all Project phases.

Common Nighthawk

During the 2017 to 2019 baseline surveys, a total of 83 auditory and visual incidental observations of Common Nighthawk were recorded in the Wildlife LSA and Terrestrial RSA (Appendix 9-B). Seven Common Nighthawks were detected in the Terrestrial RSA and 14 were detected in the Wildlife LSA (Appendix 9-B). Additionally, two Common Nighthawk nests were detected near the Project Area.

The HABISask database (SK MOE 2021c) confirmed observations of Common Nighthawk between 2011 and 2019 within a 10-km radius around the Project Area (Table 9.4-4). However, no locations or habitat associations were provided.

Auditory and visual incidental observations made during baseline surveys, although not associated with specific habitat types, showed that the Project Area, Wildlife LSA, and Terrestrial RSA provide habitat for Common Nighthawk (Appendix 9-B). Based on their habitat requirements described in Section 9.4.3.3.1, regenerating forest and cleared areas provide suitable habitat for the species (COSEWIC 2018a) and are used to describe available habitat for Common Nighthawk in the study areas.

The mix of regenerating forest ecosites (i.e., BS3 and BS7 [jack pine – blueberry/lichen and black spruce - blueberry/lichen]) comprise 64.9%, 46.8% and 43.5% of the Project Area, Wildlife LSA, and Terrestrial RSA, respectively, and anthropogenic disturbance features (commonly used by Common Nighthawk [COSEWIC 2018a]) currently cover 14.6%, 3.5% and 1.5% of the Project Area, Wildlife LSA, and Terrestrial RSA, respectively. For the purposes of this assessment, all habitat types within the RSA could potentially be used by Common Nighthawks for foraging or breeding opportunities (Table 9.4-19).

Table 9.4-19 provides a summary of available habitat for Common Nighthawk in the Project Area, Wildlife LSA and Terrestrial RSA. Ecosite codes and descriptions are adopted from Table 9.2-5. Figure 9.4-12 depicts available habitat for Common Nighthawk in the Project study areas.

Table 9.4-19: Summary of Available Common Nighthawk Habitat in the Project Study Areas

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
AN	Anthropogenic disturbance	24.8	14.6	168.0	3.5	599.0	1.5
BS3	Jack pine - blueberry / lichen	31.1	18.3	1693.7	35.0	10374.8	25.8
BS4	Jack pine - black spruce / feathermoss	2.9	1.7	18.2	0.4	332.8	0.8

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS3 and BS7 (regenerating forest types)	Jack pine - blueberry / lichen and black spruce - blueberry / lichen	110.2	64.9	2,268.0	46.8	17,494.0	43.5
BS9	Black spruce - jack pine / feathermoss	0.3	0.2	12.3	0.3	148.5	0.4
BS14	White birch / lingonberry - Labrador tea	-	-	0.03	0.001	1.8	0.00
BS16	Black spruce/ balsam poplar / river alder swamp	-	-	-	-	8.8	0.02
BS17	Black spruce treed bog	0.4	0.2	98.8	2.0	1157.1	2.9
BS18	Labrador tea shrubby bog	0.003	0.002	105.1	2.2	967.6	2.4
BS18 (regenerating bog types)	Labrador tea shrubby bog	-	-	-	-	22.3	0.1
BS19	Graminoid bog	-	-	10.0	0.2	160.5	0.4
BS19/24	Graminoid bog / Graminoid fen	-	-	2.4	0.05	2.4	0.01
BS20	Open bog	-	-	4.8	0.1	65.5	0.2
BS21	Tamarack treed fen	-	-	15.6	0.3	66.5	0.2
BS22	Leatherleaf shrubby poor fen	-	-	13.2	0.3	28.5	0.1
BS23	Willow shrubby rich fen	0.1	0.04	3.2	0.1	20.9	0.1
BS24	Graminoid fen	-	-	-	-	9.0	0.02
BS25	Open fen	-	-	2.1	0.04	5.7	0.01
BS26	Rush sandy shore	-	-	0.8	0.02	15.1	0.04
BS27	Sedge rocky shore	-	-	4.2	0.1	29.3	0.1
Waterbody	Lake	-	-	181.3	3.7	4314.1	10.7
Waterbody	Waterbody	0.02	0.01	230.8	4.8	4067.5	10.1
Total		**169.6**[1]	**100.0**	**4,842.7**[2]	**100.0**	**40,173.6**[3]	**100.0**

1, 2, 3 These areas represent the total area of available Common Nighthawk habitat within each study area; the percentages are the amount of available habitat relative to the Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha).

The characterization of the alteration and/or loss of habitat residual effect considers the Project effects on available Common Nighthawk habitat within the Wildlife LSA and Terrestrial RSA. As outlined in Table 9.4-19, the study areas provide available habitat types for this species.

Based on studies summarized in Section 9.4.3.2.1, and the SARGSS, which support the avoidance of sensitive species' habitats during sensitive periods (SK MOE 2017), alteration of available habitat for Common Nighthawk is quantified by applying a buffer of 500 m around the Project Area in which Project effects in the form of sensory disturbance are assumed to affect available habitat and make it functionally unavailable for use. For Common Nighthawk, the SARGSS specify setback distances between 100 m and 200 m around nesting birds for medium and high disturbance categories, respectively, between May 1 and August 31 (SK MOE 2017).

Progressive reclamation is anticipated to begin during Construction. However, a conservative approach is used, with Common Nighthawk habitat in the Project Area considered to be unavailable for the duration of the Project, only becoming available as habitat following Post-Decommissioning (i.e., during the regeneration of vegetation following Decommissioning).

In addition to regenerating forest types, Common Nighthawk use cleared areas resulting from anthropogenic disturbances (COSEWIC 2018a). Therefore, Project-related direct habitat loss (including already disturbed areas) is considered to be temporary, and some areas cleared for the Project may return to available Common Nighthawk habitat as soon as Project activities cease. However, in this residual effects evaluation, direct habitat loss is calculated as the area of available Common Nighthawk habitat (including previously disturbed areas) lost due to site clearing within the Project Area. Direct habitat loss has been mitigated by reducing the size of the Project Area to the extent practicable during Project design; however, available habitat is still predicted to be cleared during the Construction Phase. In the Project Area, 169.6 ha or 100% of available habitat is assumed to be removed and will not be available to Common Nighthawk for the duration of Project activities, which represents the removal of 3.5% of available habitat in the Wildlife LSA and 0.4% in the Terrestrial RSA (Table 9.4-20).

An additional 30.1% (1,460.7 ha) of available Common Nighthawk habitat in the Wildlife LSA may experience habitat alteration resulting from indirect Project effects, such as sensory disturbance and in the Terrestrial RSA, 3.6% of available habitat may experience habitat alteration (Table 9.4-20). Mitigation measures outlined in Section 9.4.5 are anticipated to reduce the effects of alteration and/or loss of habitat on Common Nighthawk, but not eliminate them.

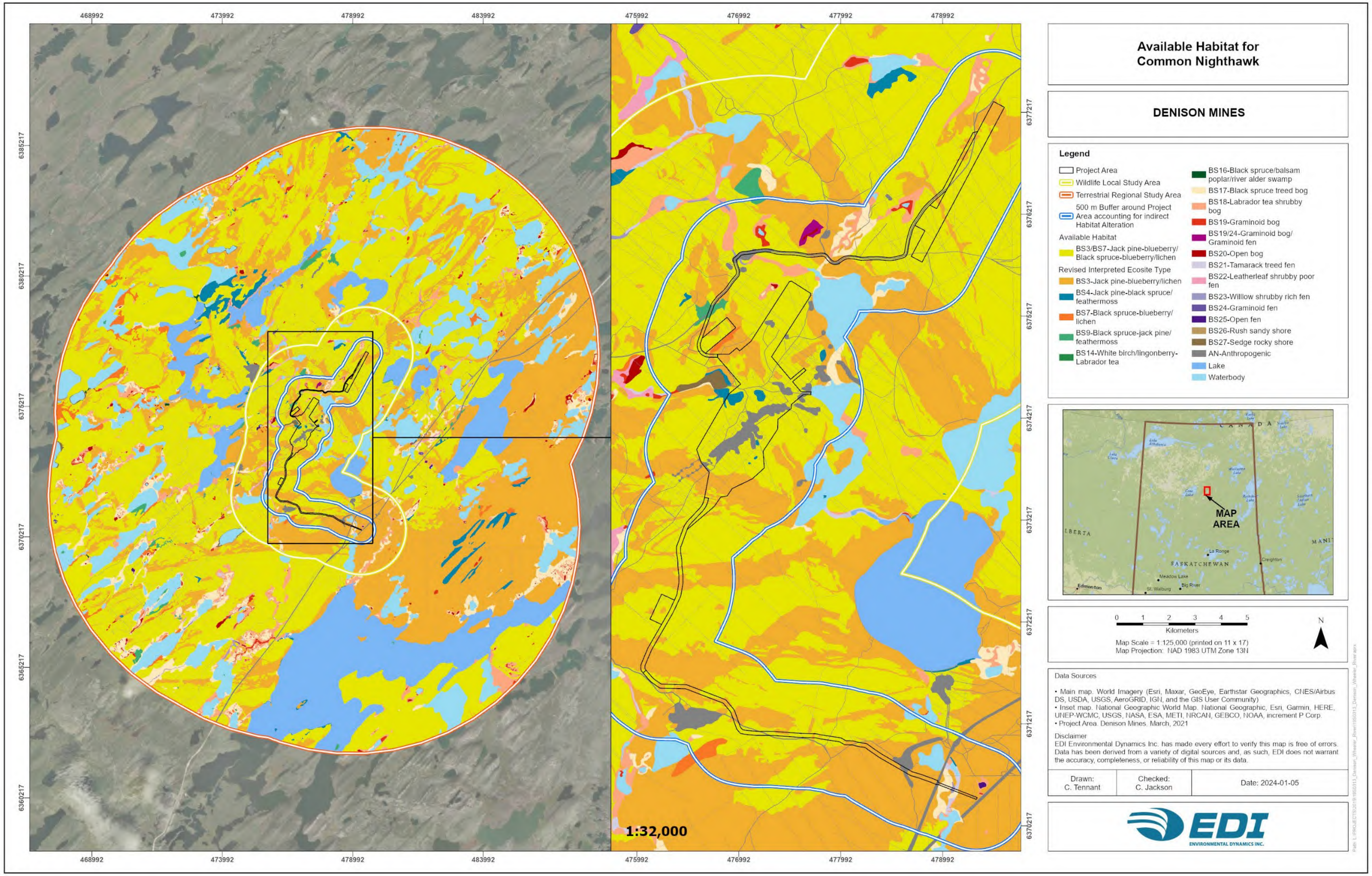

Figure 9.4-12: Available Habitat for Common Nighthawk

Table 9.4-20: Summary of Available Common Nighthawk Habitat, Direct Habitat Loss, and Habitat Alteration in the Study Areas

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
Project Area	Anthropogenic disturbance	24.77	14.61	24.77	100	N/A	N/A
	BS3 Jack pine - blueberry / lichen	31.06	18.31	31.06	100	N/A	N/A
	BS4 Jack pine - black spruce / feathermoss	2.85	1.68	2.85	100	N/A	N/A
	BS7 Black spruce - blueberry / lichen	0.04	0.03	0.04	100	N/A	N/A
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry / lichen and black spruce - blueberry / lichen	110.16	64.95	110.16	100	N/A	N/A
	BS9 Black spruce - jack pine / feathermoss	0.29	0.17	0.29	100	N/A	N/A
	BS17 Black spruce treed bog	0.37	0.22	0.37	100	N/A	N/A
	BS18 Labrador tea shrubby bog	0.003	0.002	0.003	100	N/A	N/A
	BS23 Willow shrubby rich fen	0.07	0.04	0.07	100	N/A	N/A
	Waterbodies	0.02	0.01	0.02	100	N/A	N/A
	Total	**169.6[2]**	**100.0**	**169.6**	**100**	**N/A**	**N/A**
Wildlife LSA	Anthropogenic disturbance	168.33	3.48	24.77	14.72	79.91	47.47
	BS3 Jack pine - blueberry / lichen	1,693.69	34.97	31.06	1.83	476.16	28.11
	BS4 Jack pine - black spruce / feathermoss	18.16	0.38	2.85	15.71	6.22	34.25
	BS7 Black spruce - blueberry / lichen	9.82	0.20	0.04	0.45	5.34	54.33
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry /	2,267.98	46.83	110.16	4.86	766.69	33.80

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
	lichen and black spruce - blueberry / lichen						
	BS9 Black spruce - jack pine / feathermoss	12.34	0.25	0.29	2.33	3.78	30.60
	BS14 White birch / lingonberry - Labrador tea	0.03	0.00	-	-	-	-
	BS17 Black spruce treed bog	98.76	2.04	0.37	0.37	22.37	22.66
	BS18 Labrador tea shrubby bog	105.06	2.17	0.003	0.003	30.01	28.56
	BS19 Graminoid bog	9.95	0.21	-	-	2.84	28.50
	BS19/24 Graminoid bog / Graminoid fen	2.39	0.05	-	-	2.39	100.00
	BS20 Open bog	4.82	0.10	-	-	0.56	11.58
	BS21 Tamarack treed fen	15.58	0.32	-	-	2.21	14.18
	BS22 Leatherleaf shrubby poor fen	13.21	0.27	-	-	-	-
	BS23 Willow shrubby rich fen	3.23	0.07	0.07	2.22	0.76	23.48
	BS25 Open fen	2.13	0.04	-	-	0.36	16.69
	BS26 Rush sandy shore	0.83	0.02	-	-	-	-
	BS27 Sedge rocky shore	4.19	0.09	-	-	4.15	99.21
	Waterbody – Lake	181.33	3.74	-	-	-	-
	Waterbody - Waterbody	230.85	4.77	0.02	0.01	56.97	24.68
	Total	**4,842.7[3]**	**100.0**	**169.6**	**3.50**	**1,460.7**	**30.16**
Wildlife RSA	Anthropogenic disturbance	600.07	1.49	24.77	4.13	79.91	13.32
	BS3 Jack pine - blueberry / lichen	10,374.79	25.82	31.06	0.30	476.16	4.59
	BS4 Jack pine - black spruce / feathermoss	332.76	0.83	2.85	0.86	6.22	1.87

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
	BS7 Black spruce - blueberry / lichen	280.99	0.70	0.04	0.02	5.34	1.90
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry / lichen and black spruce - blueberry / lichen	17,494.00	43.55	110.16	0.63	766.69	4.38
	BS9 Black spruce - jack pine / feathermoss	148.47	0.37	0.29	0.19	3.78	2.54
	BS14 White birch / lingonberry - Labrador tea	1.84	0.00	-	-	-	-
	BS16 Black spruce/ balsam poplar / river alder swamp	8.77	0.02	-	-	-	-
	BS17 Black spruce treed bog	1,157.07	2.88	0.37	0.03	22.37	1.93
	BS18 Labrador tea shrubby bog	967.57	2.41	0.00	0.00	30.01	3.10
	BS19 Graminoid bog	160.48	0.40	-	-	2.84	1.77
	BS19/24 Graminoid bog / Graminoid fen	2.39	0.01	-	-	2.39	100.00
	BS20 Open bog	65.45	0.16	-	-	0.56	0.85
	BS21 Tamarack treed fen	66.48	0.17	-	-	2.21	3.32
	BS22 Leatherleaf shrubby poor fen	28.49	0.07	-	-	-	-
	BS23 Willow shrubby rich fen	20.86	0.05	0.07	0.34	0.76	3.64
	BS24 Graminoid fen	9.04	0.02	-	-	-	-
	BS25 Open fen	5.72	0.01	-	-	0.36	6.21
	BS26 Rush sandy shore	15.10	0.04	-	-	-	-
	BS27 Sedge rocky shore	29.30	0.07	-	-	4.15	14.18
	Waterbody – Lake	4,314.13	10.74	-	-	-	-

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
	Waterbody – Waterbody	4,067.48	10.12	0.02	0.00	56.97	1.40
	Total	**40,173.6[4]**	**100.0**	**169.6**	**0.42**	**1,460.7**	**3.64**

1 Based on a 500 m buffer around the Project Area.

2, 3, 4 This area does not reflect the entire Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha) but represents the total area of available Common Nighthawk habitat in each study area.

N/A = Not Applicable

Short-eared Owl

No Short-eared Owl observations occurred during the baseline surveys (Appendix 9-B) and no known occurrences were reported within a 10-km area around the Project Area in the HABISask database (Table 9.4-4; SK MOE 2021c).

As described in Section 9.4.3.3.1, Short-eared Owl largely avoid forested areas in their northern range (COSEWIC 2008), limiting the available habitat for this species in the study areas to shrubby, graminoid, and open bog and fen habitat types. These bog and fen ecosites combined are considered to provide limited available habitat for Short-eared Owl in the Project Area (0.04%), the Wildlife LSA (3.0%), and the Terrestrial RSA (3.3%) (Table 9.4-21).

Table 9.4-21 provides a summary of available Short-eared Owl habitat in the Project Area, Wildlife LSA and Terrestrial RSA. Ecosite codes and descriptions are adopted from Table 9.2-5.

Figure 9.4-13 depicts available Short-eared Owl habitat in the Project study areas.

Table 9.4-21: Summary of Available Short-eared Owl Habitat in the Project Study Areas

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS18	Labrador tea shrubby bog	0.003	0.002	105.1	2.2	990.0	2.5
BS19	Graminoid bog	-	-	10.0	0.2	160.5	0.4
BS19/24	Graminoid bog / Graminoid fen	-	-	2.4	0.05	2.4	0.006
BS20	Open bog	-	-	4.8	0.1	65.5	0.2
BS22	Leatherleaf shrubby poor fen	-	-	13.2	0.3	28.5	0.1
BS23	Willow shrubby rich fen	0.1	0.04	3.2	0.1	20.9	0.1
BS24	Graminoid fen	-	-	-	-	9.0	0.02
BS25	Open fen	-	-	2.1	0.04	5.7	0.01

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
Total		**0.1[1]**	**0.04**	**140.8[2]**	**3.0**	**1,282.5[3]**	**3.3**

1, 2, 3 These areas represent the total area of available Short-eared Owl habitat within each study area; the percentages are the amount of available habitat relative to the Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha).

The characterization of the alteration and/or loss of habitat residual effect considers the Project effects on available Short-eared Owl habitat within the Wildlife LSA and Terrestrial RSA. As summarized in Table 9.4-21, the study areas provide limited available habitat for this species.

Based on studies summarized in Section 9.4.3.2.1, and the SARGSS, which support the avoidance of sensitive species' habitats during sensitive periods (SK MOE 2017), alteration of available habitat for Short-eared Owl is quantified by applying a buffer of 500 m around the Project Area in which Project effects in the form of sensory disturbance are assumed to affect available habitat and make it functionally unavailable for use. For Short-eared Owls, the SARGSS specify setback distances between 300 m and 500 m around nesting birds for medium and high disturbance categories, respectively, between March 25 and August 1 (SK MOE 2017).

Progressive reclamation is anticipated to begin during Construction. However, a conservative approach is used, with Short-eared Owl habitat in the Project Area considered to be unavailable for the duration of the Project, only becoming available as habitat following Post-Decommissioning (i.e., during the regeneration of vegetation following Decommissioning).

Project-related direct habitat loss is calculated as the area of available Short-eared Owl habitat lost due to site clearing within the Project Area. Direct habitat loss has been mitigated by reducing the size of the Project Area to the extent practicable during Project design; however, available habitat is still predicted to be cleared during Construction. In the Project Area, 0.1 ha or 100% of available habitat is assumed to be removed and will not be available to Short-eared Owl for the duration of Project activities, which represents the removal of 0.1% of available habitat in the Wildlife LSA and 0.01%in the Terrestrial RSA (Table 9.4-22).

An additional 26.2% (36.9 ha) of available Short-eared Owl habitat in the Wildlife LSA may experience habitat alteration resulting from indirect Project effects, such as sensory disturbance, representing 2.9% of available habitat within the Terrestrial RSA that may experience habitat alteration (Table 9.4-22). Mitigation measures outlined in Section 9.4.5 are anticipated to reduce the effects of alteration and/or loss of habitat on Short-eared Owl, but not eliminate them.

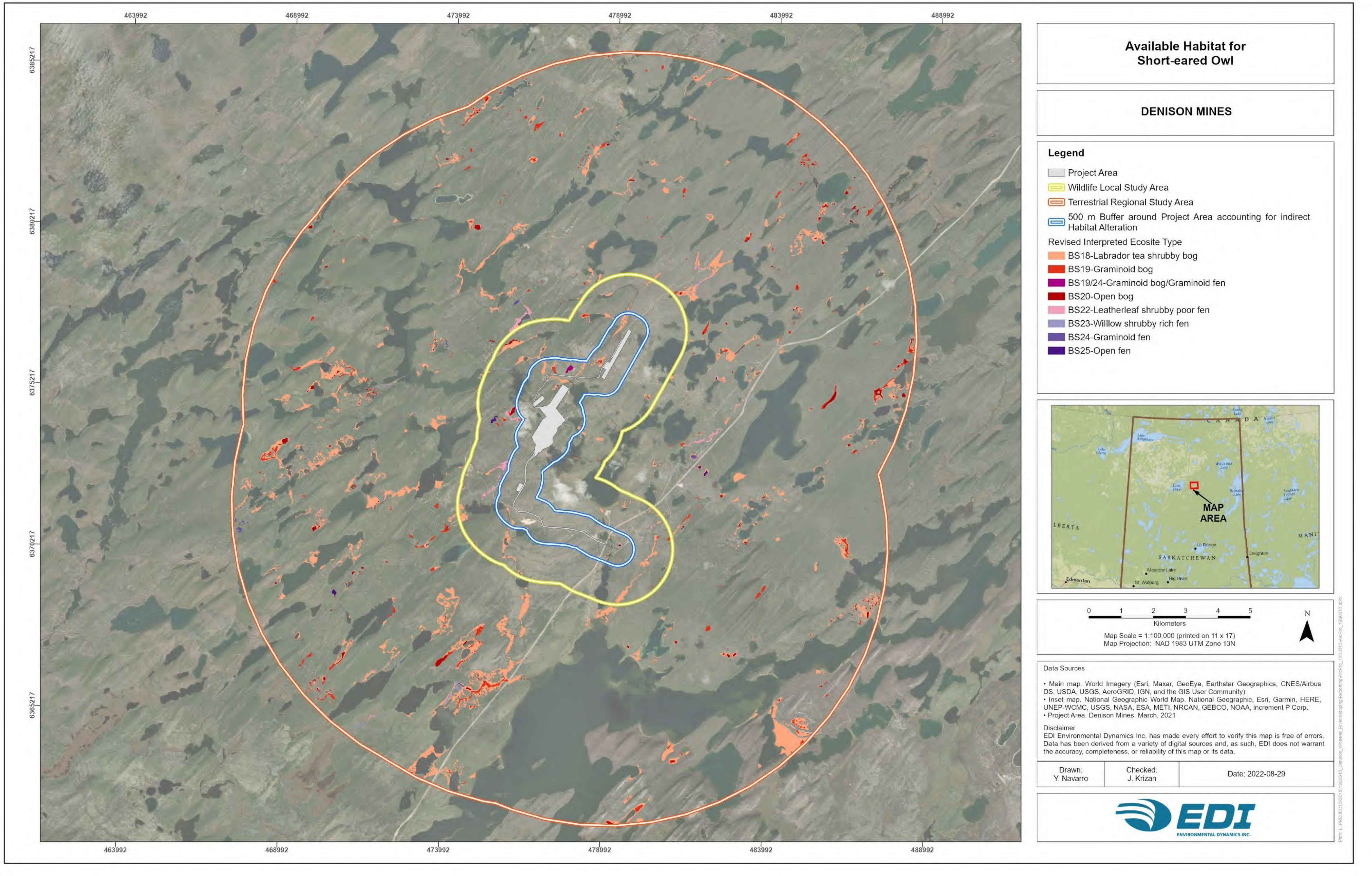

Figure 9.4-13: Available Habitat for Short-eared Owl

Table 9.4-22: Summary of Available Short-eared Owl Habitat, Direct Habitat Loss, and Habitat Alteration in the Study Areas

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
Project Area	BS18 Labrador tea shrubby bog	0.003	0.002	0.003	100	N/A	N/A
	BS19 Graminoid bog	-	-	-	-	-	-
	BS19 / BS24 Graminoid bog / Graminoid fen	-	-	-	-	-	-
	BS20 Open bog	-	-				
	BS22 Leatherleaf shrubby poor fen	-	-	-	-	-	-
	BS23 Willow shrubby rich fen	0.1	0.04	0.1	100	N/A	N/A
	BS24 Graminoid fen	-	-	-	-	-	-
	BS25 Open fen	-	-				
	Total	**0.1[2]**	**0.04**	**0.1**	**100**	**N/A**	**N/A**
Wildlife LSA	BS18 Labrador tea shrubby bog	105.1	2.2	0.003	0.003	30.0	28.6
	BS19 Graminoid bog	10.0	0.2	-	-	2.8	28.5
	BS19 / BS24 Graminoid bog / Graminoid fen	2.4	0.05	-	-	2.4	100
	BS20 Open bog	4.8	0.1	-	-	0.6	11.6
	BS22 Leatherleaf shrubby poor fen	13.2	0.3	-	-	-	-
	BS23 Willow shrubby rich fen	3.2	0.1	0.1	2.2	0.7	21.3
	BS24 Graminoid fen	-	-	-	-	-	-
	BS25 Open fen	2.1	0.04	-	-	0.4	16.7
	Total	**140.8[3]**	**3.0**	**0.1**	**0.1**	**36.9**	**26.2**
Terrestrial RSA	BS18 Labrador tea shrubby bog	990.0	2.5	0.003	0.0003	30.0	3.0
	BS19 Graminoid bog	160.5	0.4	-	-	2.8	1.8

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
	BS19 / BS24 Graminoid bog / Graminoid fen	2.4	0.006	-	-	2.4	100
	BS20 Open bog	65.5	0.2	-	-	0.6	0.9
	BS22 Leatherleaf shrubby poor fen	28.5	0.1	-	-	-	-
	BS23 Willow shrubby rich fen	20.9	0.05	0.1	0.3	0.7	3.3
	BS24 Graminoid fen	9.0	0.02	-	-	-	-
	BS25 Open fen	5.7	0.01	-	-	0.4	6.2
	Total	**1,282.5[4]**	**3.3**	**0.1**	**0.01**	**36.9**	**2.9**

1 Based on a 500 m buffer around the Project Area.

2, 3, 4 This area does not reflect the entire Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha) but represents the total area of available Short-eared Owl habitat in each study area.

N/A = Not Applicable

Yellow Rail

No Yellow Rail observations occurred during the baseline surveys (Appendix 9-B) and no known occurrences were reported within a 10-km area around the Project Area in the HABISask database (Table 9.4-4; SK MOE 2021c).

As described in Section 9.4.3.3.1, Yellow Rail prefer shallow, vegetated wetlands (Leston and Bookhout 2020), limiting the available habitat for this species in the study areas to treed, shrubby, graminoid and open bog and fen habitat types. These bog and fen ecosites combined are considered to provide limited available habitat for Yellow Rail with 0.2%, 5.3%, and 6.4% of the Project Area, Wildlife LSA, and Terrestrial RSA, respectively (Table 9.4-23).

Table 9.4-23 provides a summary of available Yellow Rail habitat in the Project Area, Wildlife LSA and Terrestrial RSA. Ecosite codes and descriptions are adopted from Table 9.2-5. Figure 9.4-14 depicts available habitat for Yellow Rail (and Rusty Blackbird) in the Project study areas.

Table 9.4-23: Summary of Available Yellow Rail Habitat in the Study Areas

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS16	Black spruce/ balsam poplar / river alder swamp	-	-	-	-	8.8	0.02
BS17	Black spruce treed bog	0.4	0.2	98.8	2.0	1,157.1	2.9
BS18	Labrador tea shrubby bog	0.003	0.002	105.1	2.2	989.9	2.5
BS19	Graminoid bog	-	-	10.0	0.2	160.5	0.4
BS19/24	Graminoid bog / Graminoid fen	-	-	2.4	0.05	2.4	0.006
BS20	Open bog	-	-	4.8	0.1	65.5	0.2
BS21	Tamarack treed fen	-	-	15.6	0.3	66.5	0.2
BS22	Leatherleaf shrubby poor fen	-	-	13.2	0.3	28.5	0.1
BS23	Willow shrubby rich fen	0.1	0.04	3.2	0.1	20.9	0.05
BS24	Graminoid fen	-	-	-	-	9.0	0.02
BS25	Open fen	-	-	2.1	0.04	5.7	0.01
Total		**0.5**[1]	**0.2**	**255.2**[2]	**5.3**	**2,514.9**[3]	**6.4**

1, 2, 3 These areas represent the total area of available Yellow Rail habitat within each study area; the percentages are the amount of available habitat relative to the Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha).

The characterization of the alteration and/or loss of habitat residual effect considers the Project effects on available Yellow Rail habitat within the Wildlife LSA and Terrestrial RSA. As summarized in Table 9.4-23, the study areas provide limited available habitat for this species.

Based on studies summarized in Section 9.4.3.2.1, and the SARGSS, which support the avoidance of sensitive species' habitats during sensitive periods (SK MOE 2017), alteration of available habitat for Yellow Rail is quantified by applying a buffer of 500 m around the Project Area in which Project effects in the form of sensory disturbance are assumed to affect available habitat and make it functionally unavailable for use. For Yellow Rail, the SARGSS specify setback distances between 150 m and 350 m around nesting birds for medium and high disturbance categories, respectively, between May 1 and July 15 (SK MOE 2017).

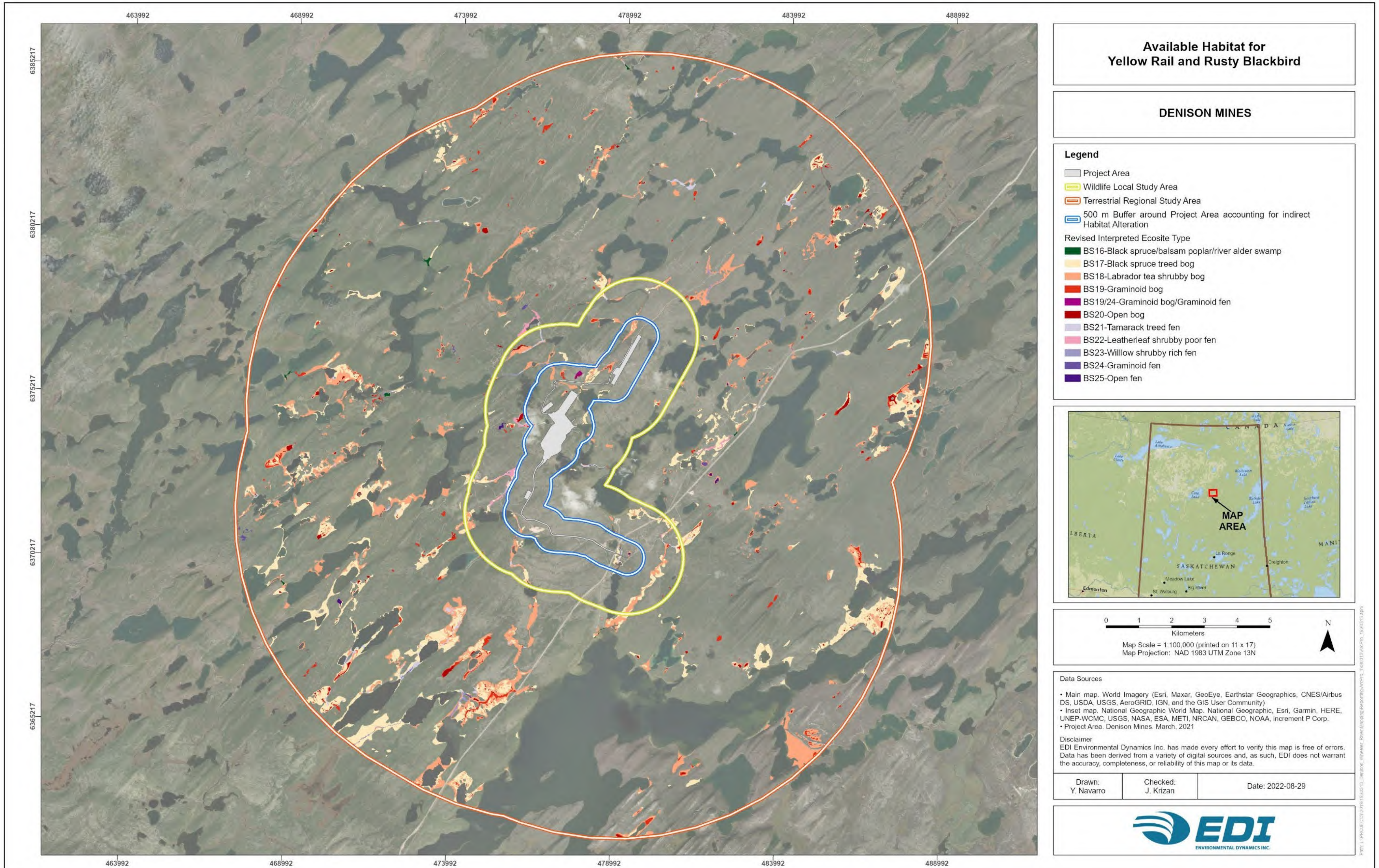

Figure 9.4-14: Available Habitat for Yellow Rail and Rusty Blackbird

Progressive reclamation is anticipated to begin during Construction. However, a conservative approach is used, with Yellow Rail habitat in the Project Area considered to be unavailable for the duration of the Project, only becoming available as habitat following Post-Decommissioning (i.e., during the regeneration of vegetation following Decommissioning).

Project-related direct habitat loss is calculated as the area of available Yellow Rail habitat lost due to site clearing within the Project Area. Direct habitat loss has been mitigated by reducing the size of the Project Area to the extent practicable during Project design; however, available habitat is still predicted to be cleared during Construction. In the Project Area, 0.5 ha or 100% of available habitat is assumed to be removed and will not be available to Yellow Rail for the duration of Project activities, which represents the removal of 0.2% of available habitat in the Wildlife LSA and 0.02% in the Terrestrial RSA (Table 9.4-24).

An additional 24.0% (61.1 ha) of available Yellow Rail habitat in the Wildlife LSA may experience habitat alteration resulting from indirect Project effects, such as sensory disturbance. This habitat alteration relates to 2.4% of available habitat in the Terrestrial RSA (Table 9.4-24). Mitigation measures outlined in Section 9.4.5 are anticipated to reduce the effects of alteration and/or loss of habitat on Yellow Rail, but not eliminate them.

Table 9.4-24: Summary of Available Yellow Rail Habitat, Direct Habitat Loss, and Habitat Alteration in the Study Areas

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
Project Area	BS16 Black spruce / balsam poplar / river alder swamp	-	-	-	-	-	-
	BS17 Black spruce treed bog	0.4	0.2	0.4	100	N/A	N/A
	BS18 Labrador tea shrubby bog	0.003	0.002	0.003	100	N/A	N/A
	BS19 Graminoid bog	-	-	-	-	-	-
	BS19 / BS24 Graminoid bog / Graminoid fen	-	-	-	-	-	-
	BS20 Open bog	-	-				
	BS21 Tamarack treed fen	-	-	-	-	-	-
	BS22 Leatherleaf shrubby poor fen	-	-	-	-	-	-
	BS23 Willow shrubby rich fen	0.1	0.04	0.1	100	N/A	N/A

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
	BS24 Graminoid fen	-	-	-	-	-	-
	BS25 Open fen	-	-				
	Total	**0.5[2]**	**0.2**	**0.5**	**100**	**N/A**	**N/A**
Wildlife LSA	BS16 Black spruce / balsam poplar / river alder swamp	-	-	-	-	-	-
	BS17 Black spruce treed bog	98.8	2.0	0.4	0.4	22.0	22.3
	BS18 Labrador tea shrubby bog	105.1	2.2	0.003	0.003	30.0	28.6
	BS19 Graminoid bog	10.0	0.2	-	-	2.8	28.5
	BS19 / BS24 Graminoid bog / Graminoid fen	2.4	0.05	-	-	2.4	100
	BS20 Open bog	4.8	0.1	-	-	0.6	11.6
	BS21 Tamarack treed fen	15.6	0.3	-	-	2.2	14.2
	BS22 Leatherleaf shrubby poor fen	13.2	0.3	-	-	-	-
	BS23 Willow shrubby rich fen	3.2	0.1	0.1	2.2	0.7	21.3
	BS24 Graminoid fen	-	-	-	-	-	-
	BS25 Open fen	2.1	0.04	-	-	0.4	16.7
	Total	**255.2[3]**	**5.3**	**0.5**	**0.2**	**61.1**	**24.0**
Terrestrial RSA	BS16 Black spruce / balsam poplar / river alder swamp	8.8	0.02	-	-	-	-
	BS17 Black spruce treed bog	1,157.1	2.9	0.4	0.03	22.0	1.9
	BS18 Labrador tea shrubby bog	990.0	2.5	0.003	0.0003	30.0	3.0
	BS19 Graminoid bog	160.5	0.4	-	-	2.8	1.8
	BS19 / BS24 Graminoid bog / Graminoid fen	2.4	0.006	-	-	2.4	100
	BS20 Open bog	65.5	0.2	-	-	0.6	0.9

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
	BS21 Tamarack treed fen	66.5	0.2	-	-	2.2	3.3
	BS22 Leatherleaf shrubby poor fen	28.5	0.1	-	-	-	-
	BS23 Willow shrubby rich fen	20.9	0.05	0.1	0.3	0.7	3.3
	BS24 Graminoid fen	9.0	0.02	-	-	-	-
	BS25 Open fen	5.7	0.01	-	-	0.4	6.2
	Total	**2,514.9[4]**	**6.4**	**0.5**	**0.02**	**61.1**	**2.4**

1 Based on a 500 m buffer around the Project Area.

2, 3, 4 This area does not reflect the entire Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha) but represents the total area of available Yellow Rail habitat in each study area.

N/A = Not Applicable

Rusty Blackbird

No Rusty Blackbird were detected during the baseline surveys (Appendix 9-B). The HABISask database (SK MOE 2021c) results confirmed Rusty Blackbird observations in 2019 within a 10-km radius around the Project Area (Table 9.4-4). However, no locations or habitat associations were provided.

As described in Section 9.4.3.3.1, Rusty Blackbird habitat is characterized by vegetated, shallow wetland habitats such as fens, bogs, muskeg, and wet forest margins along lakes and streams, near upland coniferous forests (Smith et al. 2019, Avery 2020). This habitat is limited in the study areas to treed, shrubby, graminoid and open bog and fen habitat types, representing 0.2%, 5.3%, and 6.4% of the Project Area, Wildlife LSA, and Terrestrial RSA, respectively (Table 9.4-25).

Table 9.4-25 provides a summary of available Rusty Blackbird habitat in the Project Area, Wildlife LSA, and Terrestrial RSA. Ecosite codes and descriptions are adopted from Table 9.2-5. Figure 9.4-14 depicts available habitat for Rusty Blackbird (and Yellow Rail) in the Project study areas.

Table 9.4-25: Summary of Available Rusty Blackbird Habitat in the Project Study Areas

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS16	Black spruce/ balsam poplar / river alder swamp	-	-	-	-	8.8	0.02
BS17	Black spruce treed bog	0.4	0.2	98.8	2.0	1,157.1	2.9

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS18	Labrador tea shrubby bog	0.003	0.002	105.1	2.2	989.9	2.5
BS19	Graminoid bog	-	-	10.0	0.2	160.5	0.4
BS19/24	Graminoid bog / Graminoid fen	-	-	2.4	0.05	2.4	0.006
BS20	Open bog	-	-	4.8	0.1	65.5	0.2
BS21	Tamarack treed fen	-	-	15.6	0.3	66.5	0.2
BS22	Leatherleaf shrubby poor fen	-	-	13.2	0.3	28.5	0.1
BS23	Willow shrubby rich fen	0.1	0.04	3.2	0.1	20.9	0.05
BS24	Graminoid fen	-	-	-	-	9.0	0.02
BS25	Open fen	-	-	2.1	0.04	5.7	0.01
Total		**0.5[1]**	**0.2**	**255.2[2]**	**5.3**	**2,514.9[3]**	**6.4**

1, 2, 3 These areas represent the total area of available Rusty Blackbird habitat within each study area; the percentages are the amount of available habitat relative to the Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha).

The characterization of the alteration and/or loss of habitat residual effect considers the Project effects on available Rusty Blackbird habitat within the Wildlife LSA and Terrestrial RSA. As summarized in Table 9.4-26, the study areas provide limited available habitat for this species.

Based on studies summarized in Section 9.4.3.2.1, and the SARGSS, which support the avoidance of sensitive species' habitats during sensitive periods (SK MOE 2017), alteration of available habitat for Rusty Blackbird is quantified by applying a buffer of 500 m around the Project Area in which Project effects in the form of sensory disturbance are assumed to affect available habitat and make it functionally unavailable for use. For Rusty Blackbird, the SARGSS specify setback distances between 150 m and 300 m around nesting birds for medium and high disturbance categories, respectively, between May 1 and July 31 (SK MOE 2017).

Progressive reclamation is anticipated to begin during Construction. However, a conservative approach is used, with Rusty Blackbird habitat within the Project Area considered to be unavailable for the duration of the Project, only becoming available as habitat following Post-Decommissioning (i.e., during the regeneration of vegetation following Decommissioning).

Project-related direct habitat loss is calculated as the area of available Rusty Blackbird habitat lost due to site clearing within the Project Area. Direct habitat loss has been mitigated by reducing the size of the Project Area to the extent practicable during Project design; however, available habitat is still predicted to be cleared during Construction. In the Project Area, 0.5 ha or 100% of available habitat is assumed to be removed and will not be available to Rusty Blackbird for the duration of

Project activities, which represents the removal of 0.2% of available habitat in the Wildlife LSA and 0.02% in the Terrestrial RSA (Table 9.4-26).

An additional 24.0% (61.1 ha) of available Rusty Blackbird habitat in the Wildlife LSA may experience habitat alteration resulting from indirect Project effects, such as sensory disturbance, representing 2.4% of available habitat in the Terrestrial RSA (Table 9.4-26). Mitigation measures outlined in Section 9.4.5 are anticipated to reduce the effects of alteration and/or loss of habitat on Rusty Blackbird, but not eliminate them.

Table 9.4-26: Summary of Available Rusty Blackbird Habitat, Direct Habitat Loss, and Habitat Alteration in the Study Areas

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
Project Area	BS16 Black spruce / balsam poplar / river alder swamp	-	-	-	-	-	-
	BS17 Black spruce treed bog	0.4	0.2	0.4	100	N/A	N/A
	BS18 Labrador tea shrubby bog	0.003	0.002	0.003	100	N/A	N/A
	BS19 Graminoid bog	-	-	-	-	-	-
	BS19 / BS24 Graminoid bog / Graminoid fen	-	-	-	-	-	-
	BS20 Open bog	-	-				
	BS21 Tamarack treed fen	-	-	-	-	-	-
	BS22 Leatherleaf shrubby poor fen	-	-	-	-	-	-
	BS23 Willow shrubby rich fen	0.1	0.04	0.1	100	N/A	N/A

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
	BS24 Graminoid fen	-	-	-	-	-	-
	BS25 Open fen	-	-	-	-	-	-
	Total	**0.5[2]**	**0.2**	**0.5**	**100**	**N/A**	**N/A**
Wildlife LSA	BS16 Black spruce / balsam poplar / river alder swamp	-	-	-	-	-	-
	BS17 Black spruce treed bog	98.8	2.0	0.4	0.4	22.0	22.3
	BS18 Labrador tea shrubby bog	105.1	2.2	0.003	0.003	30.0	28.6
	BS19 Graminoid bog	10.0	0.2	-	-	2.8	28.5
	BS19 / BS24 Graminoid bog / Graminoid fen	2.4	0.05	-	-	2.4	100
	BS20 Open bog	4.8	0.1	-	-	0.6	11.6
	BS21 Tamarack treed fen	15.6	0.3	-	-	2.2	14.2
	BS22 Leatherleaf shrubby poor fen	13.2	0.3	-	-	-	-
	BS23 Willow shrubby rich fen	3.2	0.1	0.1	2.2	0.7	21.3
	BS24 Graminoid fen	-	-	-	-	-	-
	BS25 Open fen	2.1	0.04	-	-	0.4	16.7
	Total	**255.2[3]**	**5.3**	**0.5**	**0.2**	**61.1**	**24.0**

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
Terrestrial RSA	BS16 Black spruce / balsam poplar / river alder swamp	8.8	0.02	-	-	-	-
	BS17 Black spruce treed bog	1,157.1	2.9	0.4	0.03	22.0	1.9
	BS18 Labrador tea shrubby bog	990.0	2.5	0.003	0.0003	30.0	3.0
	BS19 Graminoid bog	160.5	0.4	-	-	2.8	1.8
	BS19 / BS24 Graminoid bog / Graminoid fen	2.4	0.006	-	-	2.4	100
	BS20 Open bog	65.5	0.2	-	-	0.6	0.9
	BS21 Tamarack treed fen	66.5	0.2	-	-	2.2	3.3
	BS22 Leatherleaf shrubby poor fen	28.5	0.1	-	-	-	-
	BS23 Willow shrubby rich fen	20.9	0.05	0.1	0.3	0.7	3.3
	BS24 Graminoid fen	9.0	0.02	-	-	-	-
	BS25 Open fen	5.7	0.01	-	-	0.4	6.2
	Total	**2,514.9[4]**	**6.4**	**0.5**	**0.02**	**61.1**	**2.4**

1 Based on a 500 m buffer around the Project Area.

2, 3, 4 This area does not reflect the entire Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha) but represents the total area of available Rusty Blackbird habitat in each study area.

N/A = Not Applicable

Olive-sided Flycatcher

During the 2017 breeding songbird surveys, Olive-sided Flycatcher were detected in the Wildlife LSA and the Terrestrial RSA (Appendix 9-B). These observations were in the BS17 (black spruce treed bog), BS21 (tamarack treed fen), BS22 (leatherleaf shrubby poor fen), BS23 (willow shrubby rich fen), BS24 (graminoid fen) ecosites, and regenerating forest types BS3 and BS7 (jack pine - blueberry/lichen and black spruce - blueberry/lichen) ecosites. The HABISask database (SK MOE 2021c) results confirmed observations of Olive-sided Flycatcher between 2016 and 2019 within a 10-km radius around the Project Area (Table 9.4-4). However, no locations or habitat associations were provided.

As described in Section 9.4.3.3.1, preferred habitat for Olive-sided Flycatchers consists of coniferous and mixed-wood forest edges, forest openings, and burned forests with standing trees and snags (COSEWIC 2018b). These habitat types (including those recorded in baseline surveys [Appendix 9-B]) are considered available Olive-sided Flycatcher habitat and are present across the study areas, with 85.4%, 85.4%, and 74.5% in the Project Area, Wildlife LSA, and Terrestrial RSA, respectively (Table 9.4-27).

Table 9.4-27 provides a summary of available Olive-sided Flycatcher habitat in the Project Area, Wildlife LSA, and Terrestrial RSA. Ecosite codes and descriptions are adopted from Table 9.2-5. Figure 9.4-15 depicts available habitat for Olive-sided Flycatcher in the Project study areas.

Table 9.4-27: Summary of Available Olive-sided Flycatcher Habitat in the Project Study Areas

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS3 (mature forest)	Jack pine - blueberry / lichen	31.1	18.3	1,693.7	35.0	10,374.8	25.8
BS3 and BS7 (regenerating forest types)	Jack pine - blueberry / Black spruce - blueberry / lichen	110.2	64.9	2,268.0	46.8	17,494.0	43.5
BS4	Jack pine - black spruce / feathermoss	2.9	1.7	18.2	0.4	332.8	0.8
BS7 (mature)	Black spruce - blueberry / lichen	0.04	0.03	9.8	0.2	281.0	0.7
BS9	Black spruce - jack pine / feathermoss	0.3	0.2	12.3	0.3	148.5	0.4
BS14	White birch / lingonberry - Labrador tea	-	-	0.03	0.0006	1.8	0.005
BS17	Black spruce treed bog	0.4	0.2	98.8	2.0	1,157.1	2.9
BS21	Tamarack treed fen	-	-	15.6	0.3	66.5	0.2
BS22	Leatherleaf shrubby poor fen	-	-	13.2	0.3	28.5	0.1

Ecosite Code	Ecosite Description	Project Area (ha)	Project Area (%)	Wildlife LSA (ha)	Wildlife LSA (%)	Terrestrial RSA (ha)	Terrestrial RSA (%)
BS23	Willow shrubby rich fen	0.1	0.04	3.2	0.1	20.9	0.05
BS24	Graminoid fen	-	-	-	-	9.0	0.02
Total		**145.0**[1]	**85.4**	**4,132.8**[2]	**85.4**	29,914.9[3]	**74.5**

1, 2, 3 These areas represent the total area of available Olive-sided Flycatcher habitat within each study area; the percentages are the amount of available habitat relative to the Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha).

The characterization of the alteration and/or loss of habitat residual effect considers the Project effects on available Olive-sided Flycatcher habitat within the Wildlife LSA and Terrestrial RSA. As summarized in Table 9.4-27, the available habitat for this species is present across the study areas.

Based on studies summarized in Section 9.4.3.2.1, and the SARGSS, which support the avoidance of sensitive species' habitats during sensitive periods (SK MOE 2017), alteration of available habitat for Olive-sided Flycatcher is quantified by applying a buffer of 500 m around the Project Area in which Project effects in the form of sensory disturbance are assumed to affect available habitat and make it functionally unavailable for use. For Olive-sided Flycatcher, the SARGSS specify setback distances between 150 m and 300 m around nesting birds for medium and high disturbance categories, respectively, between May 1 and August 31 (SK MOE 2017).

Progressive reclamation is anticipated to begin during Construction. However, a conservative approach is used, with Olive-sided Flycatcher habitat in the Project Area considered to be unavailable for the duration of the Project, only becoming available as habitat following Post-Decommissioning (i.e., during the regeneration of vegetation following Decommissioning).

Project-related direct habitat loss is calculated as the area of available Olive-sided Flycatcher habitat lost due to site clearing within the Project Area. Direct habitat loss has been mitigated by reducing the size of the Project Area to the extent practicable during Project design; however, available habitat is still predicted to be cleared during Construction. In the Project Area, 145.9 ha or 100% of available habitat is assumed to be removed and will not be available to Olive-sided Flycatcher for the duration of Project activities, which represents the removal of 3.5% and 0.5% of available habitat in the Wildlife LSA and the Terrestrial RSA, respectively (Table 9.4-28).

An additional 27.6% (1,138.7 ha) of available Olive-sided Flycatcher habitat in the Wildlife LSA may experience habitat alteration resulting from indirect Project effects, such as sensory disturbance, representing 3.8% of available habitat in the Terrestrial RSA (Table 9.4-28). Mitigation measures outlined in Section 9.4.5 are anticipated to reduce the effects of alteration and/or loss of habitat on Olive-sided Flycatcher, but not eliminate them.

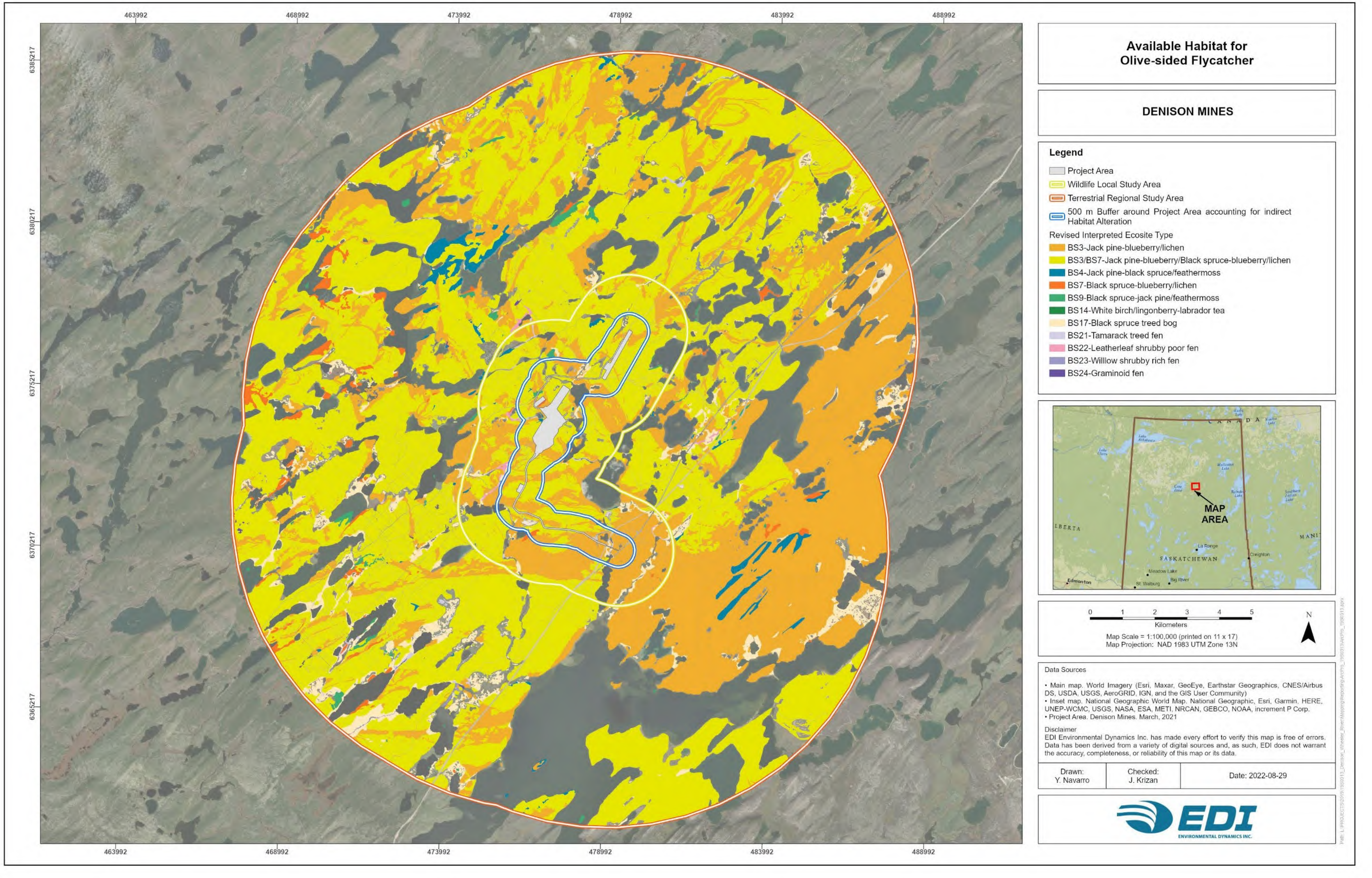

Figure 9.4-15: Available Habitat for Olive-sided Flycatcher

Table 9.4-28: Summary of Available Olive-sided Flycatcher Habitat, Direct Habitat Loss, and Habitat Alteration in the Study Areas

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
Project Area	BS3 (mature forest) Jack pine - blueberry / lichen	31.1	18.3	31.1	100	N/A	N/A
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry / lichen and black spruce - blueberry / lichen	110.2	64.9	110.2	100	N/A	N/A
	BS4 Jack pine - black spruce / feathermoss	2.9	1.7	2.9	100	N/A	N/A
	BS7 (mature forest) Black spruce - blueberry / lichen	0.04	0.03	0.04	100	N/A	N/A
	BS9 Black spruce - jack pine / feathermoss	0.3	0.2	0.3	100	N/A	N/A
	BS14 White birch / lingonberry - Labrador tea	-	-	-	-	-	-
	BS17 Black spruce treed bog	0.4	0.2	0.4	100	N/A	N/A
	BS21 Tamarack treed fen	-	-	-	-	-	-
	BS22 Leatherleaf shrubby poor fen	-	-	-	-	-	-
	BS23 Willow shrubby rich fen	0.1	0.04	0.1	100	N/A	N/A
	BS24 Graminoid fen	-	-	-	-	-	-
	Total	**145.0[2]**	**85.4**	**145.0**	**100**	**N/A**	**N/A**
Wildlife LSA	BS3 (mature forest) Jack pine - blueberry / lichen	1,693.7	35.0	31.1	1.8	445.1	26.3
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry / lichen and black	2,268	46.8	110.2	4.9	656.5	29.0

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
	spruce - blueberry / lichen						
	BS4 Jack pine - black spruce / feathermoss	18.2	0.4	2.9	15.7	3.4	18.5
	BS7 (mature forest) Black spruce - blueberry / lichen	9.8	0.2	0.04	0.5	5.3	53.9
	BS9 Black spruce - jack pine / feathermoss	12.3	0.3	0.3	0.3	3.5	28.3
	BS14 White birch / lingonberry - Labrador tea	0.03	0.0006	-	-	-	-
	BS17 Black spruce treed bog	98.8	2.0	0.4	0.4	22.0	22.3
	BS21 Tamarack treed fen	15.6	0.3	-	-	2.2	14.2
	BS22 Leatherleaf shrubby poor fen	13.2	0.3	-	-	-	-
	BS23 Willow shrubby rich fen	3.2	0.1	0.1	2.2	0.7	21.3
	BS24 Graminoid fen	-	-	-	-	-	-
	Total	**4,132.8[3]**	**85.3**	145.0	**3.5**	**1,138.7**	**27.6**
Terrestrial RSA	BS3 (mature forest) Jack pine - blueberry / lichen	10,374.8	25.8	31.1	0.3	445.1	4.3
	BS3 / BS7 (regenerating forest types) Jack pine - blueberry / lichen and black spruce - blueberry / lichen	17,494.0	43.5	110.2	0.6	656.5	3.8
	BS4 Jack pine - black spruce / feathermoss	332.8	0.8	2.9	0.9	3.4	1.0
	BS7 (mature forest) Black spruce - blueberry / lichen	281.0	0.7	0.04	0.02	5.3	1.9

Study Area	Ecosite Description	Amount of Available Habitat (ha)	Percent of Available Habitat (%)	Amount of Available Habitat Loss (ha)	Percent of Available Habitat Loss (%)	Amount of Available Habitat Altered (ha)[1]	Percent of Available Habitat Altered (%)
	BS9 Black spruce - jack pine / feathermoss	148.5	0.4	0.3	0.2	3.5	2.4
	BS14 White birch / lingonberry - Labrador tea	1.8	0.005	-	-	-	-
	BS17 Black spruce treed bog	1,157.1	2.9	0.4	0.03	22.0	1.9
	BS21 Tamarack treed fen	66.5	0.2	-	-	2.2	3.3
	BS22 Leatherleaf shrubby poor fen	28.5	0.1	-	-	-	-
	BS23 Willow shrubby rich fen	20.9	0.05	0.1	0.3	0.7	3.3
	BS24 Graminoid fen	9.0	0.02	-	-	-	-
	Total	**29,914.9[4]**	**74.5**	**145.0**	**0.5**	**1,138.7**	**3.8**

1 Based on a 500 m buffer around the Project Area.

2, 3, 4 This area does not reflect the entire Project Area (169.6 ha), Wildlife LSA (4,842.7 ha), and Terrestrial RSA (40,173.6 ha) but represents the total area of available Olive-sided Flycatcher habitat in each study area.

N/A = Not Applicable

Residual Effects Characteristics for Bird Species at Risk

The residual effects characterization for the alteration and/or loss of available habitat for the Bird Species at Risk VC and its five KIs is provided in Table 9.4-29.

The direction of the residual effect is predicted to be adverse. The Project is expected to affect available habitat directly (through habitat loss) and indirectly (through habitat alteration).

The magnitude is predicted to be low. Up to 4.7% of available Common Nighthawk habitat within the Terrestrial RSA (including previously disturbed areas) is anticipated to be altered or lost as a result of the Project: 0.8% of available habitat will be lost within the Project Area during the Construction, and an additional 3.9% may be altered through indirect effects (such as sensory disturbance through noise and dust deposition) during all Project phases (Table 9.4-20). For Short-eared Owl (Table 9.4-22), 2.9% of available habitat within the Terrestrial RSA may be altered or lost as a result of the Project: 0.01% of available habitat will be lost within the Project Area during Construction, and an additional 2.9% of available habitat may be altered through indirect effects (such as sensory disturbance through noise and dust deposition) during all Project phases. Yellow Rail and Rusty Blackbird have similar habitat requirements and may experience habitat loss or alteration affecting 2.4% of the available habitat (Table 9.4-24 and Table 9.4-26, respectively): 0.02% of available habitat is expected to be lost within the Project Area during Construction, and an additional 2.4% of available habitat may be altered through indirect effects (such as sensory disturbance through noise and dust deposition) during all Project phases. For Olive-sided Flycatcher (Table 9.4-28), 4.3% of available habitat within the Terrestrial RSA may be altered or lost as a result of the Project: 0.5% of available habitat will be lost during Construction, and an additional 3.8% of available habitat may be altered through indirect effects (such as sensory disturbance through noise and dust deposition) during all Project phases. Changes to available habitat for the Bird Species at Risk VC as a result of the Project are predicted, with a limited number of individuals expected to interact with the Project through alteration and/or loss of habitat. Some of the species may not be present in the Project Area due to limited habitat availability (e.g., Short-eared Owl, Yellow Rail, and Rusty Blackbird). For other species (e.g., Common Nighthawk and Olive-sided Flycatcher), individuals displaced by the Project are expected to relocate to areas of available habitat within the Wildlife LSA and Terrestrial RSA, which are expected to be able to support the low numbers of displaced individuals.

The residual effect is predicted to be local in geographic extent. While the direct loss of available habitat is expected to be limited to the Project Area during Construction and Operation, indirect Project effects are anticipated to occur within the Wildlife LSA around the Project Area during all Project phases.

The residual effect is predicted to occur over the long-term (i.e., longer than 38 years) because of the time required for available habitat to regenerate following disturbance. Differences may exist between habitat types depending on the areas and types of reclamation and the time frame for regeneration of vegetation within reclaimed areas. Progressive reclamation is anticipated to begin in some parts of the Project Area following Construction; however, the revegetation within most of the Project Area will occur as part of reclamation activities during Decommissioning up to 23 years after clearing during Construction. The Project Area is expected to support areas of suitable upland forest habitat after revegetation following Project completion and vegetation has re-established within reclaimed areas. While several avian species prefer regenerating vegetation types that may become available sooner (i.e., medium-term), regeneration of disturbed areas to mature forests is expected to extend beyond Post-Decommissioning (i.e., long-term).

The frequency is predicted to be frequent. While loss of available habitat resulting from vegetation clearing during Construction will occur only initially, additional clearing for maintenance and safety purposes may happen throughout Operation. Alteration of available habitat within the Wildlife LSA through indirect Project effects is anticipated to be frequent throughout the Construction, Operation, and Decommissioning phases, and infrequent during Post-Decommissioning.

The residual effect is predicted to be fully reversible. Through progressive and final reclamation, disturbed areas within the Project Area will be revegetated with a focus on achieving baseline conditions. Revegetated areas are anticipated to become available to the avian species after Post-Decommissioning. Progressive reclamation may occur in some parts of the Project Area prior to Post-Decommissioning; however, most revegetation is anticipated to occur following the end of Operation and become available habitat following Post-Decommissioning. The alteration of available habitat for bird species at risk is expected to be reversed within a similar time frame as sensory disturbances diminish with the ceasing of Project activities and subsequent decommissioning of Project components. Available habitat predicted to be lost or altered within or adjacent to the Project Area is expected to recover over time following reclamation activities. Once disturbed areas are reclaimed, the habitat for the KIs of the Bird Species at Risk VC is expected to progressively include these disturbed areas.

The context of the residual effect of alteration and/or loss of available habitat for bird species at risk is predicted to be high. Bird species at risk have been exposed to historic and ongoing anthropogenic and natural disturbances throughout their ranges, including within the Terrestrial RSA (i.e., 1.5% of the Terrestrial RSA has currently experienced anthropogenic disturbances). Available habitat that is altered or cleared will remain so until Post-Decommissioning when final reclamation and revegetation is expected to occur. Revegetated areas are anticipated to become available habitat within a few years of revegetation for some species that prefer habitat following disturbance at an early seral stage. All five KIs are listed federally and provincially (Table 9.4-4), with Common Nighthawk and Olive-sided Flycatcher being assessed as Threatened under SARA and Short-eared Owl recently being re-assessed by COSEWIC with a Threatened designation (ECCC 2021). All KIs are expected to be sensitive to changes in their environment; however, the Project is anticipated to interact with a limited number of individuals through the alteration and/or loss of habitat. If present in the Project Area, individuals displaced by the Project are expected to relocate to habitat available within the Wildlife LSA and Terrestrial RSA.

The residual effect of alteration and/or loss of available breeding bird species at risk habitat is predicted to be likely. Available habitat (although limited for Short-eared Owl, Yellow Rail, and Rusty Blackbird) is expected to be lost during site clearing and the construction and installation of Project components and available habitat around the Project Area is expected to be indirectly affected.

Project mitigation measures identified in Section 9.4.5 are expected to limit the residual effect on bird species at risk. Although Project activities may result in habitat alteration and/or loss for bird species at risk within the Terrestrial RSA, with the implementation of mitigation measures, the residual effect is not expected to result in a change to their populations.

Table 9.4-29: Summary of the Characteristics Ratings for Alteration and/or Loss of Available Habitat for Bird Species at Risk

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project is expected to directly and indirectly affect available habitat for bird species at risk.
Magnitude	Low	Common Nighthawk (Low): 4.7% of available Common Nighthawk habitat (including previously disturbed areas) within the Terrestrial RSA may be altered or lost: 0.8% will be cleared during Construction, and an additional 3.9% may be altered through indirect effects during all Project phases. Short-eared Owl (Low): 2.9% of limited available Short-eared Owl habitat within the Terrestrial RSA may be altered or lost: 0.01% will be cleared within the Project Area during Construction, and an additional 2.9% within the Terrestrial RSA may be altered through indirect effects during all Project phases. Yellow Rail and Rusty Blackbird (Low): 2.4% of the limited available Yellow Rail and Rusty Blackbird habitat within the Terrestrial RSA may be altered or lost: 0.02% will be cleared during Construction, and an additional 2.4% may be altered through indirect effects during all Project phases. Olive-sided Flycatcher (Low): 4.3% of available Olive-sided Flycatcher habitat within the Terrestrial RSA may be altered or lost: 0.5 % will be cleared during Construction, and an additional 3.8% may be altered through indirect effects during all Project phases.
Geographic Extent	Local	The direct loss of available habitat for bird species at risk is expected to be limited to the Project Area during Construction, and indirect effects resulting in habitat alteration are expected to be restricted to the Wildlife LSA during all Project phases.
Duration	Long-term	The loss of available habitat for bird species at risk will mainly occur during Construction; however, the alteration of habitat will continue through all phases. The reclamation and revegetation of the Project Area will not be complete until after Post-Decommissioning at which time revegetated areas will become available habitat for bird species at risk that prefer mature forests.
Frequency	Frequent	Loss of available habitat for bird species at risk will occur initially during Construction; alteration of available habitat through indirect Project effects is anticipated to be frequent throughout all Project phases until Post-Decommissioning.
Reversibility	Fully Reversible	Disturbed habitat within the Project Area will be revegetated and will likely become available to bird species at risk after Post-Decommissioning. The alteration of available habitat for bird species at risk is expected to be reversed as sensory disturbances diminish with the ceasing of Project Operation activities and subsequent Decommissioning.
Context	High	Revegetated areas are expected to become available habitat for bird species at risk after areas are revegetated upon completion of the Project. All KIs are listed federally and provincially with Common Nighthawk and Olive-sided Flycatcher being assessed as Threatened under SARA and Short-eared Owl recently being re-assessed by COSEWIC with a Threatened designation (ECCC 2021).
Likelihood	Likely	Available habitat for bird species at risk (although limited for some KIs) is expected to be cleared in the Project Area during Construction and to be indirectly affected in the Wildlife LSA during all phases of the Project.

Significance and Confidence

The residual effect of alteration and/or loss of available habitat for bird species at risk is not expected to result in a change that will alter their habitat integrity to the point where it would not be able to sustain their regional populations. Therefore, the effect is assessed as **not significant**.

The level of confidence of this prediction is moderate. The effects of habitat loss and alteration on bird species at risk (i.e., the five KIs) are well known, and effective mitigation measures will be implemented. However, some level of uncertainty exists related to the available background and baseline information used to identify available habitat for the Bird Species at Risk VC and its five KIs in this assessment.

9.4.6.4.2 Change in Mortality

Change in mortality is assessed qualitatively by considering the residual effect of the Project on the abundance of the Bird Species at Risk VC, as represented by the five KIs (i.e., Common Nighthawk, Short-eared Owl, Yellow Rail, Rusty Blackbird, and Olive-sided Flycatcher). The assessment includes considerations of direct mortality from Project activities and interactions with Project components, and indirect mortality as a result of the Project. Considering the respective life requisites and behaviours of the five KIs of the Bird Species at Risk VC, several sources of direct and indirect mortality were considered for the assessment of change in mortality on bird species at risk.

Potential sources of direct mortality include incidental take during Project-related site clearing and vegetation management; entrapment in Project components (e.g., buildings, pipes, vents, other enclosed spaces); collisions with Project-related vehicles, equipment, and components (e.g., buildings, windows), collisions with Project aircraft, and collisions with/electrocution caused by power transmission lines/energized equipment, and associated infrastructure.

Potential sources of indirect mortality include nest failure or abandonment caused by sensory disturbance from Project activities; exhaustion and eventual collision with the ground or Project components caused by disorientation of nocturnal migrating birds by artificial light; and changes in predator-prey dynamics caused by increased public access or Project-related edge effects.

Common Nighthawk

Common Nighthawk build inconspicuous nests on the ground in a variety of open areas in natural and anthropogenic environments (e.g., grasslands, open forests, burns, agricultural fields, cutblocks, gravel roads, and railsides) (Campbell et al. 2006, Environment Canada 2016a, COSEWIC 2018a, Brigham et al. 2020). The Project study areas overlap with available Common Nighthawk habitat (Table 9.4-19, Figure 9.4-12; Appendix 9-B). If present in the Project Area, Common Nighthawk may be vulnerable to incidental take during Project-related site clearing and vegetation management. Individual Common Nighthawks that may nest or roost on or near Project-related site and access roads, the airstrip, or power transmission line ROW could also be vulnerable to incidental take during Project activities.

Common Nighthawk are aerial insectivores that forage in open and semi-open areas at dawn and dusk, often in large groups (Campbell et al. 2006, Environment Canada 2016a, COSEWIC 2018a, Brigham et al. 2020). Project infrastructure that overlaps with feeding areas may lead to increased collision risk with Project-related vehicles and mobile equipment. Collision risk may also increase for Common Nighthawks that nest or roost along Project-related gravel roads.

Collisions with vehicles are a known source of mortality for Common Nighthawk in southern British Columbia This is likely due to high bird and road densities coupled with high traffic volumes (Campbell et al. 2006). Because traffic volumes on Project roads are expected to be less than traffic volumes on public roads, and the density of Common Nighthawks is expected to be low in the Project Area, the risk of collisions is anticipated to be low.

The foraging behaviour of Common Nighthawk may also increase the risk of bird strikes for this species. Large-bodied flocking birds are considered at highest risk of bird-airplane collisions, but smaller species are also known to collide with aircraft during take-off and landing (Nilsson et al. 2021, Bird Strike Association of Canada 2021, Transport Canada 2019). The bird strike risk is amplified if the airport is close to suitable habitat that supports these species. Due to minimal aircraft traffic at the Project airstrip (approximately five flights per week during Operation) and the limited likelihood of take-offs and landings during dawn and dusk, the risks of collisions with Project aircraft are considered low for Common Nighthawk.

Although collision risk with powerlines has not been quantified for Common Nighthawk, it is presumed to be limited to adult males who may collide with Project transmission lines during aerial courtship displays (Environment Canada 2016a, COSEWIC 2018a), possibly resulting in electrocutions. Common Nighthawks may nest along power transmission line ROW, which could increase collision and electrocution risk with powerline infrastructure / energized equipment.

Common Nighthawk are not considered to be vulnerable to collisions with buildings or other vertical structures (Environment Canada 2016a, COSEWIC 2018a); therefore, their susceptibility to collisions with other Project components (e.g., buildings, windows) is expected to be low.

Short-eared Owl

Short-eared Owl nest and forage in open habitats (e.g., grasslands, wetlands, agricultural areas, cleared and regenerating forest) with a reliable source of small mammal prey (COSEWIC 2008, Cannings 2015, ECCC 2018, Wiggins et al. 2020). Therefore, they are susceptible to incidental take when vegetation clearing occurs prior to young fledging (COSEWIC 2008, ECCC 2018). Although baseline studies did not detect any Short-eared Owls in the study areas (Appendix 9-B) and a query of the HABISask database (Table 9.4-4) did not record any known occurrences, the Project Area, Wildlife LSA and Terrestrial RSA are considered to provide limited areas of available habitat for the species; 0.1 ha of available habitat was identified in the Project Area (Table 9.4-21 and

Figure 9.4-13). If present, Short-eared Owl individuals, nests, or eggs may be vulnerable to incidental take during Project-related site clearing and vegetation management.

Collisions with vehicles, powerlines, buildings, and other vertical structures (e.g., fences) have resulted in Short-eared Owl mortalities; however, quantitative data are lacking and the extent of mortality resulting from these sources is unknown (COSEWIC 2008, ECCC 2018, Wiggins et al. 2020). Project roads, the airstrip, and power transmission line ROW that overlap with nesting and feeding areas may lead to collisions between Short-eared Owl and Project-related vehicles, mobile equipment, and aircraft; however, the vulnerability of these birds to collisions is expected to be low. Short-eared Owl may be susceptible to collisions with the Project power transmission lines (measuring approximately 7 km in length) during low-level flights (Avian Power Line Interaction Committee 2006, 2012. The susceptibility of Short-eared Owl to collisions with other Project components (e.g., buildings, windows) is expected to be low.

Yellow Rail and Rusty Blackbird

Breeding habitat for Yellow Rail and Rusty Blackbird is similar (Section 9.4.6.4.1) and generally characterized by wet coniferous and mixed forests adjacent to wetland habitats such as fens, bogs, muskeg, and wet forest margins along lakes and streams (Smith et al. 2019, Avery 2020). The nest sites are typically close to water. The baseline studies (Appendix 9-B) and the query of the HABISask database (Table 9.4-4) did not identify Yellow Rail or Rusty Blackbird in the Project study areas. The Wildlife LSA and Terrestrial RSA contain limited areas of available habitat for the two species (Table 9.4-23, Table 9.4-25, and Figure 9.4-14). If present, the two species are likely less vulnerable to incidental take during Project-related site clearing and vegetation management in the Project Area as wetlands and riparian areas, where they nest, are limited. However, they may be vulnerable to changes in surface hydrology from Project activities that alter wetland and riparian habitats (Environment Canada 2015, COSEWIC 2017).

Based on the limited habitat availability for the two species in the Project Area, the susceptibility to collisions with vehicles, mobile equipment and aircraft is expected to be minimal. Yellow Rail and Rusty Blackbird may be susceptible to collisions with the power transmission lines during low-altitude flights between nesting and feeding areas (Avian Power Line Interaction Committee 2006, 2012). The susceptibility of the two species to collisions with other Project components (e.g., buildings, windows) is expected to be low (Environment Canada 2016b).

Olive-sided Flycatcher

Olive-sided Flycatcher nest in coniferous, mixed, and riparian forests that may include open mature and old growth forests, burns, cutblocks, wetlands, and waterbodies. Nests are typically located in coniferous trees (COSEWIC 2018b, Altman and Sallabanks 2020). Baseline studies (Appendix 9-B) and the HABISask database review (Table 9.4-4) documented Olive-sided Flycatchers in the study areas and the Project study areas overlap with available Olive-sided Flycatcher habitat (Table 9.4-27 and Figure 9.4-15). As such, Olive-sided Flycatcher may be vulnerable to incidental take during Project-related site clearing and vegetation management.

Olive-sided Flycatcher use disturbed habitats for nesting and foraging, but species distribution models predict lower densities near linear features and anthropogenic disturbances (COSEWIC 2018b). This suggests that Olive-sided Flycatchers may be sensitive to Project-related disturbances and, as a response to Project activities, they may reduce the use of or avoid the Project Area, which, in turn, may limit the potential for interactions and subsequent mortality.

Studies demonstrate that passerines are susceptible to collisions with vehicles and aircraft (Environment Canada 2016b, Bird Strike Association of Canada 2021, Transport Canada 2019). Olive-sided Flycatcher are aerial insectivores that typically forage in open areas or along forest edges at heights near or above the adjacent forest canopy; however, they may forage at lower heights during inclement weather (COSEWIC 2018b, Altman and Sallabanks 2020). Use of Project roads and power transmission line ROW that overlap with feeding areas may lead to collisions between the birds and Project-related vehicles and mobile equipment. The bird strike risk is amplified if the airport is close to suitable habitat that supports this species. Due to minimal aircraft traffic at the Project airstrip (approximately five flights per week during Operation), the risk of collisions with Project aircraft is considered low.

Passerines have been known to collide with powerlines (e.g., during aerial hunting activities or courtship displays; during low-altitude flights between nesting and feeding areas), and electrocutions have been documented (Avian Power Line Interaction Committee 2006, 2012). As such, Olive-sided Flycatchers may be susceptible to collisions with the power transmission lines or energized equipment, which could result in electrocution mortalities. Based on observation in other regions, the susceptibility of Olive-sided Flycatcher to collisions with other Project components (e.g., buildings, windows) is expected to be low (Environment Canada 2016b).

Project mitigation measures identified in Section 9.4.5 are expected to limit interactions between bird species at risk and potential sources of direct and indirect mortality, thereby minimizing the residual effect of change in mortality. Although Project activities may result in a change of direct and/or indirect mortality for bird species at risk within the Terrestrial RSA, with the implementation of mitigation measures, the residual effect is not expected to result in a change to their populations.

Residual Effect Characteristics

The residual effect characteristics for change in mortality on the Bird Species at Risk VC are summarized below and provided in Table 9.4-30.

The direction of the residual effect is predicted to be adverse. While it is expected that the risks for Project-related mortalities for bird species at risk is limited (due to effective mitigation measures), any additional mortality may affect the avian populations.

The magnitude is predicted to be low. Mitigation measures are expected to limit the potential for interactions between the Bird Species at Risk VC and potential sources of direct and indirect mortality. Loss and alteration of available habitat for the five KIs are expected due to the Project (Table 9.4-20, Table 9.4-22, Table 9.4-24, Table 9.4-26, and Table 9.4-28), resulting in a limited number of individuals to likely interact with the Project and experiencing direct and/or indirect sources of mortality. Individuals that may be displaced by the Project are expected to relocate to areas of available habitat within the Wildlife LSA and Terrestrial RSA, thereby limiting the potential for further interactions with the Project. However, no reports confirmed the presence of Short-eared Owl, Yellow Rail, or Rusty Blackbird in the Project study areas.

The geographic extent is predicted to be regional. While most direct mortality is expected to be limited to the Project Area, effects from power transmission lines, indirect mortality related to edge effects, sensory disturbance, increased public access, and exposure to hazardous materials is anticipated to extend into adjacent habitats within the Wildlife LSA and may affect bird species at risk in the Terrestrial RSA.

The duration is predicted to occur over the long-term (i.e., longer than 38 years). Sources of direct mortality and most sources of indirect mortality are expected to occur during Construction and Operation and the residual effects are expected to persist until Project activities cease, Project components are removed during Decommissioning, and disturbed areas are reclaimed at the end of Post-Decommissioning (i.e., medium-term). Indirect sources of mortality related to edge effects are also expected to occur during Construction; however, the residual effects are expected to persist until disturbed areas are reclaimed and vegetation has re-established within reclaimed areas, which may include a time frame that differs between avian species. Regeneration of disturbed areas to mature forest habitat, preferred by some species, is expected to extend beyond Post-Decommissioning (i.e., long-term).

The frequency is predicted to be infrequent. Direct and/or indirect mortality could occur sporadically through all Project phases and occurrences of mortality are expected to be isolated and infrequent events given the implementation of mitigation measures.

The residual effect is predicted to be fully reversible once Project activities cease, Project components are removed, disturbed habitats are reclaimed, and vegetation has re-established within reclaimed areas.

The context is predicted to be high. Bird species at risk have been exposed to historic and ongoing anthropogenic and natural disturbances throughout their ranges, including within the Terrestrial RSA (i.e., 1.5% of the Terrestrial RSA has currently experienced anthropogenic disturbances). Each of the species at risk (i.e., the five KIs) selected to inform the assessment of the Bird Species at Risk VC are listed federally (ECCC 2021), with some listed provincially (SK CDC 2021), and are considered to be sensitive to changes in their environment. Although the Project is expected to interact with a limited number of individuals that may be affected by direct and/or indirect sources of mortality, populations of species at risk may be less resilient to changes in mortality.

The likelihood is predicted to be likely. Available habitat for the five KIs of the Bird Species at Risk VC is present within the Project study areas; therefore, it is possible that Project activities may interact with the species and result in direct and/or indirect mortality.

Project mitigation measures identified in Section 9.4.5 are expected to limit interactions between bird species at risk and potential sources of direct and indirect mortality, thereby minimizing the residual effect of change in mortality. Although Project activities may result in a change of direct and/or indirect mortality of bird species at risk within the Terrestrial RSA, with the implementation of mitigation measures, the residual effect is not expected to result in a change to their populations.

Table 9.4-30: Summary of the Characteristics Ratings for Change in Mortality of Bird Species at Risk

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project is expected to affect a change in mortality of migratory breeding birds.
Magnitude	Low	Mitigation measures are anticipated to be effective at reducing the potential for a change in direct and indirect mortality, and the risk of mortality is expected to be within the range of natural variability.
Geographic Extent	Regional	The change in direct mortality is expected to occur mainly within the Project Area; however, indirect mortality of bird species at risk may extend into the Wildlife LSA and the Terrestrial RSA.
Duration	Long-term	Bird species at risk mortality may occur during all phases of the Project. The potential for a change in direct mortality is expected to be highest during the Construction and Operation phases and the potential for indirect mortality is expected to be highest during Operation, decreasing during Decommissioning, and limited during Post-Decommissioning. Regeneration of disturbed areas to mature forest habitat, used by Olive-sided Flycatchers, is expected to extend beyond Post-Decommissioning.
Frequency	Infrequent	The potential for a change in direct and indirect mortality for bird species at risk is expected to be limited, but the residual effect may occur sporadically throughout the life of the Project.
Reversibility	Fully Reversible	The change in mortality of bird species at risk is expected to decline during Decommissioning following the removal of Project components and a reduction in Project activities and diminish to baseline conditions following Post-Decommissioning.
Context	High	Each KI of the Bird Species at Risk VC is listed federally (ECCC 2021) and is considered sensitive to changes in their environment. Although the Project is expected to interact with a limited number of individuals that may be affected by direct and/or indirect sources of mortality, populations of species at risk may be less resilient to changes in mortality.
Likelihood	Likely	Mitigation measures are expected to reduce, but not fully eliminate, the residual effect on bird species at risk.

Significance and Confidence

The residual effect of change in mortality is not expected to result in a change in mortality that will alter the integrity of the bird species at risk populations to the point where the regional populations could not be sustained. Therefore, the effect is assessed as **not significant**.

The level of confidence of this prediction is moderate. The risks of increased mortality are well known, and effective mitigation measures will be implemented. They are anticipated to reduce the change in direct and/or indirect mortality of species to levels within the range of natural variability. However, some level of uncertainty exists about the status of the regional populations and, with that, their ability to assimilate limited additional mortality.

9.4.6.5 Summary of Project-related Residual Effects on Raptors, Migratory Breeding Birds, and Bird Species at Risk

The residual effects evaluation process in Section 9.4.6 assessed the following residual effects of the Project on the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs:

- alteration and/or loss of habitat; and
- change in mortality.

The evaluation process characterized the residual effects of the Project on the respective VCs, the results of which are summarized in Table 9.4-31 and Table 9.4-32. The residual effects of the Project are not expected to result in a change to the viability and persistence of the VCs and associated KIs and were, therefore, predicted to be **not significant**.

Table 9.4-31: Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs – Summary of the Characteristics Ratings for Alteration and/or Loss of Habitat

Residual Effects Characteristic	Rating			Summary Rationale for Rating
	Raptors	Migratory Breeding Birds	Bird Species at Risk	
Direction	Adverse	Adverse	Adverse	**Raptors:** The Project is expected to affect available raptor habitat. **Migratory Breeding Birds:** The Project is expected to affect available migratory breeding bird habitat. **Bird Species at Risk:** The Project is expected to affect available habitat for bird species at risk.
Magnitude	Moderate	Low	Low	**Raptors:** Up to 6.9% of available raptor habitat within the Terrestrial RSA is predicted to be affected by the Project. This includes 0.4% habitat loss and 6.5% of habitat alteration.

Residual Effects Characteristic	Rating			Summary Rationale for Rating
	Raptors	Migratory Breeding Birds	Bird Species at Risk	
				Migratory Breeding Birds: Waterbirds and waterfowl: 1.6% of available habitat for waterbirds and waterfowl within the Terrestrial RSA may be altered or lost: 0.0002% will be cleared and an additional 1.6% may be altered. Upland game birds: 4.3% of available habitat for upland game birds within the Terrestrial RSA may be altered or lost: 0.5% will be cleared and an additional 3.8% may be altered. Migratory songbirds: 4.1% of available habitat for migratory songbirds within the Terrestrial RSA may be altered or lost: 0.6 % will be cleared and an additional 3.5% may be altered. **Bird Species at Risk:** Common Nighthawk: 4.7% of available Common Nighthawk habitat (including previously disturbed areas) may be altered or lost: 0.8% will be cleared and an additional 3.9% may be altered. Short-eared Ow): 2.9% of limited available Short-eared Owl habitat may be altered or lost: 0.01 % will be cleared and an additional 2.9% may be altered. Yellow Rail and Rusty Blackbird: 2.4% of the limited available Yellow Rail and Rusty Blackbird habitat may be altered or lost: 0.02% will be cleared and an additional 2.4% may be altered. Olive-sided Flycatcher: 4.3% of available Olive-sided Flycatcher habitat may be altered or lost: 0.5% will be cleared and an additional 3.8% may be altered.
Geographic Extent	Local	Local	Local	**Raptors:** The direct loss of available raptor habitat is expected to be limited to the Project Area. Indirect effects resulting in habitat alteration are expected to be restricted to the Wildlife LSA. **Migratory Breeding Birds:** The direct loss of available habitat for migratory breeding birds is expected to be limited to the Project Area. Indirect effects resulting in habitat alteration are expected to be restricted to the Wildlife LSA. **Bird Species at Risk:** The direct loss of available habitat for bird species at risk is expected to be limited to the Project Area. Indirect effects resulting in habitat alteration are expected to be restricted to the Wildlife LSA.

Residual Effects Characteristic	Rating			Summary Rationale for Rating
	Raptors	Migratory Breeding Birds	Bird Species at Risk	
Duration	Long-term	Long-term	Long-term	**Raptors:** The loss of available raptor habitat will mainly occur during Construction; however, the alteration of habitat will continue through all phases. The reclamation of the Project Area will not be complete until after Project completion when vegetation has re-established within reclaimed areas. Regeneration of disturbed areas into mature forests is expected to extend beyond Post-Decommissioning. **Migratory Breeding Birds:** The loss of available habitat for migratory breeding birds will mainly occur during Construction; however, the alteration of habitat will continue through all phases. The reclamation of the Project Area will not be complete until after Project completion when vegetation has re-established within reclaimed areas. Regeneration of disturbed areas into mature forests (for species that prefer these habitats) is expected to extend beyond Post-Decommissioning. **Bird Species at Risk:** The loss of available habitat for bird species at risk will mainly occur during Construction; however, the alteration of habitat will continue through all phases. The reclamation of the Project Area will not be complete until after Project completion when vegetation has re-established within reclaimed areas. Regeneration of disturbed areas into mature forests (for species that prefer these habitats) is expected to extend beyond Post-Decommissioning.
Frequency	Frequent	Frequent	Frequent	**Raptors:** Loss of available raptor habitat will occur initially during Construction, and alteration of available habitat is anticipated to be frequent throughout all Project phases until Post-Decommissioning. **Migratory Breeding Birds:** Loss of available habitat for migratory breeding birds will occur initially during Construction, and alteration of habitat through indirect Project effects is anticipated to be frequent throughout all Project phases until Post-Decommissioning. **Bird Species at Risk:** Loss of available habitat for bird species at risk will occur initially during Construction, and alteration of habitat through indirect Project effects is anticipated to be frequent throughout all Project phases until Post-Decommissioning.
Reversibility	Fully Reversible	Fully Reversible	Fully Reversible	**Raptors:** Disturbed habitat within the Project Area will be revegetated and will likely become available to raptors. The alteration of available raptor habitat is expected to be reversed as sensory disturbances diminish with the ceasing of Project operation activities and subsequent decommissioning of Project components. **Migratory Breeding Birds:** Disturbed habitat within the Project Area will be revegetated and will likely become available to migratory breeding birds. The alteration of available habitat for migratory breeding birds is expected to be reversed as sensory disturbances diminish with the

Residual Effects Characteristic	Rating			Summary Rationale for Rating
	Raptors	Migratory Breeding Birds	Bird Species at Risk	
				ceasing of Project operation activities and subsequent decommissioning of Project components. **Bird Species at Risk:** Disturbed habitat within the Project Area will be revegetated and will likely not become available to migratory breeding birds. The alteration of available habitat for bird species at risk is expected to be reversed as sensory disturbances diminish with the ceasing of Project operation activities and subsequent decommissioning of Project components.
Context	High	Moderate	High	**Raptors:** Revegetated areas are expected to become available raptor habitat after areas are revegetated upon completion of the Project. While Bald Eagle populations in Saskatchewan are considered secure, Osprey are listed provincially as S2B and S2M. **Migratory Breeding Birds:** Revegetated areas are expected to become available habitat for migratory breeding birds after areas are revegetated upon completion of the Project. Declining trends across North America have been recorded for some waterbird and waterfowl species as well as some migratory songbird species. **Bird Species at Risk:** Revegetated areas are expected to become available habitat for bird species at risk after areas are revegetated upon completion of the Project. All KIs are listed federally with Common Nighthawk and Olive-sided Flycatcher listed as Threatened under SARA and Short-eared Owl as Threatened by COSEWIC.
Likelihood	Likely	Likely	Likely	**Raptors:** Available raptor habitat is expected to be cleared in the Project Area during Construction and to be indirectly affected in the Wildlife LSA during all phases of the Project. **Migratory Breeding Birds:** Available habitat for migratory breeding birds is expected to be cleared in the Project Area during Construction and to be indirectly affected in the Wildlife LSA during all phases of the Project. **Bird Species at Risk:** Available habitat for bird species at risk is expected to be cleared in the Project Area during Construction and to be indirectly affected in the Wildlife LSA during all phases of the Project.
Significance	Not Significant	Not Significant	Not Significant	The residual effect on the Raptors, Migratory Breeding Birds and Bird Species at Risk VCs and associated KIs is not expected to result in a change of habitat that will alter habitat integrity to the point where it would not be able to sustain regional populations.
Level of Confidence	Moderate	Moderate	Moderate	The effects of habitat loss and alteration on the Raptors, Migratory Breeding Birds and Bird Species at Risk VCs and associated KIs are well known, and proven, effective mitigation measures will be implemented. However, some level of uncertainty exists related to the accuracy of available background and baseline information used to identify available habitat in this assessment.

Table 9.4-32: Raptors, Migratory Breeding Birds and Bird Species at Risk VCs – Summary of the Characteristics Ratings for Change in Mortality

Residual Effects Characteristic	Rating			Summary Rationale for Rating
	Raptors	Migratory Breeding Birds	Bird Species at Risk	
Direction	Adverse	Adverse	Adverse	**Raptors:** The Project is expected to affect a change in mortality of raptors. **Migratory Breeding Birds:** The Project is expected to affect a change in mortality of migratory breeding birds. **Bird Species at Risk:** The Project is expected to affect a change in mortality of bird species at risk.
Magnitude	Low	Low	Low	**Raptors:** Mitigation measures are anticipated to be effective at reducing the potential for a change in direct and/or indirect mortality, and the risk of mortality is expected to be within the range of natural variability for raptors. **Migratory Breeding Birds:** Mitigation measures are anticipated to be effective at reducing the potential for a change in direct and/or indirect mortality, and the risk of mortality is expected to be within the range of natural variability for migratory breeding birds. **Bird Species at Risk:** Mitigation measures are anticipated to be effective at reducing the potential for a change in direct and/or indirect mortality, and the risk of mortality is expected to be within the range of natural variability for bird species at risk.
Geographic Extent	Regional	Regional	Regional	**Raptors:** The change in direct mortality is expected to occur mainly within the Project Area; however, indirect raptor mortality may extend into the Wildlife LSA and the Terrestrial RSA. **Migratory Breeding Birds:** The change in direct mortality is expected to occur mainly within the Project Area; however, indirect migratory breeding bird mortality may extend into the Wildlife LSA and the Terrestrial RSA. **Bird Species at Risk:** The change in direct mortality is expected to occur mainly within the Project Area; however, indirect bird species at risk mortality may extend into the Wildlife LSA and the Terrestrial RSA.
Duration	Medium-term	Long-term	Long-term	**Raptors:** Raptor mortality may occur during all phases of the Project. The potential for a change in direct mortality is expected to be highest during Construction and Operation. The potential for indirect mortality is expected to be highest during Operation, decreasing during Decommissioning, and limited during Post-Decommissioning.

Residual Effects Characteristic	Rating			Summary Rationale for Rating
	Raptors	Migratory Breeding Birds	Bird Species at Risk	
				Migratory Breeding Birds: Migratory breeding bird mortality may occur during all phases of the Project. The potential for a change in direct mortality is expected to be highest during Construction and Operation. The potential for indirect mortality is expected to be highest during Operation, decreasing during Decommissioning, and limited during Post-Decommissioning. Regeneration of disturbed areas to mature forest habitat, preferred by some avian species, is expected to extend beyond Post-Decommissioning. **Bird Species at Risk:** Bird species at risk mortality may occur during all phases of the Project. The potential for a change in direct mortality is expected to be highest during Construction and Operation. The potential for indirect mortality is expected to be highest during Operation, decreasing during Decommissioning, and limited during Post-Decommissioning. Regeneration of disturbed areas to mature forest habitat, preferred by some avian species, is expected to extend beyond Post-Decommissioning.
Frequency	Infrequent	Infrequent	Infrequent	**Raptors:** The potential for a change in direct and indirect raptor mortality is expected to be limited, but the residual effect may occur sporadically throughout the life of the Project. **Migratory Breeding Birds:** The potential for a change in direct and indirect mortality migratory breeding birds is expected to be limited, but the residual effect may occur sporadically throughout the life of the Project. **Bird Species a Risk:** The potential for a change in direct and indirect mortality of bird species at risk is expected to be limited, but the residual effect may occur sporadically throughout the life of the Project.
Reversibility	Fully Reversible	Fully Reversible	Fully Reversible	**Raptors:** The change in mortality of raptors is anticipated to decline during Decommissioning following the removal of Project components and a reduction in Project activities and diminish to baseline conditions following Post-Decommissioning. **Migratory Breeding Birds:** The change in mortality of migratory breeding birds is anticipated to decline during Decommissioning following the removal of Project components and a reduction in Project activities and diminish to baseline conditions following Post-Decommissioning. **Bird Species at Risk:** The change in mortality of bird species at risk is anticipated to decline during Decommissioning following the removal of Project components and a reduction in Project activities and diminish to baseline conditions following Post-Decommissioning.

Residual Effects Characteristic	Rating			Summary Rationale for Rating
	Raptors	Migratory Breeding Birds	Bird Species at Risk	
Context	High	Moderate	High	**Raptors:** Bald Eagle populations in Saskatchewan are considered secure; however, Osprey are listed provincially as S2B and S2M and may be less resilient to changes in mortality. **Migratory Breeding Birds:** The Project is expected to interact with a limited number of migratory breeding birds that may be affected by direct and/or indirect sources of mortality. While the KIs are generally considered secure in Saskatchewan, declining trends for some waterbird and waterfowl species in their range have been reported (Prairie Habitat Joint Venture 2014) and songbird declines have been documented across North America (Van Wilgenburg 2015). Indigenous Knowledge reported declines in Grouse, Ptarmigan, Canada Geese, Loons (in some lakes), and Mallards (19-LK-ERFNTrap-134.163, 19-LK-ERFNTrap-134.164, 19-LK-ERFNTrap-134.166). **Bird Species at Risk:** Each KI of the Bird Species at Risk VC is listed federally (ECCC 2021) and is considered sensitive to changes in their environment. Populations of species at risk may be less resilient to changes in mortality.
Likelihood	Likely	Likely	Likely	**Raptors:** Mitigation measures are expected to reduce, but not fully eliminate, the residual effect on raptors. **Migratory Breeding Birds:** Mitigation measures are expected to reduce, but not fully eliminate, the residual effect on migratory breeding birds. **Bird Species at Risk:** Mitigation measures are expected to reduce, but not fully eliminate, the residual effect on bird species at risk.
Significance	Not Significant	Not Significant	Not Significant	The residual effect of change in mortality is not expected to result in a change in the mortality of raptor, migratory breeding birds, and bird species at risk that would alter the integrity of their populations to the point where regional populations could not be sustained.
Level of Confidence	Moderate	Moderate	Moderate	The effects of increased mortality are well known, and mitigation measures that will be implemented are anticipated to reduce the change in direct and indirect mortality of raptors, migratory breeding birds, and bird species at risk to levels within the range of natural variability. However, some level of uncertainty exists about the status of their regional populations and, with that, their ability to assimilate limited additional mortality.

9.4.7 Cumulative Effects

The CEA considers whether residual adverse effects of the Project on the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs will overlap spatially and/or temporally with the same residual adverse effects resulting from other past, present, and reasonably foreseeable projects or activities. The CEA follows standard methodology as per provincial (e.g., Guidelines for an Environmental Assessment under the [Saskatchewan] *Environmental Assessment Act* 1980) and federal (e.g., Assessing Cumulative Environmental Effects under the Canadian *Environmental Assessment Act* 2012) guidance, and is discussed in detail in Section 5.9.

The spatial boundaries of the CEA for the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs are defined as the Terrestrial RSA. Projects/activities that are outside of the Terrestrial RSA but could have effects that extend into the Terrestrial RSA were also considered.

The temporal boundaries of the CEA encompass the periods during which the proposed Project-related residual effects are expected to interact with residual effects of other past, present, or reasonably foreseeable future projects and activities, and include the Construction, Operation, Decommissioning, and Post-Decommissioning phases of the Project.

Baseline conditions (described in Section 9.4.3) represent the effects of past and present projects and activities, including all resulting disturbances that may still exist. As such, the focus of the CEA is on ongoing and reasonably foreseeable future projects and activities. All projects and activities listed in the Project and Activity Inclusion List (Section 5) that are not listed below in Section 9.4.7.1 are not considered in the CEA for Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs because the residual effects of these developments are not anticipated to overlap spatially or temporally with the residual effects of the Project on these VCs.

9.4.7.1 Potential Cumulative Effects

As outlined in Section 9.4.4.2, the following Project-related residual effects were considered for their potential to interact cumulatively with the residual effects of projects and activities identified within, or extending into the Terrestrial RSA:

- alteration and/or loss of habitat; and
- change in mortality.

9.4.7.2 Ongoing and Future Projects and Activities

Spatial information is not available for some future projects and most activities. The following projects and activities are expected to interact cumulatively with the residual Project effects on

Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs, within or extending into the Terrestrial RSA (Figure 9.4-16):

- **Infrastructure Use and Maintenance Activities**

Existing infrastructure within the Terrestrial RSA, such as old exploration roads and trails, Highway 914, and the power transmission line ROW are anticipated to be continuously used during the lifetime of the Project and may require varying levels of maintenance. Maintenance activities may include vegetation management for safety and line-of-sight, road grading and gravelling, improvement of surface water management infrastructure (e.g., culvert replacement and recontouring of ditches and drainages), and other repairs. Such activities have the potential to contribute to the cumulative effects on the Raptors, Migratory Breeding Birds and Bird Species at Risk VCs through habitat loss, increased sensory disturbance (e.g., noise and dust deposition), potential avian-vehicle collisions, and increased hunting and predation pressure within the Terrestrial RSA.

- **Exploration and Mining Activities**

Wildlife habitat within the Terrestrial RSA has experienced historic anthropogenic disturbance such as line cutting, drilling, and access development in support of past exploration and mining activities. Future exploration activities within the Terrestrial RSA are likely. Such exploration activities are expected to contribute to the cumulative effects on the Raptors, Migratory Breeding Birds and Bird Species at Risk VCs through habitat loss, increased sensory disturbance (e.g., noise and dust deposition), potential wildlife-vehicle collisions, increased hunting and predation pressure, increased risk of human-avian encounters, and deposition of trace metals and radionuclides to soil, vegetation, and waterbodies in the Terrestrial RSA.

- **Indigenous and Other Land Use Activities**

Highway 914 is presently gated at the Key Lake Operation (approximately 30 km south of the Terrestrial RSA), which restricts further access to the northeast (the north gate is on a decommissioned road and the south gate is manned). Increased access to the area was identified as a concern (20-LK-LEASESUR-267.67; ERFN and SVS 2022). While this highway is the main access into the Terrestrial RSA, trails and old exploration roads connect to Highway 914 and are used to access areas within and beyond the Terrestrial RSA (Figure 9.4-16). Improved access to the Terrestrial RSA is expected to contribute to the cumulative effects on the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs through increased sensory disturbance (e.g., noise and dust deposition), potential avian-vehicle collisions, increased hunting and predation pressure, and increased risk of human-avian encounters in the Terrestrial RSA.

- **Lodges/Outfitters and Tourist/Recreational Activities**

Ongoing and potential future use of access roads and trails within the Terrestrial RSA may interact cumulatively with the residual effects of the Project through increased recreational activities and/or additional trail development (19-LK-ERFNTrap-134.133). Roads and trails may be used to support guided hunting and fishing tours, as well as canoe tours. These activities have the potential to contribute to cumulative effects on the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs through increased sensory disturbance (e.g., noise and dust deposition), potential avian-vehicle collisions, increased hunting and predation pressure, and increased risk of human-avian encounters in the Terrestrial RSA.

The above-described projects and activities were used to inform the CEA. In the absence of comprehensive activity details and spatial information, the assessment was primarily qualitative, based on available information and understanding of the scope of these projects and activities.

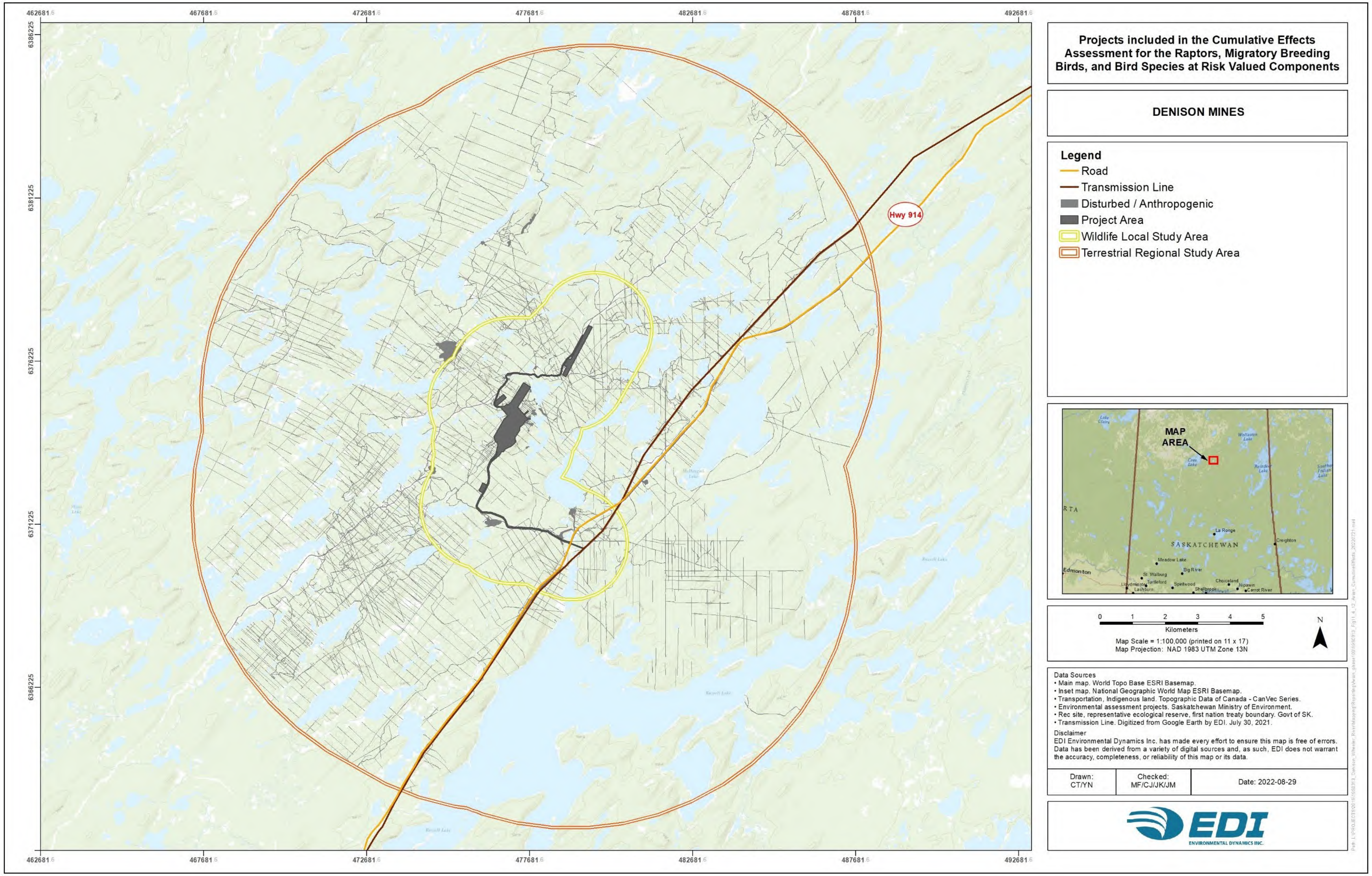

Figure 9.4-16: Projects Included in the Cumulative Effects Assessment for Raptors, Migratory Breeding Birds, and Bird Species at Risk Valued Components

9.4.7.3 Additional Mitigation Measures

It is assumed that the projects and activities considered in the CEA will have regulatory approvals and will include mitigation measures and BMPs set by the applicable jurisdictional and regulatory agencies and with appropriate consideration of IK. Additional mitigation (i.e., in addition to the mitigation considered in the assessment of Project-related effects [Section 9.4.5]) is not considered necessary to avoid or minimize the predicted cumulative effects on the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs.

9.4.7.4 Cumulative Effects Characterization and Determination of Significance

The interactions between the predicted Project residual effects and the residual effects of other projects and activities were reviewed to determine potential cumulative effects on the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs.

In the following subsections, cumulative effects on the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs are assessed and characterized in terms of magnitude, geographical extent, duration, frequency, reversibility, context, likelihood, significance, and level of confidence of the assessment predictions. Characterization criteria and significance definitions for this CEA are consistent with those presented in Section 9.4.6.

9.4.7.4.1 Raptors

Residual effects on the Raptors VC and associated KIs (i.e., Bald Eagle and Osprey) resulting from the Project were identified and assessed as **not significant** in Section 9.4.6.2. Residual effects resulting from the Project in combination with those from ongoing and reasonably foreseeable projects and activities identified and described in Section 9.4.7.2 are expected to act cumulatively to potentially affect raptors in the Terrestrial RSA through the alteration and/or loss of habitat and change in mortality.

<u>Alteration and/or Loss of Habitat</u>

The residual effect of alteration and/or loss of habitat on raptors resulting from the Project was identified and assessed as **not significant** in Section 9.4.6.2.1. The assessment of the cumulative effects of alteration and/or loss of raptor habitat considers the direct loss of habitat and the indirect alteration of habitat that is caused by a change in the quality or availability of habitat in the area surrounding a project or activity resulting from associated activities. It determines if the Project-related residual effect interacts with the residual effects of other past, current, or reasonably foreseeable projects and activities in the Terrestrial RSA.

As described in Section 9.4.4.2.1, existing habitat disturbances due to past and ongoing anthropogenic development have altered the Terrestrial RSA resulting currently in 1.5% of habitat loss in the Terrestrial RSA. The Terrestrial RSA currently provides 37,023.3 ha (92.1%) of available Bald Eagle and Osprey habitat (Section 9.4.6.2.1). While both raptor species forage in open water, their nesting habitat consists of forested areas near open water. Bald Eagle show a preference for coniferous trees for nesting sites (Buehler 2020) and Osprey will nest on tall trees or structures (Bierregaard et al. 2020).

The cumulative effect characteristics for the alteration and/or loss of habitat for Bald Eagle and Osprey are summarized below and provided in Table 9.4-33.

Vegetation clearing is anticipated to be required for the Project and most of the ongoing and reasonably foreseeable projects and activities; however, the amount, location, and timing are unknown. Mining exploration and development are expected to be responsible for most of the ongoing and future habitat loss and alteration within the Terrestrial RSA. The spatial and temporal extents of these activities are unknown, but future exploration and development is anticipated to be conducted in accordance with applicable provincial and federal approval processes and will follow BMPs and implement proven mitigation measures.

Natural disturbances such as fires and forest pests have the potential to affect raptor nesting habitat within the Terrestrial RSA. The Terrestrial RSA is located within the Boreal Shield Ecozone, known to experience a largely natural fire regime that results in the most area burned per unit area and the highest proportion of very large fires (more than 50,000 ha) in the province (Parisienne et al. 2004). As a result, much of the vegetation within the Terrestrial RSA (70.6%) is currently comprised of post-fire regeneration (Appendix 9-B), and additional forest fire disturbance within the Terrestrial RSA is likely to occur in the future (Wang et al. 2014).

Due to the spatial and temporal uncertainty of ongoing and reasonably foreseeable future developments and activities and natural disturbances, which may affect Bald Eagle and Osprey nesting habitat, raptor habitat is expected to be lost or altered and, therefore, the magnitude of the cumulative effect is predicted to be moderate.

The residual effects of the Project are expected to interact with the residual effects of other projects and activities located in the Terrestrial RSA. Therefore, the cumulative effect of alteration and/or loss of habitat is predicted to be regional in geographic extent.

The residual effects of the Project are expected to extend until after Post-Decommissioning. Once vegetation has re-established within reclaimed areas and regeneration of disturbed areas into mature forests has occurred, the residual effects of the Project will no longer interact with the residual effects of other past, current, and reasonably foreseeable future projects and activities. Therefore, the cumulative effect is expected to be long-term in duration.

The Project and other ongoing and reasonably foreseeable future projects and activities that are anticipated to require vegetation clearing are anticipated to occur as one-time events at the project/activity location and habitat loss is, therefore, predicted to be infrequent. However, sensory disturbances (e.g., vehicle traffic) associated with ongoing and reasonably foreseeable future projects and activities may result in the ongoing alteration of habitat, and the cumulative effect is, therefore, predicted to be frequent.

The residual effects from past, current, and reasonably foreseeable future projects and activities that may result in the alteration and/or loss of habitat are expected to interact with the Project's residual effects; however, these are expected to end following Post-Decommissioning. Therefore, the cumulative effect is considered to be fully reversible.

Available raptor habitat that is altered or cleared will likely remain so until after Post-Decommissioning when final reclamation and revegetation has occurred. Additional projects and activities may also affect raptor habitat and natural disturbances (i.e., forest fires) within the Boreal Shield Ecozone (including the Terrestrial RSA) are expected to increase with a changing climate (Wang et al. 2014). Bald Eagle populations in Saskatchewan are considered secure; however, Osprey have been assigned the status of S2B and S2M (SK CDC 2021). Regional Osprey populations may be sensitive to changes in their environment. Therefore, the context of the cumulative alteration and/or loss of raptor habitat is predicted to be high.

Vegetation clearing and sensory disturbances as the result of the Project and past, current, and reasonably foreseeable projects and activities are likely to result in the cumulative alteration and/or loss of habitat. Mitigation measures implemented by the Project and other projects and activities are expected to reduce, but not fully eliminate, the cumulative effect.

The cumulative effect is not expected to alter the integrity of raptor habitat within the Terrestrial RSA to the point where it is not sustainable or available to contribute to ecological functions. Therefore, the cumulative effect resulting from the Project's residual effect interacting with residual effects from other projects and activities is predicted to be **not significant**.

The effects of habitat alteration and/or loss on raptors are well known, and proven, effective mitigation measures will be implemented. The spatial and temporal details of cumulative habitat alteration and/or loss, mostly due to ongoing and future mining exploration and development and potential natural disturbances, are unknown, as is the amount of habitat alteration through sensory disturbances and habitat fragmentation. As a result, the level of confidence of the prediction for the cumulative effect is moderate.

Change in Mortality

The residual effect of change in mortality on Bald Eagle and Osprey resulting from the Project was identified and assessed as **not significant** in Section 9.4.6.2.2. The assessment of the cumulative effect of change in raptor mortality considers potential direct and/or indirect sources of mortality. It determines if the Project-related residual effect interacts with the residual effects of other past, current, or reasonably foreseeable projects and activities in the Terrestrial RSA.

The cumulative effect characteristics for the change in raptor mortality are summarized below and are provided in Table 9.4-33.

Approved projects and activities have the potential to result in a change in mortality through direct (e.g., incidental take during site clearing, collisions with vehicles, aircraft, equipment, and power transmission line infrastructure) and indirect sources (e.g., sensory disturbance). These projects and activities are expected to follow mitigation measures, BMPs, and applicable regulations and legislation that are considered to be effective at maintaining mortality within the range of natural variability. Therefore, the magnitude of the cumulative effect is anticipated to be low.

The Project's residual effects may interact with the residual effects of other projects and activities that are located throughout the Terrestrial RSA. Therefore, the cumulative effect of change in mortality is predicted to be regional in geographic extent.

The interactions between the residual effects of the Project with the residual effects of other projects and activities are expected to end during Post-Decommissioning when Project activities have ceased, and Project components have been removed. Therefore, the cumulative effect is expected to be medium-term in duration.

The frequency of the cumulative effect is predicted to be infrequent. Direct and indirect mortality could occur sporadically through all Project phases and occurrences of mortality are expected to be isolated and infrequent events given the implementation of appropriate mitigation measures by the Project and other ongoing and reasonably foreseeable future projects and activities.

The residual Project effect of change in mortality is anticipated to revert to baseline conditions upon Project completion; the same is predicted for cumulative interactions with the residual effects of other projects and activities. Therefore, the cumulative effect of change in mortality is considered to be fully reversible.

Raptors have been exposed to historic and ongoing anthropogenic and natural disturbances throughout their ranges, including within the Terrestrial RSA. While Bald Eagle populations in Saskatchewan are considered secure, Osprey have been assigned the status of S2B and S2M (SK CDC 2021). Although the cumulative effect of change in mortality is expected to affect a limited number of individuals, due to their status in Saskatchewan, regional Osprey populations may be less resilient to changes in mortality. Therefore, the cumulative effect on raptors is considered to be of high context.

The cumulative effect of change in raptor mortality is likely to occur. The raptors are known to occur in the Terrestrial RSA and available habitat is present; therefore, it is possible that Project activities in combination with those of other projects and activities may interact with raptors and result in direct and/or indirect mortality. Mitigation measures implemented by the Project and other projects and activities are expected to reduce, but not fully eliminate, the cumulative effect.

The cumulative effect of a change in mortality is not expected to alter the integrity of the regional Bald Eagle and Osprey populations to the point where they are not sustainable or available to contribute to ecological functions. Therefore, the cumulative effect is predicted to be **not significant**.

Raptor mortality may be affected by the Project and ongoing and reasonably foreseeable projects and activities; however, their populations can be resilient to additional mortality and BMPs and mitigation measures will be followed and implemented. The resulting moderate confidence rating of the residual effect considered the uncertainty related to regional Bald Eagle and Osprey population characteristics.

Table 9.4-33: Summary of Cumulative Effects on Raptors (Bald Eagle and Osprey)

Cumulative Effects	Project Phases	Cumulative Effects Characterisation[1]								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Alteration and/or Loss of Habitat	Construction Operation Decommissioning Post-Decommissioning	M	RSA	LT	FF	FR	H	L	NS	M
Change in Mortality	Construction Operation Decommissioning Post-Decommissioning	L	RSA	MT	IF	FR	H	L	NS	M

[1] Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility: Fully Reversible (FR), Partially Reversible (PR), Irreversible (IR)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (U), Likely (L)
Significance: Not Significant (NS), Significant (S)
Level of Confidence: High (H), Moderate (M), Low (L)

9.4.7.4.2 Migratory Breeding Birds

Residual effects on the Migratory Breeding Birds VC and associated KIs (i.e., waterbirds and waterfowl, upland game birds, and migratory songbirds) resulting from the Project were identified and assessed as **not significant** in Section 9.4.6.3. Residual effects resulting from the Project in combination with those from ongoing and reasonably foreseeable projects and activities identified and described in Section 9.4.7.2 are expected to act cumulatively to potentially affect migratory breeding birds in the Terrestrial RSA through the alteration and/or loss of habitat and change in mortality.

Alteration and/or Loss of Habitat

The CEA of the alteration and/or loss of habitat residual effect on migratory breeding birds considers the direct loss of habitat and the indirect alteration of habitat that is caused by a change in the quality or availability of habitat in the area surrounding a project resulting from project activities. It determines if the Project-related residual effect interacts cumulatively with the residual effects of other past, current, or reasonably foreseeable projects and activities in the Terrestrial RSA. As described in Section 9.4.4.2.1, existing habitat disturbances due to past and ongoing anthropogenic development have altered the Terrestrial RSA resulting currently in 1.5% of habitat loss in the Terrestrial RSA. The Terrestrial RSA currently provides migratory breeding bird habitat for the three KIs (Section 9.4.6.3.1) that includes:

- 8,426.0 ha (21.0%) of available habitat for waterbirds and waterfowl;
- 31,076.6 ha (77.4%) of available habitat for upland game birds; and
- 20,349.8 ha (50.7%) of available habitat for migratory songbirds.

While available habitat for waterbirds and waterfowl in the Terrestrial RSA is limited to waterbodies, habitat for upland game birds and migratory songbirds comprises a variety of different vegetated ecosites (Section 9.4.3.2)

The cumulative effect characteristics for alteration and/or loss of habitat for the Migratory Breeding Bird VC are summarized below and provided in Table 9.4-34.

Vegetation clearing is anticipated to be required for the Project and most of the ongoing and reasonably foreseeable projects and activities; however, the amount, location and timing for the ongoing and reasonably foreseeable projects and activities are unknown. Mining exploration and development are expected to be responsible for most of the ongoing and future habitat loss and alteration within the Terrestrial RSA. The spatial and temporal extents of these activities are unknown, but future exploration and development is anticipated to be conducted in accordance with applicable provincial and federal approval processes and will follow BMPs and implement effective mitigation measures.

In addition, natural disturbances, such as fires and forest pests, have the potential to affect migratory breeding bird habitat within the Terrestrial RSA. The Terrestrial RSA is located within the Boreal Shield Ecozone, known to experience a largely natural fire regime that results in the most area burned per unit area and the highest proportion of very large fires (more than 50,000 ha) in the province (Parisien et al. 2004). As a result, much of the vegetation within the Terrestrial RSA (70.6%) is comprised of post-fire regeneration (Appendix 9-B), and additional forest fire disturbance within the Terrestrial RSA is likely to occur in the future.

Due to the spatial and temporal uncertainty of ongoing and reasonably foreseeable future developments and activities and natural disturbances, it is expected that a limited amount of migratory breeding bird habitat might be lost or altered and, therefore, the magnitude of the cumulative effect is predicted to be low.

The residual effects of the Project are expected to interact with the residual effects of other projects and activities located in the Terrestrial RSA. Therefore, the cumulative effect of alteration and/or loss of habitat on migratory breeding birds is predicted to be regional in geographic extent.

The residual effects of the Project are expected to extend beyond Post-Decommissioning. Once vegetation has re-established within reclaimed areas and regeneration of disturbed areas into mature forests has occurred, the residual effects of the Project are anticipated to no longer interact with the residual effects of other past, current, and reasonably foreseeable future projects and activities. The cumulative effect is, therefore, expected to be long-term in duration.

Vegetation clearing and/or soil disturbance required for the Project and other past, current, and reasonably foreseeable future projects and activities are anticipated to occur as one-time events at a location and habitat loss is, therefore, predicted to be infrequent. However, sensory disturbances associated with ongoing and reasonably foreseeable future projects and activities may result in the ongoing alteration of habitat, and the cumulative effect is, therefore, predicted to be frequent.

The residual effects from past, current, and reasonably foreseeable future projects and activities that may result in the alteration and/or loss of habitat are expected to interact with the Project's residual effects; however, these are expected to end after Post-Decommissioning. Most areas of cleared vegetation, as the result of the Project and other past, current, or reasonably foreseeable projects or activities, are anticipated to be reclaimed and/or vegetation and are expected to recover to a safe, stable, and self-sustaining condition upon Project, similar to the future state of the areas of other projects and activities within the Terrestrial RSA. As a result, the cumulative effect is considered fully reversible.

Available habitat for migratory breeding birds can be reasonably resilient to stress and regenerate after a disturbance (e.g., vegetation clearing, forest fire); however, the variability in natural disturbances (i.e., forest fires) within the Boreal Shield Ecozone (including the Terrestrial RSA) is expected to increase, and natural disturbance events may increase in frequency (Wang et al. 2014). Declining trends for some waterbird and waterfowl species in their range, including Saskatchewan, have been reported (Prairie Habitat Joint Venture 2014). Songbird declines have been documented across North America; however, population trends in the northern boreal forest of Saskatchewan are not well documented (Van Wilgenburg 2015). Indigenous Knowledge reported declines in some species, such as Grouse, Ptarmigan, Canada Geese, Loons (in some lakes), and Mallards[38]. Therefore, the context of the residual effect of alteration and/or loss of available furbearer habitat is predicted to be moderate.

[38] 19-LK-ERFNTrap-134.163, 19-LK-ERFNTrap-134.164, 19-LK-ERFNTrap-134.166.

Vegetation clearing and sensory disturbances as the result of the Project and past, current, and reasonably foreseeable projects and activities are likely to result in the cumulative alteration and/or loss of migratory breeding bird habitat. Mitigation measures implemented by the Project and other projects and activities are expected to reduce, but not fully eliminate, the cumulative effect.

The cumulative effect is not expected to alter the integrity of migratory breeding bird habitat within the Terrestrial RSA to the point where it is not sustainable or available to contribute to ecological functions. Therefore, the cumulative effect is predicted to be **not significant**.

The effects of habitat alteration and/or loss on migratory breeding birds are well known, and proven, effective mitigation measures will be implemented. The spatial and temporal details of cumulative habitat loss, mostly due to ongoing and future mining exploration and development and natural disturbances are unknown, as is the amount of habitat alteration through sensory disturbances and habitat fragmentation. As a result, the level of confidence of the prediction for the cumulative effect of habitat alteration and/or loss on the Migratory Breeding Bird VC is moderate.

Change in Mortality

The residual effect of change in mortality on migratory breeding birds resulting from the Project was identified and assessed as **not significant** in Section 9.4.6.2.2. The assessment of the cumulative effect of change in migratory breeding bird mortality considers potential direct and/or indirect sources of mortality. It determines if the Project-related residual effect interacts with the residual effects of other past, current, or reasonably foreseeable projects and activities in the Terrestrial RSA.

The cumulative effect characteristics for the change in the Migratory Breeding Bird VC mortality are summarized below and are provided in Table 9.4-34.

Approved projects and activities have the potential to result in a change in mortality through direct (e.g., incidental take during site clearing; collisions with vehicles, aircraft, equipment, and power transmission line infrastructure) and indirect sources (e.g., sensory disturbance, or increased ease of access which may facilitate hunting). These projects and activities are expected to implement mitigation measures and BMPs and follow applicable regulations and legislation considered to be effective at maintaining mortality within the range of natural variability and management guidelines. Therefore, the magnitude of the cumulative effect is expected to be low.

The Project's residual effects may interact with the residual effects of other projects and activities that are located throughout the Terrestrial RSA. Therefore, the cumulative effect of change in mortality is predicted to be regional in geographic extent.

The interactions between the residual effects of the Project with the residual effects of other projects and activities are expected to extend beyond Post-Decommissioning when Project activities have ceased, Project components have been removed, disturbed areas are reclaimed, and vegetation has re-established within reclaimed areas (which includes mature forests for some avian species). Therefore, the cumulative effect is expected to be long-term in duration.

The frequency of the cumulative effect is predicted to be infrequent. Although the Migratory Breeding Bird VC may be affected cumulatively through change in mortality, direct and indirect mortality are anticipated to occur sporadically through all Project phases; therefore, occurrences of mortality are expected to be isolated and infrequent events given the implementation of appropriate mitigation measures by the Project and other ongoing and reasonably foreseeable future projects and activities.

The residual Project effect of change in mortality is anticipated to revert to baseline conditions upon Project completion; the same is predicted for cumulative interactions with the residual effects of other projects and activities. Therefore, the cumulative effect of change in mortality is considered to be fully reversible.

Migratory breeding birds have been exposed to historic and ongoing anthropogenic and natural disturbances throughout their ranges, including within the Terrestrial RSA (i.e., 1.5% of the Terrestrial RSA has currently experienced anthropogenic disturbances). The Project, as well as other ongoing and foreseeable future projects and activities, are expected to interact with a limited number of individuals that may be affected by direct and/or indirect sources of mortality. While the three KIs (i.e., waterbirds and waterfowl, upland game birds, and migratory songbirds) are considered secure in Saskatchewan, declining trends have been reported for some waterbird and waterfowl species in their range, including Saskatchewan, (Prairie Habitat Joint Venture 2014). Songbird declines have been documented across North America; however, population trends in the northern boreal forest of Saskatchewan are not well documented (Van Wilgenburg 2015). Indigenous Knowledge reported declines in some species, such as Grouse, Ptarmigan, Canada Geese, Loons (in some lakes), and Mallards[39]. Therefore, the cumulative effect is considered to be of moderate context.

The cumulative effect of change in mortality is likely to occur. Known occurrences of several species of the Migratory Breeding Bird VC have been reported (Appendix 9-B) and available habitat for the three KIs is present within the Terrestrial RSA; therefore, it is possible that Project activities and those of other projects and activities may interact with migratory breeding birds and result in direct and/or indirect mortality. Mitigation measures implemented by the Project and other projects and activities are expected to reduce, but not fully eliminate, the cumulative effect.

The cumulative effect of a change in mortality is not expected to alter the integrity of the regional migratory breeding bird populations to the point where they are not sustainable or available to

[39] 19-LK-ERFNTrap-134.163, 19-LK-ERFNTrap-134.164, 19-LK-ERFNTrap-134.166.

contribute to ecological functions. Therefore, the cumulative effect is predicted to be **not significant**.

Migratory breeding bird mortality may be affected by the Project and ongoing and reasonably foreseeable projects and activities; however, their populations can be resilient to additional mortality, and BMPs and mitigation measures will be followed and implemented. The resulting moderate confidence rating of the residual effect considered the uncertainty related to migratory breeding bird population characteristics.

Table 9.4-34: Summary of Cumulative Effects on Migratory Breeding Birds (Waterbirds and Waterfowl, Upland Game Birds, and Migratory Songbirds)

Cumulative Effects	Project Phases	Cumulative Effects Characterisation[1]								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Alteration and/or Loss of Habitat	Construction Operation Decommissioning Post-Decommissioning	L	RSA	LT	FF	FR	M	L	NS	M
Change in Mortality	Construction Operation Decommissioning Post-Decommissioning	L	RSA	LT	IF	FR	M	L	NS	M

[1] Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility: Fully Reversible (FR), Partially Reversible (PR), Irreversible (IR)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (U), Likely (L)
Significance: Not Significant (NS), Significant (S)
Level of Confidence: High (H), Moderate (M), Low (L)

9.4.7.4.3 Bird Species at Risk

Residual effects on the Bird Species at Risk VC and associated KIs (i.e., Common Nighthawk, Short-eared Owl, Yellow Rail, Rusty Blackbird, and Olive-sided Flycatcher) resulting from the Project were identified and assessed as **not significant** in Section 9.4.6.4**.** Residual effects resulting from the Project in combination with those from ongoing and reasonably foreseeable projects and activities identified and described in Section 9.4.7.2 are expected to act cumulatively to potentially affect bird species at risk in the Terrestrial RSA through the alteration and/or loss of habitat and change in mortality.

Alteration and/or Loss of Habitat

The residual effect of alteration and/or loss of habitat on bird species at risk resulting from the Project was identified and assessed as **not significant** in Section 9.4.6.4.1. The assessment of the cumulative effects of alteration and/or loss of bird species at risk habitat considers the direct loss of habitat and the indirect alteration of habitat that is caused by a change in the quality or availability of habitat in the area surrounding a project or activity resulting from associated activities. It determines if the Project-related residual effect interacts with the residual effects of other past, current, or reasonably foreseeable projects and activities in the Terrestrial RSA. As described in Section 9.4.4.2.1, existing habitat disturbances due to past and ongoing anthropogenic development have altered the Terrestrial RSA resulting currently in 1.5% of habitat loss in the Terrestrial RSA.

The Terrestrial RSA currently provides migratory breeding bird habitat for the five KIs (Section 9.4.6.4.1) which includes:

- 18,093.0 ha (45.0%) of available Common Nighthawk habitat;
- 1,282.5 ha (3.3 %) of available Short-eared Owl habitat;
- 2,514.9 ha (6.4 %) of available Yellow Rail and Rusty Blackbird habitat; and
- 29,914.9 ha (74.5 %) of available Olive-sided Flycatcher habitat.

The five KIs have different habitat requirements ranging from wetlands to mature forest ecosites (Section 9.4.3.3). Some of the KIs may not be present in the Project Area due to limited habitat availability (e.g., Short-eared Owl, Yellow Rail, and Rusty Blackbird). The cumulative effect characteristics for the alteration and/or loss of habitat for bird species at risk are summarized below and provided in Table 9.4-35.

Vegetation clearing is anticipated to be required for the Project and most of the ongoing and reasonably foreseeable projects and activities; however, the amount, location and timing are unknown. Mining exploration and development are expected to be responsible for most of the ongoing and future habitat loss and alteration within the Terrestrial RSA. The spatial and temporal extents of these activities are unknown, but future exploration and development is anticipated to be conducted in accordance with applicable provincial and federal approval processes and will follow BMPs and implement proven mitigation measures.

In addition, natural disturbances such as fires and forest pests have the potential to affect bird species at risk habitat within the Terrestrial RSA. The Terrestrial RSA is located within the Boreal Shield Ecozone, known to experience a largely natural fire regime that results in the most area burned per unit area and the highest proportion of very large fires (more than 50,000 ha) in the province (Parisien et al. 2004). As a result, much of the vegetation within the Terrestrial RSA (70.6%) is currently comprised of post-fire regeneration (Appendix 9-B), and additional forest fire disturbance within the Terrestrial RSA is likely to occur in the future (Wang et al. 2014).

Due to the spatial and temporal uncertainty of ongoing and reasonably foreseeable future developments and activities and natural disturbances, which may affect bird species at risk habitat, it is expected that a limited amount of bird species at risk habitat might be lost or altered and, therefore, the magnitude of the cumulative effect is predicted to be low.

The residual effects of the Project are expected to interact with the residual effects of other projects and activities located in the Terrestrial RSA. Therefore, the cumulative effect of alteration and/or loss of habitat is predicted to be regional in geographic extent.

The residual effects of the Project are expected to extend beyond Post-Decommissioning. Once vegetation has re-established within reclaimed areas and regeneration of disturbed areas into mature forests has occurred, the residual effects of the Project will no longer interact with the residual effects of other past, current, and reasonably foreseeable future projects and activities. Therefore, the cumulative effect is expected to be long-term in duration.

Vegetation clearing, required for the Project and other ongoing and reasonably foreseeable future projects and activities, is anticipated to occur as one-time events at the project/activity location and habitat loss is, therefore, predicted to be infrequent. Sensory disturbances (e.g., vehicle traffic) associated with ongoing and reasonably foreseeable future projects and activities may result in the ongoing alteration of habitat, and the cumulative effect is, therefore, predicted to be frequent.

The residual effects from past, current, and reasonably foreseeable future projects and activities that may result in the alteration and/or loss of habitat are expected to interact with the Project's residual effects; however, these are expected to end following Post-Decommissioning. Therefore, the cumulative effect is considered fully reversible.

Available habitat for bird species at risk that is altered or cleared will remain so until the end of Post-Decommissioning, when final reclamation and revegetation has occurred. Additional projects and activities may also affect habitat, and natural disturbances (i.e., forest fires) within the Boreal Shield Ecozone (including the Terrestrial RSA) are expected to increase with a changing climate (Wang et al. 2014). Revegetated areas are expected to become available habitat within a few years of revegetation for some species that prefer habitat following disturbance. All five KIs are listed federally (ECCC 2021) and are expected to be sensitive to changes in their environment. Therefore, the context of the cumulative alteration and/or loss of habitat is predicted to be high.

Vegetation clearing and sensory disturbances resulting from the Project and past, current, and reasonably foreseeable projects and activities are likely to result in the cumulative alteration and/or loss of habitat. Mitigation measures implemented by the Project and other projects and activities are expected to reduce, but not fully eliminate, the cumulative effect.

The cumulative effect is not expected to alter the integrity of bird species at risk habitat within the Terrestrial RSA to the point where it is not sustainable or available to contribute to ecological functions. Therefore, the cumulative effect resulting from the Project's residual effect interacting with residual effects from other projects and activities is predicted to be **not significant**.

The effects of habitat alteration and/or loss on bird species at risk are well known, and proven, effective mitigation measures will be implemented. The spatial and temporal details of cumulative habitat loss, mostly due to ongoing and future mining exploration and development and potential natural disturbances, are unknown, as is the amount of habitat alteration through sensory disturbances and habitat fragmentation. As a result, the level of confidence of the prediction for the cumulative effect is moderate.

Change in Mortality

The residual effect of change in mortality on the Bird Species at Risk VC resulting from the Project was identified and assessed as **not significant** in Section 9.4.6.4.2. The assessment of the cumulative effect of change in bird species at risk mortality considers potential direct and/or indirect sources of mortality. It determines if the Project-related residual effect interacts with the residual effects of other past, current, or reasonably foreseeable projects and activities in the Terrestrial RSA.

The cumulative effect characteristics for the change in bird species at risk mortality are summarized below and are provided in Table 9.4-35.

Approved projects and activities have the potential to result in a change in mortality through direct (e.g., incidental take during site clearing, collisions with vehicles, aircraft, equipment, and power transmission line infrastructure) and indirect sources (e.g., sensory disturbance). These projects and activities are expected to follow mitigation measures, BMPs, and applicable regulations and legislation that are considered to be effective at maintaining mortality within the range of natural variability. Therefore, the magnitude of the cumulative effect is anticipated to be low.

The Project's residual effects may interact with the residual effects of other projects and activities that are located throughout the Terrestrial RSA. Therefore, the cumulative effect of change in mortality is predicted to be regional in geographic extent.

The interactions between the residual effects of the Project with the residual effects of other projects and activities are expected to extend beyond Post-Decommissioning when Project activities have ceased, Project components have been removed, disturbed areas are reclaimed, and vegetation has re-established within reclaimed areas (which includes mature forests for some avian species). Therefore, the cumulative effect is expected to be long-term in duration.

The frequency of the cumulative effect is predicted to be infrequent. Although the Bird Species at Risk VC may be affected cumulatively through change in mortality, direct and indirect mortality is expected to occur sporadically through all Project phases; therefore, occurrences of mortality are expected to be isolated and infrequent events given the implementation of appropriate mitigation measures by the Project and other ongoing and reasonably foreseeable future projects and activities.

The residual Project effect of change in mortality is anticipated to revert to baseline conditions upon Project completion; the same is predicted for cumulative interactions with the residual effects of other projects and activities. Therefore, the cumulative effect of change in bird species at risk mortality is considered to be fully reversible.

Bird species at risk have been exposed to historic and ongoing anthropogenic and natural disturbances throughout their ranges, including within the Terrestrial RSA. The five KIs selected to inform the assessment of the Bird Species at Risk VC are listed federally (ECCC 2021), with some being listed provincially (SK CDC 2021), and are considered to be sensitive to changes in their environment. Although the Project is expected to interact with a limited number of individuals that may be affected by direct and/or indirect sources of mortality, populations of species at risk may be less resilient to changes in mortality. Therefore, the cumulative effect is expected to be of high context.

The cumulative effect of change in bird species at risk mortality is likely to occur. Available habitat for the five KIs is present in the Terrestrial RSA; therefore, Project activities in combination with those of other projects and activities may interact with bird species at risk and result in direct and/or indirect mortality. Mitigation measures implemented by the Project and other projects and activities are expected to reduce, but not fully eliminate, the cumulative effect.

It is not expected that the cumulative effect of a change in mortality will alter the integrity of the regional bird species at risk populations to the point where they are not sustainable or available to contribute to ecological functions. Therefore, the cumulative effect is predicted to be **not significant**.

Bird species at risk mortality may be affected by the Project and ongoing and reasonably foreseeable projects and activities; however, their populations can be resilient to additional mortality and BMPs and mitigation measures will be followed and implemented. The resulting moderate confidence rating of the residual effect considered the uncertainty related to regional species at risk population characteristics.

Table 9.4-35: Summary of Cumulative Effects on Bird Species at Risk (Common Nighthawk, Short-eared Owl, Yellow Rail, Rusty Blackbird, and Olive-sided Flycatcher)

Cumulative Effects	Project Phases	Cumulative Effects Characterisation[1]								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Alteration and/or Loss of Habitat	Construction Operation Decommissioning Post-Decommissioning	L	RSA	LT	FF	FR	H	L	NS	M
Change in Mortality	Construction Operation Decommissioning Post-Decommissioning	L	RSA	LT	IF	FR	H	L	NS	M

[1] Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility: Fully Reversible (FR), Partially Reversible (PR), Irreversible (IR)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (U), Likely (L)
Significance: Not Significant (NS), Significant (S)
Level of Confidence: High (H), Moderate (M), Low (L)

9.4.7.5 Climate Change Considerations

Section 15.5 in Section 15 summarizes the projections for future climate conditions over the life of the Project in the area (including the Terrestrial RSA). The winters will likely be warmer and snowier, and the summers longer and hotter. Some uncertainty exists around projected trends in total and extreme precipitation events that may not affect the Project (Section 15.5 in Section 15). As further described in Section 15.5 in Section 15, forest fire frequency, severity, and extent are expected to increase in all areas of the Canadian boreal forest (including the Terrestrial RSA) over the next decades (Wotton et al. 2017). Future climate change models predict that in the area around and including the Terrestrial RSA more frequent fires will occur. This prediction considers the influence of factors affecting fire occurrence, such as lightning, fuel moisture, temperature, precipitation, and vegetation (Government of Canada 2020). Rising temperatures could add damaged or dead wood to the forest fuel load (e.g., from insect outbreaks, ice storms, or high winds) and may increase the risk of fire activity.

Forest fires are considered the most likely factor, under a predicted future climate change scenario, affecting avian species (assessed in this EIS) through habitat effects.

The Terrestrial RSA and surrounding areas are experiencing a natural fire regime that has resulted in much of the vegetation (i.e., 70.6% of the Terrestrial RSA) being comprised of post-fire regeneration (Appendix 9-B). Raptors are known to use the Terrestrial RSA (Appendix 9-B), indicating that the area currently provides suitable habitat for Bald Eagle and Osprey. However, future potential increased frequency and severity of fires in the boreal forest (Wang et al. 2014), may adversely affect their habitat in the Terrestrial RSA.

While the three Migratory Breeding Bird KIs assessed in this EIS (i.e., waterbirds and waterfowl, upland gamebirds, and migratory songbirds) may have evolved in the region under the current wildfire regime, predicted future increases in frequency and severity of forest fires (Wang et al. 2014) are expected to affect their habitat. These effects may vary by species with their dependence on forest ecosystems. In addition to forest fires, non-migratory upland gamebirds may be affected by predicted future warmer and snowier winters.

The past and current wildfire regime resulted in 70.6% of the vegetation within the Terrestrial RSA being comprised of post-fire regeneration (Appendix 9-B). Forest habitats experiencing such disturbances currently provide habitat for several Bird Species at Risk KIs (e.g., Common Nighthawk, Yellow Rail, Rusty Blackbird, and Olive-sided Flycatcher [Appendix 9-B; SK MOE 2021c]) and potential habitat for others (i.e., Short-eared Owl). However, future potential increased frequency and severity of fires in the boreal forest (Wang et al. 2014), may adversely affect their habitat in the Terrestrial RSA.

9.4.8 Monitoring and Follow-up

As outlined in Section 5.10 in Section 5, monitoring and follow-up for this EIS are defined as follows:

- Monitoring programs are designed to meet regulatory requirements (e.g., permit or license conditions), and/or to demonstrate compliance with environmental commitments made in the EIS.
- Follow-up programs are those that are proposed to address any uncertainties identified during the EA process (e.g., to verify predictions made during the EA and to determine the effectiveness of implemented mitigation measures) and to determine if and when to implement adaptive management measures.

Monitoring Programs

Monitoring requirements will be directed by the provincial or federal regulators and as requested by Indigenous groups during the Project licensing process and are expected to include requirements related to scheduling, sampling design, frequency, and reporting. The monitoring programs may follow the same processes as described for follow-up programs (see below).

Targeted monitoring programs (described below) will be completed during the Construction, Operation, and Decommissioning phases to verify that Project design and mitigation measures

(Section 9.4.5) have been appropriately applied and maintained. Following verification, the success of Project design and mitigation measures will be evaluated to assist in the determination of additional mitigation measure requirements.

An adaptive management process will be employed, after applicable consultations and approvals, if implemented mitigation measures are found to be unsuccessful. Management plans will be considered living documents, and updated when warranted to include input from consultations, monitoring results, regulatory or legislative changes, and updated, improved, or revised BMPs and scientific methods. Project monitoring programs specific to Raptors, Migratory Breeding Bird, and Bird Species at Risk VCs are expected to include:

- pre-construction nest surveys conducted in accordance with the EMS prior to the commencement of any vegetation clearing or soil disturbance;
- avian species routinely monitored throughout the life of the Project (e.g., through the Project-wide implementation of the current wildlife card system) in accordance with the EMS (including implemented setback distances during sensitive time periods, if applicable);
- Denison is committed to monitoring avian mortality related to avian use of waste and water facilities, as well as mortality events associated with interactions with access roads (particularly related to large-bodied carcasses) and transmission lines. Such mortalities will be documented and reported to the SK MOE on a regular basis as determined in consultation between the SK MOE and Denison; and
- progressive reclamation and revegetation of disturbed areas (i.e., transitioning into avian habitat) monitored in accordance with the Reclamation and Closure Plan.

Avian movements across the Project study areas may bring species or individuals into contact with Project components (e.g., buildings, power transmission lines, waste ponds and waste pads) and activities (i.e., vehicle and aircraft traffic), which can result in mortalities and changes to habitat use. Project design and mitigation measures (Section 9.4.5) have been identified that are expected to minimize the likelihood of adverse Project effects. However, changes in avian habitat and habitat use over the life of the Project require an adaptive management process to update Project design and additional mitigation measures, if required. The potential for these changes will require appropriate monitoring for changes in avian mortality or encounters to determine, in a timely manner, whether changes are warranted through the adaptive management process.

Follow-up Programs

Follow-up programs are typically used to address uncertainties with the current assessment and will work toward following goals:

- quantify and qualify Project-related and cumulative effects against predictions;
- assess the effectiveness of implemented mitigation measures;

- identify unexpected environmental constraints or problems (if they should arise);
- and environmental protection measures are expected to determine any issues that need to be addressed. If an issue is identified, then Denison's adaptive management process modify existing mitigation measures or implement additional mitigation measures/adaptations in accordance with the adaptive management process to maintain valid effect predictions; and
- implement additional mitigation measures (if required) including triggers and corrective actions, in accordance with the adaptive management process.

Considering the Project planning, baseline survey results, and proposed mitigation measures, no follow-up programs are considered to be warranted at this time. The monitoring programs would be initiated and the issue, the design of the appropriate response, and the schedule to address would be completed in a timely manner.

If unforeseen adverse effects are identified during follow-up programs, Denison will, as per its ongoing adaptive management process, adjust the existing mitigation measures or, if necessary, develop new mitigation measures to address those effects. This could result in Denison refining or modifying the design and implementation of management plans (see Section 16), mitigation measures, and Project operations, with the final approach selected depending on the issue identified. Interested Parties, Indigenous groups, and government agencies will be involved in developing mitigation and adaptive management measures where applicable to minimize any adverse effects on the Raptors, Migratory Breeding Bird, and Bird Species at Risk VCs.

9.4.9 Raptors, Migratory Breeding Birds, and Bird Species at Risk Summary

The avian VC's (and KI's) considered in this EIS are Raptors (Bald Eagle and Osprey), Migratory Breeding Birds (waterbirds and waterfowl, upland gamebirds, and migratory songbirds) and Bird Species at Risk (Common Nighthawk, Short-eared Owl, Yellow Rail, Rusty Blackbird, and Olive-sided Flycatcher). The main activities considered in the effects assessment include site preparation (i.e., clearing, grading and construction of roads, airstrip, and surface infrastructure), operation (i.e., vehicle movement, material handling), water management (i.e., withdrawal/use of surface and/or groundwater and release of effluent), waste management (i.e., temporary storage, handling, and off-site transportation), and reclamation (i.e., progressive and final reclamation of disturbed areas).

Based on the timing and nature of the interactions between the Project activities and the KI's, the following adverse effects on the Raptors, Migratory Breeding Birds , and Bird Species at Risk VCs have the potential to occur during the lifetime of the Project: alteration and/or loss of habitat (direct loss of avian habitat due vegetation clearing and vegetation management and indirect alteration of avian habitat due to sensory disturbances, habitat fragmentation, and edge effect); change in direct mortality (due to incidental take, entrapment in enclosed spaces, collisions with vehicles, equipment, buildings, and windows, collisions with aircraft, and collisions with power transmission lines/energized equipment) and indirect mortality (due to nest failure or abandonment caused by sensory disturbance, changes in predator-prey dynamics, or increased public access).

Mitigation measures were designed to avoid or minimize potential effects, including the following:

- The Project footprint has been reduced and is primarily within previously disturbed areas, thereby minimizing direct and indirect habitat loss and/or alteration.
- Denison staff would facilitate access to undertake Aboriginal and / or Treaty Rights, provided it was safe to do so given activities in the area.
- The powerline to the main substation at the site is relatively short (i.e., approximately 7 km) and will be constructed from the existing provincial power line adjacent to Highway 914.
- Policies will be implemented prohibiting employees and contractors from feeding, approaching, or harassing avian wildlife within the Project Area.
- Additional mitigation measures specific to the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs, in accordance with the Migratory Birds Convention Act, and tailored to Project features have been incorporated into the various Project management plans.
- The management plans within the EMS will address specific mitigation measures based on proven and accepted mitigation measures following standard industry guidelines and BMPs and will provide guidance to avoid or minimize potential adverse effects of the Project on avian species and their habitat, including monitoring and follow-up programs, as appropriate.
- Site clearing and other works that involve disturbance of vegetation and/or soil will be conducted outside of the nesting season, whenever practicable. The nesting season for the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs in Saskatchewan spans a period from March 15 to August 31; however, the dates differ for certain species. The nesting season for raptors is generally longer (SK MOE 2017). The EMS will provide details on nesting windows for avian species occurring in the Terrestrial RSA based on the SARGSS, which were established to support the avoidance of sensitive species' habitats during sensitive periods (SK MOE 2017).
- Prior to commencing any site clearing (i.e., vegetation clearing and/or soil disturbance) during the nesting season, pre-clearing nest surveys will be conducted at that location within the Project Area.
- Active nests and suspected nest locations will be protected with a no-disturbance setback buffer consistent with regulatory guidelines (e.g., the 2017 SARGSS [SK MOE 2017]) in accordance with the level of the disturbance and species until the young have successfully fledged, the nest is confirmed as no longer active (e.g., abandoned or depredated), or the nesting window has passed (for suspected nest locations). If guidelines cannot be met, due to safety or operational concerns, SK MOE will be contacted for advice on the appropriate response to the situation.

- In accordance with a Waste Management Plan, waste will be collected and temporarily stored in wildlife-proof containers to avoid attracting scavengers and with that increase the risk for human-wildlife interactions. The plan will also regulate the handling of hazardous materials to reduce to risk of wildlife exposure to spills of fuels and other hazardous materials.

With the implementation of the above (and additional) mitigation measures, the residual effects on the Raptors, Migratory Breeding Birds, and Bird Species at Risk VCs were assessed as follows:

Effects on Raptors, related to habitat and mortality, are anticipated to be:

- Moderate magnitude for habitat effects: up to 6.9% of available raptor habitat within the Terrestrial RSA is predicted to be affected.
- Low magnitude for mortality effects: the risk of mortality is expected to be within the range of natural variability.
- Local extent of habitat effects: the direct loss of available habitat is expected to be limited to the Project Area; however, indirect alteration of habitat may extend into the Wildlife LSA.
- Regional extent of mortality effect: the change in direct mortality is expected to occur mainly within the Project Area; however, indirect mortality may extend into the Terrestrial RSA.
- Long-term duration of habitat effects: the loss of available raptor habitat will mainly occur during Construction; however, the alteration of habitat will continue through all phases and until after revegetation following Project completion and vegetation has re-established and matured within reclaimed areas.
- Medium-term duration of mortality effects: mortality may occur during all phases of the Project, but the potential direct mortality is expected to be highest during the Construction and Operation phases.
- Fully reversible: all habitat and mortality effects are anticipated to be fully reversible, i.e., upon completion of the Project, changes are expected to diminish to baseline conditions.
- Not significant: the residual effects of alteration and/or loss of available habitat and of change in mortality are not expected to result in a change that will alter habitat integrity to the point where it would not be able to sustain the regional raptor populations or the integrity of the regional raptor population to the point where it could not be sustained.

Effects on Migratory Breeding Birds, related to habitat and mortality, are anticipated to be:

- Low magnitude: between 1.6% to 4.3% of available habitat for waterbirds and waterfowl, upland gamebirds, and migratory songbirds within the Terrestrial RSA may be altered or lost; the risk of mortality is expected to be within the range of natural variability.
- Local extent of habitat effects: the direct loss of available migratory breeding bird habitat is expected to be limited to the Project Area, and indirect effects resulting in habitat alteration are expected to be restricted to the Wildlife LSA.

- Regional extent of mortality effects: the change in direct mortality is expected to occur within the Project Area; however, indirect mortality of migratory breeding birds may extend into the Terrestrial RSA, particularly for wolverine).
- Long-term duration of habitat effects: the loss of available habitat for migratory breeding birds will mainly occur during Construction; however, the alteration of habitat will continue through all phases and until after completion of Post-Decommissioning at which time revegetated areas will become available habitat for migratory breeding birds that prefer mature forests;
- Medium-term duration of mortality effects: mortality may occur during all phases of the Project, but the potential direct mortality is expected to be highest during the Construction and Operation phases.
- Fully reversible: all habitat and mortality effects are anticipated to be fully reversible, i.e., upon completion of the Project, changes are expected to diminish to baseline conditions.
- Not significant: the residual effects of alteration and/or loss of available habitat and of change in mortality are not expected to result in a change that will alter habitat integrity to the point where it would not be able to sustain the regional migratory breeding bird populations or the integrity of the regional migratory breeding bird populations to the point where they could not be sustained.

Effects on Bird Species at Risk, related to habitat and mortality, are anticipated to be:

- Low magnitude: between 2.4% and 4.7% of available habitat for Common Nighthawk, Short-eared Owl, Rusty Blackbird, Yellow Rail, and Olive-sided Flycatcher within the Terrestrial RSA are predicted to be affected by the Project; the risk of mortality is expected to be within the range of natural variability.
- Local extent of habitat effects: the direct loss of available bird species at risk habitat is expected to be limited to the Project Area, and indirect effects resulting in habitat alteration are expected to be restricted to the Wildlife LSA.
- Regional extent of mortality effect of mortality: the change in direct mortality is expected to occur within the Project Area; however, indirect mortality may extend into the Terrestrial RSA.
- Long-term duration of habitat effects: the loss of available habitat for bird species at risk will mainly occur during Construction; however, the alteration of habitat will continue through all phases and until after completion of Post-Decommissioning at which time revegetated areas will become available habitat for bird species at risk that prefer mature forests;
- Medium-term duration of mortality effects: mortality may occur during all phases of the Project, but the potential direct mortality is expected to be highest during the Construction and Operation phases.
- Fully reversible: all habitat and mortality effects are anticipated to be fully reversible, i.e., upon completion of the Project, changes are expected to diminish to baseline conditions.

- Not significant: the residual effects of alteration and/or loss of available habitat and of change in mortality are not expected to result in a change that will alter habitat integrity to the point where it would not be able to sustain the regional bird species at risk population or the integrity of the regional bird species at risk population to the point where they could not be sustained.

9.4.10 References

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Appendix 9-A Engagement Database Summary – Terrestrial Environment

See file "S9_App 9-A Terrestrial Environment Engagement_Wheeler River.pdf"

Appendix 9-B Denison Mines Corporation Wheeler River Project, Terrestrial Environment, Wildlife and Vegetation Baseline Inventory

See file “S9_App 9-B Terrestrial Baseline 2020_Wheeler River.pdf”

Appendix 9-C Wheeler River Project, Soil, Vegetation and Wildlife: Annex Baseline Report

See file “S9_App 9-C Terrestrial Baseline Addendum 2022_Wheeler River.pdf”

Appendix 9-D Wildlife Species at Risk

See file “S9_App 9-D Wildlife Species At Risk.pdf”

Appendix 9-E Caribou Management Framework

See file “S9_App 9-E Caribou Management Framework.pdf”

Appendix 9-F Supplemental Information Generated During the Draft EIS Review

See file "S9_App 9-F_Supplemental Information Generated During the Draft EIS Review.pdf"

Denison Mines

Wheeler River Project

Final Environmental Impact Statement

November 2024

Powering
PEOPLE, PARTNERSHIPS AND PASSION.

Wheeler River Project

Final Environmental Impact Statement

Section 10 – Human Health

November 2024

Denison Mines

Denison Mines Corp.

345 4th Avenue South

Saskatoon, SK, S7K 1N3

Roadmap

This roadmap of the Wheeler River Project Environmental Impact Statement (EIS) has been provided to summarize the main document sections and appendices of the EIS.

Wheeler River Project
Environmental Impact Statement

Executive Summary

Part I: Introduction and Context	Part II: Biophysical Environmental Assessments	Part III: Human Environment Assessments	Part IV: Integrated Topics and Summary
Section 1: Project Introduction and Overview	Section 6: Atmospheric and Acoustic Environment	Section 10: Human Health	Section 14: Accidents and Malfunctions
Section 2: Project Description	Section 7: Geology and Groundwater	Section 11: Land and Resource Use	Section 15: Effects of the Environment on the Project
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Abbreviations, Acronyms and Units

Abbreviation / Acronym	Definition
AAAQO	Alberta Ambient Air Quality Objectives
ALARA	As Low As Reasonably Achievable
CCME	Canadian Council of Ministers of the Environment
CNSC	Canadian Nuclear Safety Commission
COPC	Constituent of Potential Concern
CSA	Canadian Standards Association
Denison	Denison Mines Corp.
DQRARAD	Detailed Quantitative Radiological Risk Assessment
DWWTP	Domestic wastewater treatment plant
EA	Environment Assessment
EcoRA	Ecological Risk Assessment
EIS	Environmental Impact Statement
ERA	Environmental Risk Assessment
ERFN	English River First Nation
ESL	Effects screening levels
FNFNES	First Nations Food, Nutrition and Environment Study
HHRA	Human Health Risk Assessment
HQ	Hazard quotients
IK	Indigenous Knowledge
ISR	In situ recovery
ILCR	Incremental lifetime cancer risks
IWWTP	Industrial wastewater treatment plant
KI	Key Indicator
KML	Kineepik Métis Local
KPI	Key Person Interview
LK	Local Knowledge
LSA	Local Study Area
MECP	Ministry of Environment, Conservation, and Parks
MP	Measurable Parameter
NEW	Nuclear Energy Workers
NORM	Naturally Occurring Radioactive Materials
NSCA	Nuclear Safety and Control Act
NVP	Northern Village of Pinehouse Lake

Abbreviation / Acronym	Definition
OAAQC	Ontario Ambient Air Quality Criteria
PPE	Personal protective equipment
PQRA	Preliminary Quantitative Risk Assessment
Project	Wheeler River Project
RSA	Regional Study Area
RPP	Radiation Protection Plan
SAAQS	Saskatchewan Ambient Air Quality Standards
SVS	Shared Value Solutions
TCEQ	Texas Commission on Environmental Quality
TDS	Total dissolved solids
TRV	Toxicity reference values
TSP	Total suspended particulate
TSS	Total suspended solids
UBS	Uranium bearing solution
VC	Valued Component
YNLR	Ya'thi Néné Lands and Resources Office

Units	Definition
mSv	millisievert
mSv/yr	millisievert per year
Bq/m^3	becquerels per cubic metre

Glossary

Term	Definition
As low as reasonably achievable (ALARA)	A principle of radiation protection that holds that exposures to radiation are kept as low as reasonably achievable, social and economic factors taken into account. Section 4 of the Radiation Protection Regulations stipulates licensee requirements with respect to ALARA.
Background radiation	The dose or dose rate (or an observed measure related to the dose or dose rate) attributable to all sources other than the one specified.
Carcinogen	A substance that can cause cancer.
Conceptual model	A descriptive tool used to describe the relationship between constituents of potential concern, receptors, and pathways through which exposure can occur. Conceptual models can be graphics, figures, tables, maps, and text.
Conservative	The characteristic of a pathways model or parameter value that leads to an overestimate of the dose or risk.
Constituent of potential concern	Any nuclear or hazardous substance that has undergone screening and has been selected for evaluation in higher tiers of assessment in a risk assessment.
Country foods	All foods sourced outside of commercial food systems. These include any food that is trapped, fished, hunted, harvested, or grown for subsistence or medicinal purposes, outside of the commercial food chain.
Dose limit	A maximum allowable radiation dose (effective dose or equivalent dose), as specified in the Radiation Protection Regulations, which are in place to minimize the risk of adverse health effects due to radiation exposure.
Dosimetry service	A prescribed facility for the measurement and monitoring of doses of radiation.
Ecological risk assessment	The process of estimating the potential risk of contaminants on environmental indicators under defined conditions.
Effective dose	The sum of the products, in sievert, obtained by multiplying the equivalent dose of radiation received by and committed to each organ or tissue by the weighting factor of that item.
Equivalent dose	The product, in sievert, obtained by multiplying the absorbed dose of radiation of a given type by the weighting factor for that radiation type.
Exposure pathway	A route by which radiation or radionuclides (or other substances) can reach human receptors and cause a dose or risk.
Gamma radiation	Penetrating electromagnetic radiation emitted from an atom's nucleus. Also called gamma rays.
Hazard quotient	A hazard quotient is the ratio of the estimated exposure to a substance and the level at which no adverse effects are expected.
Human health risk assessment	The process of defining and quantifying risks to human health (potential for adverse health effects) and determining the acceptability of those risks.
Incremental lifetime cancer risks	The predicted increase in lifetime cancer risk from exposure to a carcinogen related to Project activities; represents risk above the background cancer risk.
Ingestion	The intake of material by humans or animals by way of the gastrointestinal system.
Inhalation	The intake of material by humans or animals by way of the respiratory system (including the portion that eventually goes to the intestinal system).
Intake	The amount of a radionuclide, measured in becquerels, taken into a body by inhalation, absorption through the skin, injection or ingestion, or through wounds.

Term	Definition
Leaching	The process by which a radioactive (or other) substance is released from the solid phase of the soil into the water phase and is then lost from the soil due to drainage with rain or irrigation water.
Member of the public	A person who is not a nuclear energy worker.
Non-carcinogen	A chemical that does not cause cancer and has a threshold concentration, below which adverse effects are unlikely.
Nuclear energy worker	A person who is required, in the course of the person's business or occupation in connection with a nuclear substance or nuclear facility, to perform duties in such circumstances that there is a reasonable probability that the person may receive a dose of radiation that is greater than the prescribed limit for the general public.
Pathways model	A model used to quantify the exposure to a member of the public from radioactive (or other) substances released from a nuclear facility by considering all possible exposure pathways.
Progeny	The radionuclides that arise following radioactive decay of a parent radionuclide. Progeny can be stable or radioactive.
Radiation	The emission by a nuclear substance, the production using a nuclear substance, or the production at a nuclear facility, of an atomic or subatomic particle or electromagnetic wave with sufficient energy for ionization.
Radioactivity	The spontaneous transformation of an atom's nucleus by expulsion of particles. Radioactivity can be accompanied by electromagnetic radiation. Solids, liquids or gases can be radioactive.
Radionuclide	A material with an unstable atomic nucleus that spontaneously decays or disintegrates, producing radiation. Nuclei are distinguished by their mass and atomic number.
Reasonably foreseeable project	Projects that are currently under regulatory review or have officially entered a formal regulatory application process, have been publicly disclosed by other proponents, or may be induced by the Project, and that occur within the spatial assessment boundary, and have the potential to change effects predictions.
Risk assessment	A representation of the potential for occurrence of adverse health effects due to exposure to a contaminant or other stressor.
Specific activity	The amount of activity of a radioactive element per unit mass of the element.
Toxicity	The inherent potential of a material to cause adverse effects to a living organism.
Toxicity reference value	A toxicological index associating specific health effects with a level of exposure to a chemical. Examples include slope factors and unit risks for carcinogens and reference doses, tolerable daily intakes, or acceptable daily intakes for non-carcinogens. Toxicity reference values are meant to protect the most sensitive individuals.
Traditional food	Animals and plants that are fished, hunted, or gathered from the land and consumed as part of a traditional diet.
Yellowcake	A product with a high abundance of uranium, obtained by physical and chemical treatments, requiring further refinement before it is suitable for use as nuclear fuel. Uranium concentrate from a mill is upgraded by refining and converting it to uranium trioxide (UO_3), and subsequently into uranium dioxide (UO_2) (used as fuel in Canada) and uranium hexafluoride (UF_6) (exported).

10 Human Health

Section 10 of the Environmental Impact Statement (EIS) for the Wheeler River Project (the Project) is focused on Human Health. The integrated biophysical and human environment assessment approach is illustrated in Figure 10-1. As a guide for EIS reviewers, Figure 10-2 provides a preview of the Valued Components (VC) associated with the assessments completed in this section of the EIS.

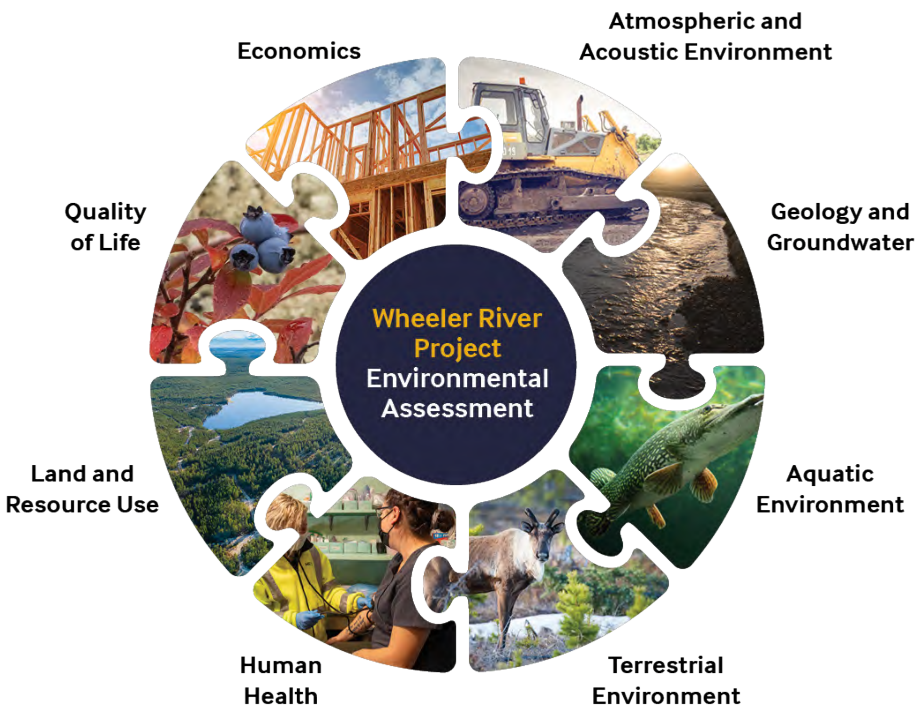


Figure 10-1: Biophysical and Human Environment Assessments for the Wheeler River Project Environmental Assessment

Figure 10-2: Human Health - Valued Components

10.1 Human Health

This subsection addresses potential effects from the Project on the Human Health VC. This section comprises the following steps as part of the assessment:

- scope of the assessment;
- summary of existing conditions;
- identification and description of potential interactions between the Project and the VC;
- identification and description of mitigation measures applicable to the VC to eliminate, reduce, or control the potential adverse Project-related effects);
- identification and characterization of predicted Project residual effects (i.e., after mitigation), including characterization of significance and assignment of the level of confidence in the predictions; and
- identification and characterization of potential cumulative effects.

Figure 10.1-1 is a graphic representation of the assessment process used in this EIS.

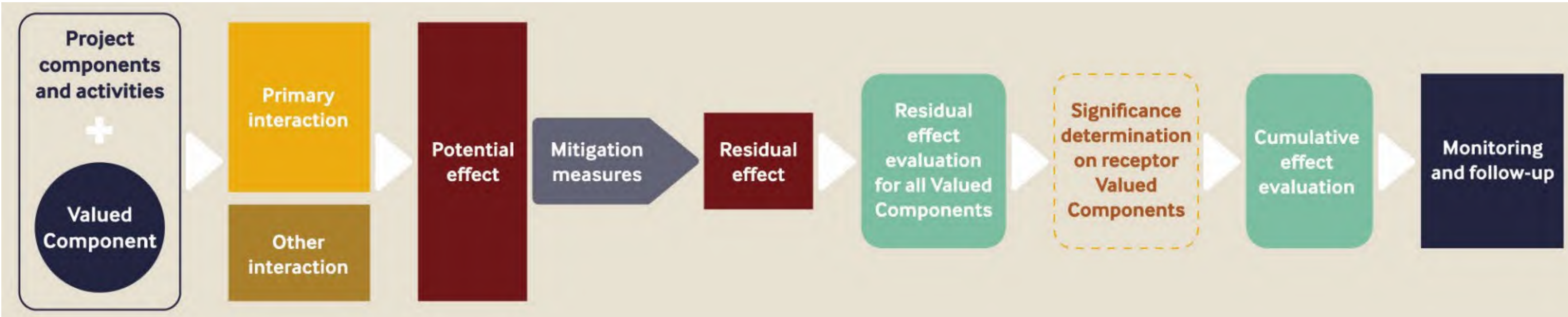


Figure 10.1-1: Environmental Assessment Process for the Wheeler River Project

10.1.1 Scope of the Assessment

10.1.1.1 Valued Component Selection

The VCs are aspects of the biophysical and human environments that will likely be affected (adversely or positively) by the Project. The VCs reflect identified scientific, local and Indigenous Knowledge, and community interests regarding the Project and its potential effects and are typically identified early in the Environmental Assessment (EA) process as a result of questions and concerns raised through engagement with government departments and agencies, Indigenous and community groups, and the general public.

Initial direction and input into VC selection were obtained through discussions with Indigenous groups, government agencies, and the public. Denison reviewed and considered this input to develop a VC list that reflects the key environmental, socio-economic, heritage, and human health components and interests to focus the detailed assessment for the EA.

Human Health was selected as a VC because Project activities have the potential to affect human health and safety through either direct exposure to constituents of potential concern (COPCs) released to air or water, or through indirect exposure to COPCs associated with soil, sediment, and food such as fish, wildlife, and plants. Human Health is important to Denison and has also been identified as important through engagement with Indigenous and local communities.

The assessment of Human Health is supported by an environmental risk assessment (ERA), which encompasses a human health risk assessment (HHRA) and an ecological risk assessment (EcoRA). The ERA is documented in Appendix 10-A of this EIS. To aid in assessing the Human Health VC in the HHRA, a number of human receptor groups were evaluated including:

- Camp worker;
- Seasonal resident;
- Recreational fisher/hunter;
- Fisher/trapper; and
- Future permanent resident.

Figure 10.1-2 is a graphic representation of the main linkages among the Human Health VC and other VCs, illustrating the flow of assessment information into and from the Human Health VC.

Figure 10.1-2: Integrated Assessment Approach - Key Connections between Human Health and Other Valued Components

10.1.1.2 Key Indicators and Measurable Parameters

To provide focus and analytical rigour to the EA, the effects assessment for each VC identifies relevant key indicators (KI) and associated measurable parameters (MP), as applicable. These are defined as follows:

- **Key Indicator**: an important component or aspect of the VC that is expected to be affected (changed) as a result of the Project. The KIs may comprise subsets or a guild of the VC (e.g., Soil Quality VC – Chemical Soil Properties KI), certain aspects of the VC that may be affected by the Project and/or which have a particular importance (e.g., Raptor VC – Bald Eagle and Osprey KIs; Indigenous Land and Resource Use VC – Resource Availability KI), and/or that can serve as indicators of potential effects on the VC.
- **Measurable Parameter**: a parameter or metric associated with the KI that can be used to detect and measure Project-related changes (e.g., amount of habitat altered, change in levels of COPCs, or change in regional unemployment rates).

Key indicators and MPs were outlined in Section 5.3 in Section 5, which described the approach and methodology of the EIS. The KIs and MPs relevant for Human Health VC are shown in Table 10.1-1.

Table 10.1-1: Key Indicators and Measurable Parameters for Human Health

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Public Health	Project activities and by-products could affect the health and safety of local community members, and land users.	Evaluation of risk of exposure to COPCs through use of hazard quotient, incremental lifetime cancer risk, or radiation dose.

10.1.1.3 Spatial and Temporal Boundaries

The spatial boundaries used to assess the potential effects on Human Health include the Project Area, the Local Study Area (LSA), and the Regional Study Area (RSA), and are shown in Figure 10.1-3. The spatial boundaries were largely influenced by the study areas for the aquatic and terrestrial environments and the Indigenous and other land and resource use assessments.

The study areas for the Human Health VC are defined as follows:

- **Project Area:** the area within which the Project and all components/activities are located (i.e., the Project footprint; the area of maximum physical disturbance). This area is not VC-specific, but is consistent throughout the EA for all VCs.
- **Local Study Area (LSA):** the area that surrounds the Project Area where both direct and indirect effects resulting from Project activities can be reasonably measured. The LSA is established to assess the potential, largely direct effects of the Project and represents the extent to which there is a reasonable potential for the Project or Project-related activities to interact with and potentially adversely affect the VCs.
  - The LSA for the Human Health VC represents the area where direct Project-related changes in air quality, sediment and water quality, and soil quality would likely occur. The LSA includes parts of the Icelander River drainage to its confluence with Russell Lake in the Wheeler River.
- **Regional Study Area (RSA):** the area that surrounds and includes the LSA, established to assess the potential, largely indirect effects of the Project in a regional context. The RSA is large enough to capture the extent of potential effects (i.e., zone of influence) on a VC and defines the area within which cumulative effects may occur (i.e., cumulative effects assessment boundary).
  - The RSA for the Human Health VC includes parts of Russell Lake and the Wheeler River downstream of the Project.

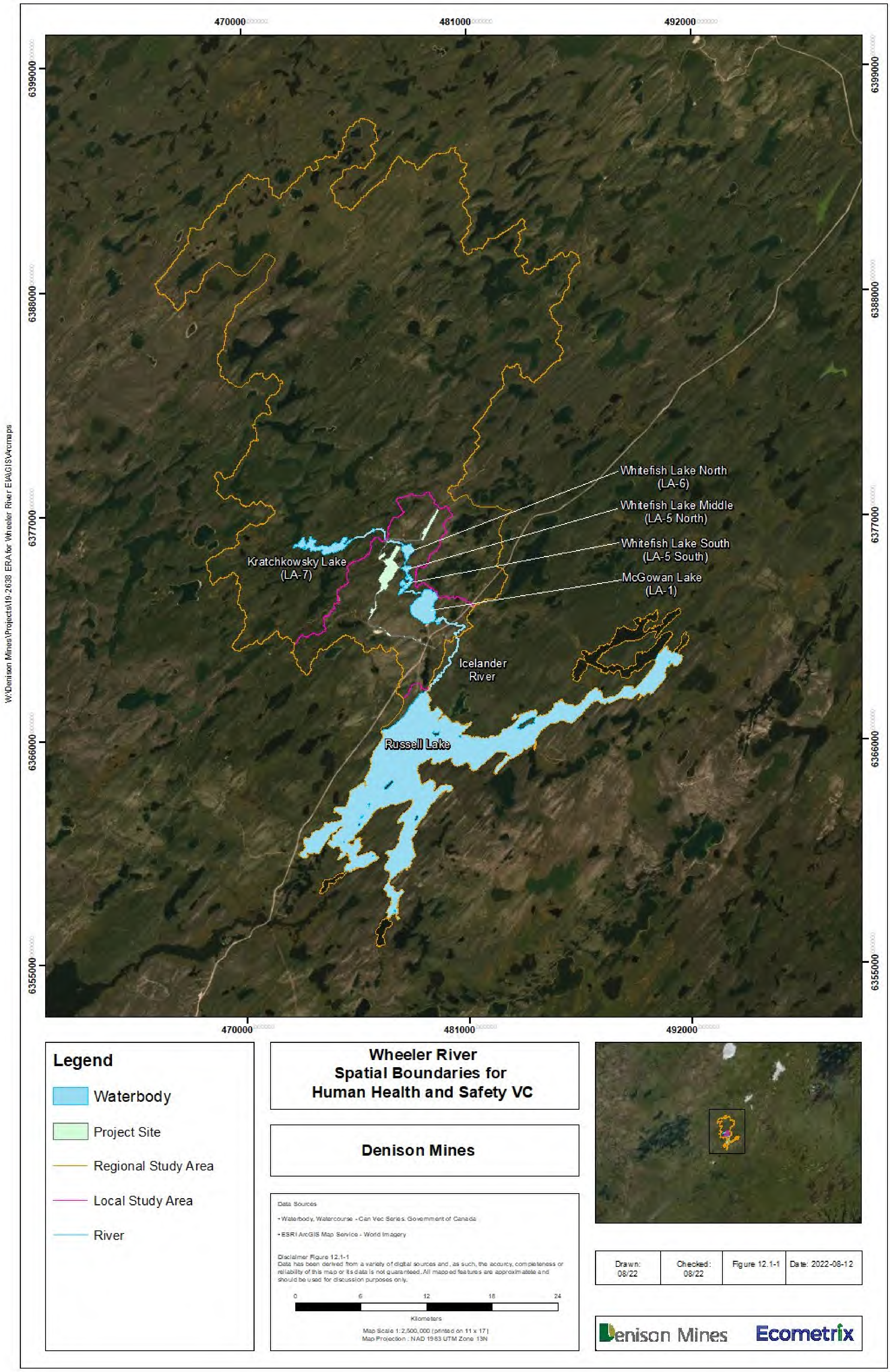


Figure 10.1-3: Spatial Boundaries for Human Health Valued Component

The temporal boundaries for the EA represent the timeframes that the Project is expected to interact with and potentially affect the Human Health VC, and as appropriate, reflect seasonal and annual variations or biophysical constraints related to the Human Health VC. The temporal boundaries are aligned with the Project development schedule (Table 10.1-2): Construction (which includes site preparation), Operation, Decommissioning, and Post-Decommissioning.

Table 10.1-2: Phases of the Project

Phase and Year	Description of Activities	
Construction Year 1 to 3	• Development of access roads and air strip • Site preparation and earthworks; clearing, leveling and grading of the project area • Power generation – generators • Installation of main substation and distribution of power around site • Wellfield and freeze hole drilling; ground freezing • Batch plant operation (concrete); crusher at borrow area • Development of surface infrastructure (camp, operations centre, plants, ponds, pads and support facilities)	• Waste management (composting, domestic and industrial landfill operation, recycling) • Water management (including treatment and site run-off) • Groundwater supply • Surface water withdrawal • Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel) • On-site and off-site operation of vehicles and transport of materials • Air transportation for workers • Regulatory site inspections • Engagement - site visit from Interested Parties
Operation Year 3 to 18	• Operation of the in situ recovery (ISR) wellfield • Wellfield and freeze wall drilling • Operation and expansion of freeze wall • Batch plant operation (grout and cement); crusher at borrow area • Expansion of pond and pads • Operation of the processing plant and production of uranium concentrate • Water withdrawal from groundwater or surface water body • Management of surface water (including seepage and site run-off) • Water treatment, both domestic and industrial • Water release to surface water body • Waste management (composting, domestic and industrial landfill operation, recycling) • Hazardous waste management (temporary storage, handling, and off-site transportation)	• Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates • On-site and off-site operation of vehicles and transport of materials • Power supply – primarily power from the grid, also generators and back-up generators • Package and transport of nuclear substances • Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel) • Air transportation for workers • Progressive decommissioning and reclamation • Regulatory site inspections • Engagement - site visit from Interested Parties
Decommissioning Year 18 to 23	• Site water management, treatment and release	• Power generation – generators

Phase and Year	Description of Activities	
	• Mining horizon remediation and thawing of freeze wall • Process water treatment and release • Closure of ISR and freeze wells and related infrastructure • Decontamination of surface facilities and injection, recovery and monitoring wells • Asset removal (including site power transmission lines and electrical infrastructure) • Demolition and disposal of non-salvageable surface infrastructure and materials • Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	• Waste management (composting and landfill operation) • Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal) • On-site and off-site operation of vehicles and transport of materials • Reclamation of disturbed areas • Regulatory site inspections • Engagement - site visit from Interested Parties
Post-Decommissioning Year 23 to 38	• Environmental monitoring • Regulatory site inspections	• Engagement - site visit from Interested Parties

Additionally, a "future centuries" scenario is considered to assess the potential effects post-restoration (i.e., beyond the Project timeline of 0 to 38 years) and to reflect the time period over which the highest constituent concentrations in groundwater are predicted to migrate towards and interact with surface water.

This period represents the time where the highest constituent concentrations in groundwater are predicted to interact with surface water based on groundwater modelling. In this context, the future centuries scenario is considered with respect to the interaction of groundwater migration from the Project site and its potential influence on surface water in local water bodies. The future centuries projection encompasses the long-term period during which slow migration of groundwater from the Phoenix Ore Zone area to the surface water environment is anticipated and constitutes a bounding scenario of maximum concentrations of constituents of potential concern.

10.1.2 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

Various sources of Indigenous Knowledge (IK) and Local Knowledge (LK) were used to inform assumptions for human health receptors (i.e., people) who consume traditional foods, specifically in terms of their locations, residency times, and components of the traditional foods diet.

Denison has recorded and stored information regarding IK, LK, and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 21-EN-SUR-446.52). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment. Appendix 10-B provides a summary of unique identification numbers referenced within Section 10.1.

The following IK and LK studies and reports were reviewed to inform assumptions related to the assessment of human health:

- Kineepik Métis Local (KML) and Northern Village of Pinehouse Lake (NVP). 2022a. *Kineepik Métis Local #9 Kineepik Valued Ecosystem Components.* KML Pre-statement for Denison EIS.
- Kineepik Métis Local and Northern Village of Pinehouse Lake. 2022b. *Response to the Environment Impact Assessment*. For the Proposed Ministry of Highways 914 Extension Project. Submitted February 11, 2022.
- English River First Nation (ERFN) and Shared Value Solutions (SVS). 2022a. *Wheeler River Project – Summary of Health and Socio-Economy Study Results – English River First Nation. Shared Value Solutions*. Prepared for English River First Nation. March 2022.
- English River First Nation and Shared Value Solutions. 2022b. *Wheeler River Project – Summary of Traditional Knowledge Study Results – English River First Nation*. Shared Value Solutions. Prepared for English River First Nation. March 2022.
- CanNorth. 2017. *English River First Nation Country Foods Study – Final Report (Project No. 2147)*. Canada North Environmental Services Limited Partnership.
- English River First Nation. 2011. *English River First Nation, Aboriginal Traditional Knowledge Summary Report*. Compiled by Environment Canada, September 2011.
- Ya'thi Néné Lands and Resources Office (YNLR). 2022*. An Exploration of Recorded Athabasca Denesųłine Traditional Knowledge, Land Use, and Occupancy Study in the Vicinity of Denison Mines Wheeler River Project*. March 2022.

A number of these studies including YNLR (2022), ERFN and SVS (2022a, 2022b), and CanNorth (2017) provided guidance for identifying locations where people may reside, areas where traditional foods are hunted, fished, and gathered, and mammal, bird, and plant species that are traditionally used by local Indigenous communities for food, medicine, and other traditional uses. Additionally, available land use maps and information about local cabin locations was used to inform receptor locations as well as receptor types, and specific engagement activities (e.g., formal and informal engagement meetings with one or more community members) were used to better incorporate LK into the assessment of human health. Other sources of engagement included:

- Key Person Interview Program (KPI Program). 2018. ERFN Patuanak Reserve workshop conducted by Denison Mines. May 3, 2018.
- Key Person Interview Program (KPI Program). 2019. Interview with the English River First Nation trapper conducted by Denison Mines. October 29, 2019. Notes finalized January 2, 2020.
- Key Person Interview Program (KPI Program). 2020. Cabin owner survey conducted by Denison Mines. February 14–24, 2020.

Information regarding IK and LK was primarily available for two Indigenous communities:

- English River First Nation; and
- Kineepik Métis Local 9.

10.1.3 Existing Environment

The existing environment described in this section establishes the current condition and setting (i.e., considers all past and current disturbances) for each KI for the assessment of Project-related effects on the Human Health VC.

10.1.3.1 Baseline Monitoring Data

The existing environment represents the baseline in the HHRA, which is supported by the baseline monitoring program in the LSA and RSA. The baseline monitoring program has provided sufficient data to support the assumptions and models used in the HHRA. A high-level description of the baseline data used to support the HHRA is included below with details provided in the respective EIS sections.

Baseline air quality monitoring in the vicinity of the Project has been completed since 2018 and has included passive monitoring methods for particulate matter (dustfall), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), radon, and external gamma. A summary of the baseline program results is provided in Section 6 Atmospheric and Acoustic Environment of the EIS and in the supporting Air Quality Impact Assessment.

Baseline soil and vegetation quality monitoring was completed in 2017. Samples of soil, blueberries (stems, leaves, and fruit), and lichen were collected primarily in the terrestrial LSA and analyzed for metals and radionuclides. A summary of the baseline program results is provided in Section 9 Terrestrial Environment of the EIS and in the terrestrial baseline report (Omnia 2020, see Appendix 9-B in Section 9).

Baseline sampling of the aquatic environment for water quality and aquatic biota was completed from 2016 to 2018. Surface water quality sampling was conducted in lakes and water courses within the LSA and RSA and both physical and chemical parameters were measured in situ during field surveys and after by laboratory analysis (including pH, conductivity, total suspended solids [TSS], total dissolved solids [TDS], alkalinity, acidity, hardness, nutrients, total metals, and radionuclides). Fish tissue (flesh and bone) and benthic invertebrate tissue (whole body) samples were collected in 2016 and 2017 and analyzed for both metals and radionuclides. Fish species included predator species (Northern Pike [*Esox lucius*]) and forage species (White Sucker [*Catostomus commersoni]*). Sediment samples (surficial top 6 cm, with the top 0 to 2 cm sectioned and sent for analysis) were collected in 2016 coincident with benthic invertebrate sampling in depositional environments of selected lakes and analyzed for total organic carbon, nutrients, grain size, metals, and radionuclides. A summary of the baseline program results is provided in Section 8

Aquatic Environment of the EIS and in the aquatic baseline report (Ecometrix 2020 in Appendix 8-D of Section 8).

Indigenous and local communities have identified the importance of protecting the existing environment in the LSA and RSA. An important guiding principle of many of ERFN's teachings is the preservation and protection of ecological and human health. Human activities that threaten environmental degradation or have the potential to substantially change the environment from its baseline conditions are viewed as direct threats to the health and wellbeing of ERFN peoples and their traditional ways of life (ERFN and SVS 2022a). Members of ERFN have directly expressed the importance of the natural environment to their culture and traditional ways of life, and that protecting the environment and limiting changes to its baseline characteristics are critical for their continued existence and wellbeing:

> *"The connection to the land, like the Elders have mentioned and I have mentioned, it's like our plate; it gives us everything. The land gives us the food that we need, it gives us the clothing that we need, it gives us the heartbeat that we need. The trees in the area also provide us with shelter and also provide us with medicines in the area. So that's really critical to us. The waters are also very important to us; without the waters, we're not alive, and that's one of the things. The forestry itself, it creates life, because the medicines we get from them is really important to us, the traditional medicines."* (ERFN and SVS 2022b).

> *"The lands and waters, we are definitely connected as peoples of English River. If we don't have the lands, we are not connected. If we don't have the water... Water is life to us."* (ERFN and SVS 2022b)

An Athabasca Denesųłiné member shared similar sentiments, saying:

> "*Fishing, hunting, trapping… we the Dene people live off the land*." (YNLR 2022)

Many Indigenous community members are active users of the land and consumers of its natural resources, and thus are often highly aware of changes in environmental and ecological conditions as they occur over time. The inclusion of IK in the characterization of environmental baseline conditions provides a more comprehensive understanding of the environmental context in which the proposed Project is being developed. Members of ERFN have highlighted the following changes with respect to baseline environmental conditions throughout their traditional territories (ERFN and SVS 2022b):

- changes in the amount of access or usability of the land, specifically with regard to harvesting and overnight locations;
- increased access and use of ancestral ERFN lands by non-ERFN individuals;
- changes to the environment (e.g., decline in water quality and abundance, habitat degradation);

- population declines of many bird, mammal, and fish species;
- changes in climate, including extreme temperature fluctuations and uncommon weather events;
- direct and indirect effects to society attributed to industrial development and its impact to the local environment; and
- cumulative effects to the environment from various historic and current industrial developments (e.g., logging and mining).

The preservation of local fisheries is of critical importance to local fishers and trappers, as local fisheries economically support some individuals in the region through commercial fishing. Additionally, a healthy local fishery encourages the consumption of fish as part of a traditional Indigenous diet, which offers many cultural and health benefits. A local fisher and trapper shared the economic importance of fish and expressed concerns regarding the future of the local commercial fishery:

> *"Fishing is a big part of my income. Right now, it is more worthwhile to fish commercially than it is to spend time trapping because fur prices, except for marten, are poor."* (19-LK-ERFNTrap-134.72).

> *"How will this effluent impact the water quality, fish health? Will I be able to sell fish from here? If there is going to water pollution, I just want to know."* (19-LK-ERFNTrap-134.255).

Local residents have voiced concerns that baseline water levels in the region may be reduced due to an increase in water consumption by the proposed Project, which may have a negative effect on fish and local fisheries. One ERFN member shared:

> *"A lot of those lakes would not be immediately impacted, but what about down the road? It changes. One lake [Lanspur Lake] about three years ago had no pickerel. In the last 2-3 years, with high water, that lake now has an abundance of pickerel. Those are some of the changes that happen. That comes from our elders, not from me."* (18-EN-ERFN-5.69).

Members of ERFN have expressed concern over the cumulative effects of industrial development in the region and its perceived contribution to the degradation of the environment and traditional ways of life over time:

> *"Well, basically we were in an isolated community before the roads came in, and so on and so forth, and basically, we had used the rivers and the lake systems for our transportation, and some of the areas that had been fly-in areas, where the people used to gather and hunt, and trap at the same time. In the last, I would say 30 to 40 years that has changed dramatically, in terms of the road access to these areas, roads*

being built because of corporations and because of development. And into our community as well, I would say in the last 47 years, since 1974, [that] road has been into English River, that has caused traumatic/dramatic change as well, so people coming into the area. As well, the areas where people used to hunt and trap, there is the construction of roads, the 914, that's Key Lake Road, that goes right across the Churchill River. That has also created stress on the land itself, because back in, I would say the early 1980s, there was an abundance of moose, an abundance of caribou, on the Haultain area, but with the road coming in, there has been more people taking the moose, taking the caribou. Also, more people starting to settle in that area, in terms of cabins, and so on and so forth, which are not the English River First Nation members." (ERFN and SVS 2022b)

"The whole area is sensitive now, with all the things that are going on. It's disturbing the environment; the environment has been disrupted. So, the animals, the birds, and the fish are all affected, especially where there's mining activity. Because of that, animals tend to move away. So, they're not around because of all the activities that are going on." (ERFN and SVS 2022b)

10.1.3.2 Traditional Foods Diet

Understanding and characterizing what people eat as part of their diet is an important component of the assessment of the Human Health VC. The total human diet is comprised of the portion of the diet obtained from traditional foods and the portion of the diet obtained from store bought foods. Traditional foods are those animals and plants that are fished, hunted, or gathered from the land and consumed as food (Health Canada 2018).

Two traditional food diets were developed for the assessment to represent a high consumer of traditional foods and to represent an average consumer of traditional foods. In both cases, the proportion of traditional foods in the overall diet of the human health receptor groups was based on dietary studies from local and Indigenous communities.

The Project is a remote site, with no communities in close proximity. By distance, the closest communities are approximately 150 km away in the northern settlement of Wollaston Lake and Lac La Hache. The closest community by road is Pinehouse which is approximately 260 km away. The communities and associated Indigenous Communities of Interest that Denison has identified for engagement activities include: the ERFN, the Kineepik Métis Local 9, the Sipisishik Métis Local 37, the A La Baie Métis Local 21, and the Patuanak Métis Local 82.

Indigenous Knowledge was available from Indigenous Communities of Interest, including a dietary study for the ERFN (CanNorth 2017). Local Knowledge was available from a local fisher/trapper whose primary residence has been in the LSA, that has extensive experience fishing, hunting, and trapping throughout the LSA and RSA. Denison recognizes that ERFN considers the fisher/trapper's use of the area as representative of current and future land users and expects that the relationship to the Project Area will be continued and strengthened through generations of future use.

The ERFN is comprised of seven historical settlements that have now grown into 19 different reserves across Saskatchewan (see Figure 3.4-1 in Section 3 of the EIS for an overview of communities in relation to the Project location). Patuanak is located on the Churchill River and the north end of Lac-Île-à-la-Crosse, approximately 90 km north of Beauval and over 500 km from Saskatoon. Patuanak has 625 members on reserve and a hamlet with approximately 75 residents. La Plonge is located approximately 90 km south of Patuanak, 8 km east of the town of Beauval near the Beaver River, and has approximately 148 people living on reserve. The ERFN community members also travel to a seasonal culture camp along Highway 914 approximately 50 km south of the Key Lake Operation to hunt, fish, and gather berries (CanNorth 2017).

A dietary study was performed for residents of Patuanak and La Plonge to understand which traditional foods were consumed by each community and the approximate amounts consumed. The results of the study were summarized in CanNorth (2017) by average daily intake in grams (fresh weight) of country foods by species and season, for Patuanak, La Plonge, and an average. A summary of the ERFN traditional food ingestion rates by food type is shown in Table 4-3 of the ERA (Appendix 10-A) and the proportions of food types are shown in Figure 4-3 of the ERA (Appendix 10-A). Overall, fish, large mammals (meat and organs), and plants make up the majority of the traditional food diet, in similar proportions. Small mammals and birds make up a smaller proportion of the traditional food diet. Moose (*Alces americanus)* is the most commonly eaten large mammal. The most commonly eaten fish include Walleye (*Sander vitreus*) and Lake Whitefish (*Coregonus clupeaformis*).

The results of the dietary study indicate that Patuanak has a higher traditional food ingestion rate than La Plonge and has a similar distribution of country food types as the average diet. As a conservative approach for this assessment, the Patuanak diet was selected to represent the average traditional foods consumer in the HHRA. This includes the seasonal resident and the recreational fisher/hunter.

The traditional food diet for past assessments for other uranium mining facilities in the area were based on the Hatchet Lake First Nation study (CanNorth 2000). Overall, the quantities and types of traditional foods documented in the Hatchet Lake First Nation study were similar to the results from the ERFN dietary study, with the exception of the high ingestion rate of barren-ground caribou (*Rangifer tarandus groenlandicus*). Responses from the ERFN dietary study indicated that the Patuanak and La Plonge communities consumed small quantities of caribou and preferred to eat moose.

For the high traditional foods consumer, the dietary assumptions were from resource use information from a local fisher/trapper that has been used for past assessments in the area. The overall assumptions regarding types of food consumed and general proportions were re-confirmed with the local fisher/trapper during an interview with Denison on October 29, 2019 (Denison 2019). The local fisher/trapper also shared the following LK regarding traditional foods and ecological receptors in the region (KPI Program 2019):

- Indigenous fishers typically prefer Northern Pike, Whitefish and Trout (*Salvelinus namaycush*). Non-Indigenous fishers will tend to catch Walleye. White Sucker is often caught for commercial purposes (e.g., for bait). (19-LK-ERFNTrap-134.131)
- Caribou are encountered more often than moose. Caribou populations are noted to be stable, but moose population have experienced a noticeable decline. (19-LK-ERFNTrap-134.151, 19-LK-ERFNTrap-134.156)
- Marten is common, whereas fisher (*Pekaxnia pennanti*) and wolverine are rarely encountered. (19-LK-ERFNTrap-134.160)
- Game mammals and birds (e.g., snowshoe hare (*Lepus americanus*), Ptarmigan) have recently experienced a population decline. (19-LK-ERFNTrap-134.163)
- Mallard (*Anas platyrhynchos*) and Canada Goose (*Branta canadensis*) have also declined in abundance, but Surf Scoters *(Melanitta perspicillata*) are more common. Some lakes have fewer loons, whereas other lakes have stable loon populations. (19-LK-ERFNTrap-134.164, 19-LK-ERFNTrap-134.166)

The detailed breakdown of the traditional foods diet for both the average and high consumer of traditional foods is included in Section 4.2.4 of the ERA for the Project in Appendix 10-A.

10.1.3.3 Background Sources of Radiation and Radioactivity

Background radiation and radioactivity is present in the environment due to natural and anthropogenic (i.e., human-caused) sources. The four primary sources of natural radiation are cosmic radiation, terrestrial radiation, and intake of naturally occurring radionuclides through inhalation and ingestion (CNSC 2020a). Exposure to natural radiation can occur both indoors and outdoors.

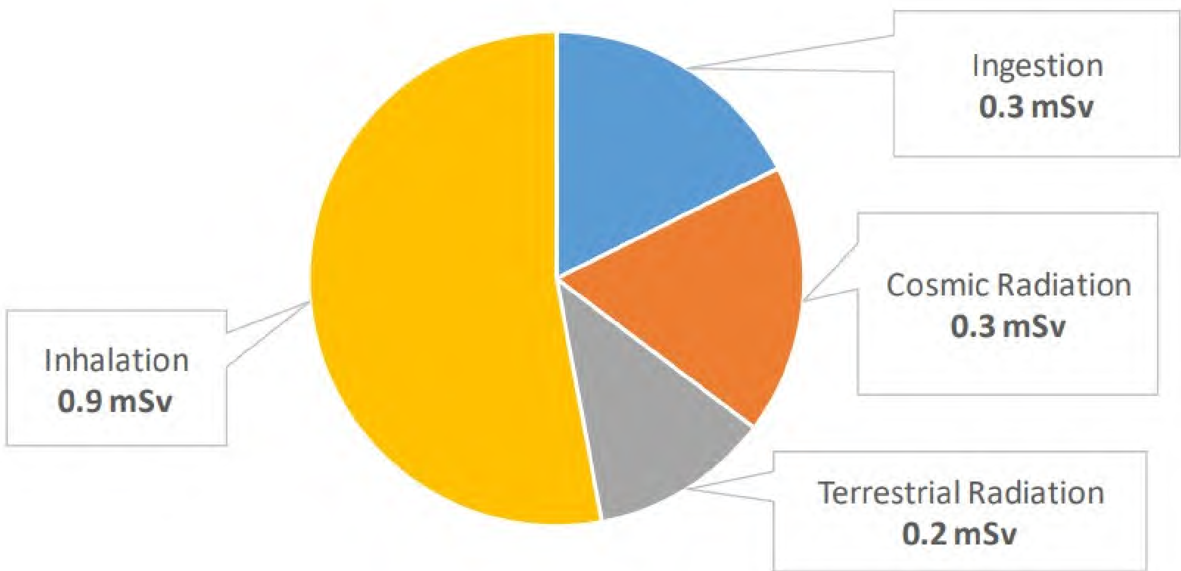
Cosmic radiation originates from the sun and celestial events. Some of the ionizing radiation can penetrate through the Earth’s atmosphere and result in an external radiation dose at the Earth’s surface. Terrestrial radiation results from the natural composition of the Earth’s crust such as deposits of uranium, potassium, and thorium present in soils, rocks, and building materials, which can release small amounts of ionizing radiation during the natural decay process, resulting in an external radiation dose (CNSC 2020a).

Naturally occurring radionuclides are also incorporated into plants, animals, and water from surrounding soils and rocks. Ingesting these foodstuffs and water results in an internal radiation dose due to exposure to natural radiation.

Radioactive gases can be produced from radioactive minerals found in soil and bedrock. Radon gas, a product of the decay of uranium in soil, typically disperses rapidly once it reaches the atmosphere; however, it can also accumulate inside buildings and when inhaled contributes to an internal radiation dose. Indoor radon levels in Canada average 45 Bq/m^3 (Health Canada 2014).

The annual effective dose from natural background radiation is approximately 1.8 millisieverts (mSv) (Figure 10.1-4) in Canada and 2.4 mSv worldwide (CNSC 2020a). The effective dose represents the amount of energy absorbed by tissue from ionizing radiation.

No known anthropogenic sources of radiation or radioactivity exist in the LSA and RSA.



Source: CNSC 2020a

Figure 10.1-4: Breakdown of Doses from Natural Background Radiation

10.1.4 Assessment of Project Related Effects

10.1.4.1 Potential Interactions Between the Project and Valued Component/Key Indicators

Potential Project-related interactions with the Human Health VC (and the associated KI of Public Health) are summarized by Project Phase in Table 10.1-3.

Potential interactions in the summary table are ranked as:

- **Primary Interaction** (✓): Project activity is expected to interact with the VC/KI which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.

- **Other Interaction** (✓): Project activity is expected to interact with the VC/KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- **No Interaction:** Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

Table 10.1-3: Potential Project Interactions for Human Health

Project Phase/Activity	Human Health Valued Component
	Key Indicator – Public Health
Construction Activities	
Development of access roads and air strip	✓
Site preparation and earthworks; clearing, leveling, and grading of the Project Area	✓
Power generation - generators	✓
Installation of main substation and distribution of power around site	
Wellfield and freeze hole drilling; ground freezing	✓
Batch plant operation (concrete); crusher at borrow area	✓
Development of surface infrastructure (camp, operations centre, plants, ponds, pads, and support facilities)	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	
Water management (including treatment and site runoff)	✓
Groundwater supply	
Surface water withdrawal	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	
On-site and off-site operation of vehicles and transport of materials	✓
Air transportation for workers	
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Operation Activities	
Operation of the ISR wellfield	✓
Wellfield and freeze wall drilling	✓
Operation and expansion of freeze wall	
Batch plant operation (grout and cement); crusher in borrow area	✓
Expansion of pond and pads	

Project Phase/Activity	Human Health Valued Component
	Key Indicator – Public Health
Operation of the processing plant and production of uranium concentrate	✓
Water withdrawal from groundwater or surface water body	
Management of surface water (including seepage and site runoff)	✓
Water treatment, both domestic and industrial	✓
Water release to surface water body	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	✓
Hazardous waste management (temporary storage, handling, and off-site transportation)	✓
Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates	✓
On-site and off-site operation of vehicles and transport of materials	✓
Power supply – primarily power from the grid, also generators and back-up generators	✓
Package and transport of nuclear substances	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	
Air transportation for workers	
Progressive decommissioning and reclamation	
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Decommissioning Activities	
Site water management, treatment, and release	✓
Mining horizon remediation and thawing of freeze wall	✓
Process water treatment and release	✓
Closure of ISR and freeze wells and related infrastructure	
Decontamination of surface facilities and injection, recovery and monitoring wells	
Asset removal (including site power transmission lines and electrical infrastructure)	✓
Demolition and disposal of non-salvageable surface infrastructure and materials	✓
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	✓

Project Phase/Activity	Human Health Valued Component
	Key Indicator – Public Health
Generators	✓
Waste management (composting and landfill operation)	
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)	✓
On-site and off-site operation of vehicles and transport of materials	✓
Reclamation of disturbed areas	✓
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Post-Decommissioning Activities	
Environmental monitoring	
Regulatory site inspections	
Engagement - Site visit from Interested Parties	

10.1.4.2 Potential Project Related Effects

Based on the anticipated Project interactions with the Human Health VC, the following potential Project-related effects are anticipated:

- Air emissions (including NOx, SO_2, CO, radon gas, particulate matter, and metals) during Project phases may affect human health.
- Release of COPCs in treated effluent to Whitefish Lake during Project phases may affect human health.
- Long-term transport of groundwater solutes to Whitefish Lake in future centuries may affect human health.

10.1.4.2.1 Air Emissions During Construction, Operation, and Decommissioning

Air emissions during Construction, Operation, and Decommissioning phases could affect the Human Health VC. Modelling of air emissions is discussed in Section 6 of the EIS and supporting Air Quality Impact Assessment. A summary of relevant interactions and sources of emissions is included below as it pertains to human health.

Construction

Air emissions during construction activities will occur from site preparation and earthworks at various locations around site, development of access roads, development of surface infrastructure, wellfield and freeze hole drilling, batch plant operation, on-site and off-site operation of vehicles and operation of diesel power generators.

Operation

Air emissions during operation activities will occur from operation of the ISR wellfield, from wellfield and freeze wall drilling, batch plant operation, processing plant operation, storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates, waste management, on-site and off-site operation of vehicles and transport of materials including yellowcake, and power supply (back-up generators).

During Operation, the site will be connected to the provincial power supply; however, back-up power will be provided by on-site generators which would release NOx, CO, and SO_2 to air.

Decommissioning

Air emissions during Decommissioning activities are primarily associated with remediation works of contaminated areas such as the wellfield, pads, ponds, domestic wastewater treatment location, and the process plant area. Other emissions would occur from reclamation of disturbed areas, supply of back-up power, and movement of vehicles and equipment.

Sources of Air Emissions

Air emissions during Construction, Operation, and Decommissioning will include: particulate matter, metals, NOx, SO_2, CO, and radon.

Fugitive dust emissions (particulate matter including total suspended particulate [TSP], particulate matter with a diameter of 10 microns or less [PM_{10}] and particulate matter with a diameter of 2.5 microns or less [$PM_{2.5}$]) will be released from unpaved roads, as well as from general construction activities such as clearing, grubbing, and building construction, and operation of the batch plant. Other sources of fugitive dust include wind erosion, material handling, wellfield drilling, and various combustion sources such as the diesel generators and propane heaters. During Decommissioning only, dozing of the wellfield and waste pads will be a source of fugitive dust.

Metals will be released as a fraction of TSP, primarily from wellfield drilling in mineralized waste, wind erosion from the mineralized waste pad, material handling at the wellfield and mineralized waste pad, and stack emissions from the ISR processing plant.

Long-lived radioactive dust is of primary concern at the back end of the ISR process since the process is wet until the yellowcake product (uranium oxides) is precipitated out of solution and dried. The long-lived species of concern at that point are uranium-238 (U-238) and uranium-234 (U-234). The uranium mass is almost entirely U-238; on an activity basis, U-238 and U-234 contribute equal activity. It was assumed that other radionuclides in the U-238 decay chain would not be present at the point of release.

The NOx, SO_2, and CO will be released from combustion of diesel, gasoline, or propane fuel.

Radon gas will be released during Construction and Operation during wellfield drilling from radium-bearing ore cuttings and when groundwater containing dissolved radon gas is exposed to the atmosphere. During Operation, radon will be primarily released to air when the uranium rich solution arrives at the radon surge tank and is subsequently vented to the atmosphere. Some radon will occasionally be released in the wellfield from venting from the wellheads and leaking transport piping. During Decommissioning, radon will be released primarily from wellfield restoration.

Details of air emissions are provided in Section 6 of the EIS and the supporting Air Quality Impact Assessment.

Evaluation of Air Quality Constituents of Potential Concern to Human Health

As discussed above by Project phase, the main input into the atmospheric environment, which could affect the Human Health VC, is the release of air emissions during Project phases. Human receptors could be exposed to air constituents through inhalation, and indirectly through soil contact/ingestion of constituents that deposit to soil, and subsequently through the terrestrial food chain. Exposure to constituents that deposit from air to surface water was not considered, as that pathway is considered negligible according to CSA N288.1-20 (CSA 2020). A conservative screening of predicted air COPC concentrations against air quality guidelines was performed to identify the COPCs for the HHRA.

Air concentrations of NOx, SO_2, and CO, particulates, metals, and radon were estimated at various human health receptor locations during Construction, Operation, and Decommissioning, using CALPUFF, an advanced three-dimensional dispersion model (see Section 6 of the EIS). The camp location was considered the closest location to the emission sources that could affect human health. Maximum predicted concentrations at the camp location were compared against long-term and short-term air quality criteria. Human receptors could also be present at the fenceline (i.e., the Project boundary) for short periods of time; therefore, predicted short-term air COPC concentrations at the fenceline were also compared against short-term air quality criteria. Maximum predicted concentrations are total concentrations, including background, except for radon which is an incremental concentration.

Ambient air quality criteria for the relevant averaging periods were selected based on the following hierarchy:

- Saskatchewan Ambient Air Quality Standards (SAAQS) are maximum concentrations in ambient air from all sources as stipulated in The Clean Air Regulations (Government of Saskatchewan 2015).
- Alberta Ambient Air Quality Objectives (AAAQO) are based on an evaluation of scientific, social, technical, and economic factors (Alberta Government 2021).
- Ontario Ambient Air Quality Criteria (OAAQC) are concentrations of a constituent in air that are protective against adverse effects on health and/or the environment (MECP 2020).
- Texas effects screening levels (ESLs) are air concentrations at or below which adverse health effects in the general public, including sensitive subgroups such as children, the elderly,

pregnant women, and people with pre-existing health conditions, are not likely to occur (TCEQ 2016).

Canadian Ambient Air Quality Standards (CAAQS) established under the national Air Quality Management System (CCME 2021b) were considered as screening criteria, as appropriate.

Screening values for radionuclide concentrations in ambient air were not available. All relevant radionuclides were assessed in the HHRA in terms of their contribution to the total radiological dose to human and ecological receptors.

Air quality COPCs with maximum concentrations that exceeded either their short- or long-term screening value at receptor locations were nitrogen dioxide (1-hr nitrogen dioxide during all Project phases), particulate matter (TSP, PM_{10}; during Construction, Operation, and Decommissioning), and uranium in PM_{10} (during Operation). Air quality COPCs with maximum concentrations that exceeded their short-term screening value at the fenceline were nitrogen dioxide (during Construction, Operation, and Decommissioning), particulate matter (TSP during Construction, Operation, and Decommissioning; PM_{10} during Construction and Operation) and uranium in PM_{10} (during Operation).

Overall, it was concluded that while there were predicted exceedances of air quality criteria for nitrogen dioxide, particulate matter, and uranium, they were not identified for further assessment in the HHRA—these COPCs are unlikely to be associated with a human health or environmental risk, and any exposures to people at elevated concentrations would be infrequent, short-term, and highly localized. The only COPCs identified for air were radionuclides (U-238, U-234 and radon) due to public interest and not due to exceeding a screening value. Additional details are provided in the ERA (Appendix 10-A).

While no specific COPCs were retained from the screening of atmospheric COPCs, as a secondary check, mine-related metals that could potentially partition from air to soil were further assessed in terms of concentration in soil. Predicted soil concentrations arising from atmospheric deposition were estimated using the IMPACT model, using the maximum air concentrations at the closest receptor location (on-site ecological), along with COPC-specific deposition rates. Predicted soil concentrations were compared against the federal Canadian Council of Ministers of the Environment (CCME; CCME 1999b) soil quality guidelines for the protection of human and environmental health. All predicted soil concentrations were below the CCME soil quality guidelines.

Considering the multi-media pathways analysis for the HHRA, all terrestrial pathways (other than air inhalation) were considered further for the COPCs identified in the aquatic environment (as identified in Section 10.1.4.2.2).

10.1.4.2.2 Release of Treated Effluent to Whitefish Lake During Operation and Decommissioning

Construction

Any waste that is generated during construction activities will be sent off site for recycling to the extent possible. Any remaining waste may be temporarily stored on site and disposed of in a landfill once construction is complete.

During Construction, no releases to the aquatic environment (Whitefish Lake) are anticipated. No effluent will be released, and runoff will be managed according to industry best practices.

Operation

Denison's approach to sustainable mining for the Project includes recycling as much process water as possible to reduce the need for fresh water supply.

When freshwater is needed, it would be obtained from a shallow groundwater well and/or from surface water, for a total maximum freshwater withdrawal of 81 m^3/h. Freshwater would be sent to the potable water treatment plant for treatment and distribution.

Domestic wastewater (which includes greywater and sewage) will be generated at the camp, processing plant, airstrip terminal, and the operations centre. Domestic wastewater from the central facilities will be piped directly to the on-site domestic wastewater treatment plant (DWWTP). Other sewage will be collected in septic tanks and transported via a vacuum truck to the DWWTP for treatment. Treated effluent from the DWWTP will be stored in a 5,000 m^3 pond prior to routing to the process water ponds or recycled if water quality allows. Any reject solids from the DWWTP will be collected, dewatered, and disposed of at the site composting system, domestic landfill, or an approved off-site facility.

Contaminated waters produced during the ISR process and from other various sources (e.g., wash bay sump water, leachate from the industrial landfill, wellfield runoff pond) will be treated in a three-stage industrial wastewater treatment plant (IWWTP). Water will be routed to the IWWTP via the process water pond. Treated water in the IWWTP will be routed back into the mining process; any excess treated water will be pumped to the effluent monitoring and release ponds. The majority of precipitates generated through the treatment process will be primarily comprised of gypsum and will be routed to the IWWTP precipitate pond.

There will be three effluent monitoring and release ponds, each with a composite liner and a capacity for 3,000 m^3 of water. The effluent monitoring and release ponds will primarily receive treated water from the DWWTP and IWWTP but may also receive water from the process water pond, IWWTP precipitate pond, and wellfield runoff pond.

Effluent will be released to Whitefish Lake (LA-5) via a discharge line with a diffuser at the end to promote effluent mixing within the lake. Effluent will be released at an expected discharge rate of 36.5 m^3/h. The maximum upper bound discharge rate is 81 m^3/hr. The predicted effluent quality is shown in Table 8.2-9 in Section 8.2, Surface Water Quality of the EIS, and is discussed further below.

Surface runoff will generally be managed through collection in ponds. The wellfield runoff pond will capture runoff from the wellfield and the special waste pad. Any runoff from the process precipitate storage pad and special waste pad will be directed to the process water pond. A pond may be constructed beside the clean waste rock pad to collect runoff if required. Any runoff from the clean waste rock pond will be directed to the process water pond.

Decommissioning

During Decommissioning, mining area remediation will be initiated which will involve injecting water into the mining horizon via the injection wells and then recovering the water via the recovery wells. Water would be processed in the processing plant. This process would continue until the recovered water is demonstrated to be stabilized (maintained) at acceptable mining area decommissioning objectives (Section 2.3.3.1.1, Table 2.3-3). After mining area remediation is complete, the freeze wall would be turned off, which would allow for gradual re-establishment of the pre-operational groundwater flow regime.

As such, during Decommissioning, effluent may be released to Whitefish Lake. No effluent is expected to be released during Post-Decommissioning.

Evaluation of Surface Water Constituents of Potential Concern to Human Health

As discussed above by Project phase, the main input into the aquatic environment, which could affect the Human Health VC, is the release of treated effluent to Whitefish Lake. Human receptors could be exposed to treated effluent released to Whitefish Lake through drinking water, consuming fish, and swimming in the LSA and RSA. A conservative screening of predicted reasonable upper bound treated effluent concentrations against surface water quality guidelines was performed to identify the COPCs for the HHRA.

Reasonable upper bound effluent quality for a broad list of constituents (see Table 8.2-9 in Section 8.2, Surface Water Quality of the EIS) was compared against water quality guidelines based on the hierarchy of water quality guidelines outlined in Figure 10.1-5. The most restrictive federal or provincial guidelines for surface water quality, based on Canadian drinking water quality guidelines, are the CCME water quality guidelines for the protection of freshwater aquatic life, the federal environmental quality guidelines, and the Saskatchewan environmental quality guidelines. These guidelines were selected as the screening values for most surface water COPCs. Guidelines were adjusted for pre-operational hardness and pH, where applicable.

Where the reasonable upper bound effluent quality exceeded the selected screening value, the constituent was identified as a COPC for further assessment in the HHRA.

The reasonable upper bound treated effluent was derived using a combination of information available from lab tests conducted by Denison as well as derived effluent quality based on not exceeding water and sediment quality guidelines in the middle part of Whitefish Lake. Effluent treatment feed solution was prepared by leaching drill core material from the Phoenix deposit, and further processing that solution through two steps (process precipitate removal and yellowcake precipitation) prior to effluent treatment testing. Effluent treatment tests incorporated three stages: low pH, high pH, and neutralization. A combination of reagents (iron sulfate, barium chloride, lime, and sulfuric acid) was used to facilitate precipitation of constituents. After each stage, solid-liquid separation was conducted by mixing flocculant with solution to settle solids to the bottom of the test vessel. The supernatant liquid was used for the following stage. The solids were washed, filtered, and dried to determine solids mass generation for mass balance purposes. For each stage, the liquids and solids were assayed for various COPCs. The reasonable upper bound effluent was usually an expected effluent quality from Denison multiplied by a conservative safety factor between 1.5 and 10. The derived effluent quality was used for a handful of constituents including cadmium, chromium, and selenium.

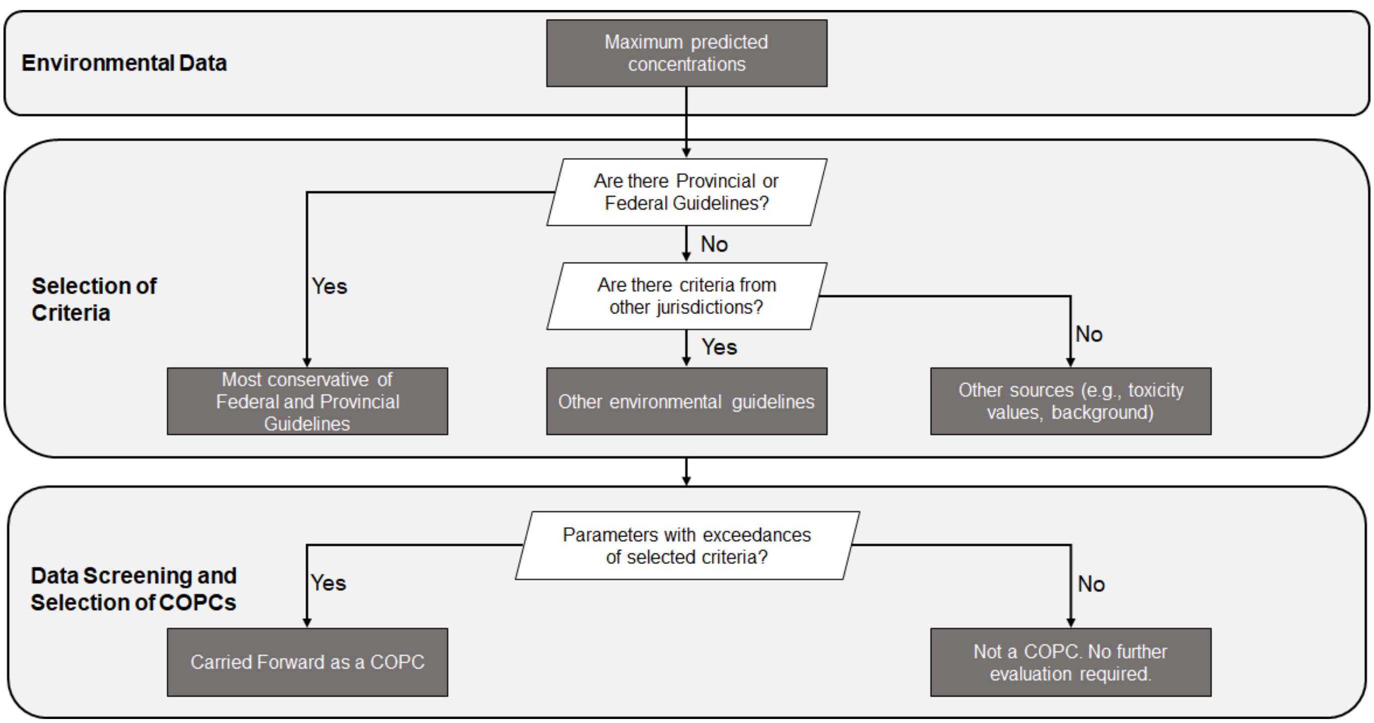


Figure 10.1-5: Selection of Surface Water Screening Values for Human Health

Additionally, a sediment screening was performed as a secondary check to determine if there are any constituents not identified as COPCs in the surface water screening that would be identified as COPCs based on exceedances of sediment quality guidelines. Predicted maximum concentrations of COPCs in sediment were compared against sediment quality guidelines for the protection of aquatic life from CCME (1999a), Burnett-Seidel and Liber (2013), and Thompson et al. (2005). Sediment concentrations were predicted from surface water concentrations using IMPACT, an environmental transport and pathways model detailed in the ERA (Appendix 10-A).

No formal screening was conducted for radionuclides. However, since radiation dose to human and ecological receptors is of great public and regulatory interest, the radionuclides in the U-238 decay series (U-238, U-234, thorium-230 [Th-230], radium-226 [Ra-226], Pb-210, polonium-210 [Po-210]) were considered COPCs for further modelling.

Radon-222 (Rn-222; radon) was not considered a COPC in surface water. Radon is expected to volatilize rapidly to air. Health Canada considers that the health risk from ingesting radon-contaminated drinking water is negligible (Health Canada 2020). Radon is expected to escape at the faucet or water outlet, leaving only minimal amounts in the water itself. This assumption is consistent with Clause 5.1.8 of CSA N288.1-20, *Guidelines for calculating derived release limits for radioactive material in airborne or liquid effluents for normal operation of nuclear facilities*, which indicates that noble gases, including radon-222, are not considered relevant for release to water because they do not enter environmental compartments other than air (CSA 2020).

Based on the completed screening, the following COPCs were identified for further assessment in the HHRA: chloride, sulphate, arsenic, cadmium, chromium, cobalt, copper, molybdenum, selenium, uranium, vanadium, zinc, Th-230, Ra-226, Pb-210, and Po-210. The predicted effluent quality is summarized in Table 10.1-4.

Based on the screening methodology, the effluent quality for TDS (6,420 mg/L) is expected to exceed its water quality guideline of 500 mg/L. The water quality guideline for TDS is an aesthetic drinking water objective from Health Canada (1991). No health effects associated with ingestion of TDS have been identified (Health Canada 1991). Modelling of TDS was not included in the IMPACT model; however, TDS concentrations were predicted in the near-field water quality model in Section 8.2, Surface Water Quality. Predicted TDS concentrations are expected to range from approximately 74 mg/L to 131 mg/L under various flow conditions and are well below the drinking water quality objective. Since TDS is not considered a health risk, and concentrations in LA-5 are predicted to be below the aesthetic objective, TDS is not considered further for the Human Health VC.

Table 10.1-4: Summary of Reasonable Upper Bound Effluent Quality as Implemented in the Human Health Risk Assessment

Constituent of Potential Concern	Unit	Effluent Quality
General Chemistry		
Chloride	mg/L	600
Sulphate	mg/L	3,915
Metals and Metalloids		
Arsenic	mg/L	0.006
Cadmium	mg/L	0.0018
Chromium	mg/L	0.025
Cobalt	mg/L	0.003
Copper	mg/L	0.022
Molybdenum	mg/L	2.5
Selenium	mg/L	0.042
Uranium	mg/L	0.057
Vanadium	mg/L	0.419
Zinc	mg/L	0.042
Radionuclides		
Uranium-238	Bq/L	0.7[1]
Uranium-234	Bq/L	0.7[1]
Thorium-230	Bq/L	0.9
Radium-226	Bq/L	0.15
Lead-210	Bq/L	0.419
Polonium-210	Bq/L	0.15

Note:

1 Estimated from uranium using the specific activity of 12,356 Bq/g and assuming secular equilibrium between U-238 and U-234 (https://www.wise-uranium.org/rup.html).

10.1.4.2.3 Long-Term Transport of Groundwater Solutes to Whitefish Lake in Future Centuries

During the “future centuries”, remediation works will be completed, and the site naturalized, thereby restoring natural drainage patterns that report to surface water bodies. As indicated in Section 7 of the EIS, Geology and Hydrogeology, groundwater plumes may develop from residual mass remaining post mining based on bench-scale lab tests of core flushing, and numerical modelling of reactive fate and transport.

Groundwater flow and reactive transport of dissolved constituents were modelled using three-dimensional modelling whereby the reactions were computed using PHREEQC and the transport was computed using FEFLOW (Ecometrix 2022 in Appendix 7-C of Section 7). Groundwater flow observed, and simulated in the calibrated groundwater model, travels eastward from the mining zone within the Lower Sandstone Aquifer before moving upward through the Desilicified Zone in the Athabasca Sandstone and overlying overburden deposits toward Whitefish Lake. Modelled transport of dissolved constituents along the groundwater flow path allowed for interactions of the dissolved constituents with the geologic media through which they are flowing. Due to the relatively low groundwater velocities between the mining zone and Whitefish Lake and chemical reactions along the groundwater flow pathway, the “Future Centuries” scenario spans 100s to 1000s of years.

The results of the numerical model (as provided in Section 7 and Appendix 7-A) support the conclusion that with the implementation of appropriate mitigation during the decommissioning and restoration phase of the Project, the residual effects of the Project on the Groundwater VC will not result in a significant adverse effect to surface water. Dissolved constituent concentrations emanating over hundreds to thousands of years in the future from the deep Ore Zone to Whitefish Lake remain below fresh water environmental quality criteria in Whitefish Lake.

For the COPCs identified in the effluent, the predicted mass flux from groundwater (see Table 10.1-5) into Whitefish Lake starting 200 years after the Project phases during the future centuries was added into the IMPACT model to predict the water and sediment concentrations over time at the exposed locations. As shown in the ERA (Appendix 10-A), predicted water and sediment concentrations at all locations are expected to be below water and sediment quality guidelines. Even though the water and sediment concentrations of COPCs are below their respective guidelines, dose and risk predictions for human receptors were performed using IMPACT as part of the HHRA to understand what the predicted effects might be during the future centuries for the same COPCs as during the Project phases.

Table 10.1-5: Summary of Predicted Mass Flux of Constituents of Potential Concern in Groundwater during the Future Centuries

Mass Flux (mg/s or Bq/s)									
Year after Project Phases	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1000**
General Chemistry (mg/s)									
Chloride	1.26E+02	1.28E+02	1.29E+02	1.29E+02	1.29E+02	1.29E+02	1.29E+02	1.28E+02	1.28E+02
Sulphate	4.08E+01	4.47E+01	4.69E+01	4.62E+01	4.44E+01	4.28E+01	4.16E+01	4.07E+01	3.99E+01
Metals and Metalloids (mg/s)									
Arsenic	5.73E-03	5.73E-03	5.73E-03	5.73E-03	5.73E-03	5.73E-03	5.73E-03	5.73E-03	5.74E-03
Cadmium	1.89E-04	1.89E-04	1.89E-04	1.89E-04	1.89E-04	1.89E-04	1.89E-04	1.88E-04	1.88E-04
Chromium	9.45E-03	9.45E-03	9.44E-03	9.43E-03	9.42E-03	9.42E-03	9.41E-03	9.40E-03	9.40E-03
Cobalt	7.51E-03	7.50E-03	7.49E-03	7.47E-03	7.46E-03	7.44E-03	7.43E-03	7.41E-03	7.40E-03
Copper	1.15E-02	1.15E-02	1.14E-02	1.14E-02	1.14E-02	1.14E-02	1.14E-02	1.14E-02	1.14E-02
Molybdenum	1.34E-02	1.34E-02	1.35E-02	1.35E-02	1.35E-02	1.35E-02	1.35E-02	1.35E-02	1.35E-02
Selenium	1.52E-02	1.52E-02	1.51E-02	1.51E-02	1.51E-02	1.51E-02	1.51E-02	1.51E-02	1.51E-02
Uranium	9.47E-03	9.47E-03	9.47E-03	9.46E-03	9.46E-03	9.45E-03	9.45E-03	9.45E-03	9.45E-03
Vanadium	1.89E-03	1.89E-03	1.90E-03	1.90E-03	1.91E-03	1.91E-03	1.91E-03	1.91E-03	1.92E-03
Zinc	8.30E-02	8.30E-02	8.30E-02	8.29E-02	8.29E-02	8.28E-02	8.28E-02	8.28E-02	8.28E-02
Radionuclides (Bq/s)									
Uranium-238 [1]	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01
Uranium-234 [1]	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01	1.17E-01
Thorium-230 [2]	3.69E-01	3.70E-01	3.71E-01	3.71E-01	3.72E-01	3.72E-01	3.72E-01	3.73E-01	3.73E-01
Radium-226 [3]	1.14E+00	1.14E+00	1.15E+00	1.15E+00	1.15E+00	1.15E+00	1.15E+00	1.15E+00	1.15E+00
Lead-210 [4]	1.14E+00	1.14E+00	1.15E+00	1.15E+00	1.15E+00	1.15E+00	1.15E+00	1.15E+00	1.15E+00
Polonium-210 [5]	1.16E+00	1.16E+00	1.17E+00	1.17E+00	1.17E+00	1.17E+00	1.17E+00	1.17E+00	1.17E+00

Note:

1. Estimated from uranium using the specific activity of 12356 Bq/g and assuming secular equilibrium between uranium-238 and uranium-234.
2. Unit conversion from mg/s to Bq/s using the specific activity of 7.47E+08 Bq/g which was calculated from its half-life of 77,000 y.
3. Unit conversion from mg/s to Bq/s using the specific activity of 3.66E+10 Bq/g which was calculated from its half-life of 1,600 y.
4. Assuming equilibrium between radium-226 and lead-210 due to the long half-life of radium-226.
5. Calculated from lead-210 assuming transient equilibrium between lead-210 and polonium-210.

10.1.5 Mitigation Measures

Mitigation in this EA is defined as the elimination, reduction, or control of the potential adverse effects of the Project and includes restitution for any damage to the VC caused by such effects through replacement, reclamation, compensation, or any other means. Mitigation measures refer to Project-specific mitigation and can include, but are not limited to, engineering design features and responses, best management practices, management plans, emergency response programs, and training. The rationale for and effectiveness of the proposed mitigation measures are discussed, as appropriate, and evaluated. Available data, survey and study results, and detailed mitigation measures that demonstrate a particular emphasis on avoidance of potential adverse effects are included here. From there, and with this base of general mitigation and optimization in place, the assessment identifies and proposes additional VC-specific mitigation measures as required and appropriate.

To mitigate potential adverse effects on surface water quality, Denison will do the following:

- Develop and implement a site-wide water management plan that provides an integrated framework to manage water quality that includes provision for water management practices for each of the primary site aspects, as well as areas of the site where contact water is expected.
- Maximize the recycle and reuse of process water to reduce freshwater intake and release to Whitefish Lake.
- Design discharge diffuser/outfall to provide effective mixing and dilution and to provide discharge flows that do not detrimentally affect sediments.
- Develop site-specific effluent treatment to treat COPCs to appropriate release limits in accordance with federal and provincial standards and licence/permit conditions.
- Discharge effluent under a scenario that will meet provincial and federal discharge criteria and be identified through permitting. Scenarios may include:
  - Discharge at a fixed rate while maintaining an appropriate minimum dilution ratio (i.e., discharge when able to meet the required dilution ratio and cease discharge during periods when unable to meet the necessary dilution ratio).
  - Discharge under a variable waste load allocation (i.e., discharge an appropriate effluent volume based on flow in the receiver to maintain minimum dilution ratio).
  - Manage discharge via a hybrid of these (i.e., discharge effluent at a fixed rate to maintain the required dilution ratio, but the fixed rate is varied on a seasonal basis [based on flow]).
- Collect and monitor contact water to determine whether treatment is required prior to release to the environment and inform optimal levels of treatment.
- Maintain the water management system in place during decommissioning until such time that water quality is suitable to release to the environment.
- Monitor and manage effluent, including contingency for effluent treatment as may be required, so that water discharge objectives are achieved as defined in applicable provincial and federal regulatory instruments.
- Design and implement an Environmental Code of Practice that defines action levels and appropriate steps to be taken to mitigate elevated concentrations of chemical and radiological COPCs in treated effluent discharge to acceptable levels.

- Implement Project-specific monitoring programs (e.g., effluent monitoring plan, environmental monitoring plan) that includes monitoring treated effluent, surface water and sediment quality and applying adaptive management if necessary.
- Work with the associated communities to develop and implement the Project-specific monitoring programs and a framework to share the results for the purpose of assessing the performance of the water management system.
- Develop and implement a decommissioning and reclamation plan to decommission and transfer the site to the Province under the Institutional Control Program.

To mitigate potential effects on air quality, Denison will do the following:

- Use scrubbers on the ISR stack to control emissions.
- Collect dust measurements during Construction, Operation, and Decommissioning, and determine whether the actual effect of Project activities is different than what was modelled.
- Create and implement a dust management plan, including the application of water to control fugitive dust, in addition to other operational strategies to assist in dust control.
- Plan vehicle and equipment routes to minimize travel distances, where possible.
- Employ standard operating procedures and complete regular inspections of equipment machinery to make sure it is in good working order.
- Avoid dust-generating activities (e.g., earthworks, material handling) during dry or high wind conditions.
- Avoid dropping material from height.
- Make sure all exhausts (e.g., mobile equipment, generators) are in good working condition.
- Turn off vehicles and equipment when not being used.
- Minimize or reduce vehicle and equipment speed by enforcing speed limits.
- Apply water at least twice per day to unpaved roads and surfaces (during summer months).
- Maintain unpaved road surfaces via grading or other maintenance practices to reduce the amount of silt (i.e., fines) present in the roadbed material.

10.1.6 Residual Effects Evaluation

The residual effects evaluation describes the likely residual effects of the Project on Human Health. Residual effects are those that remain after implementation of all mitigation measures and management plans and are the expected consequences of the Project on the Human Health VC and the Public Health KI. For Human Health, the residual effects evaluation is assessed in terms of an ERA (Appendix 10-A).

An ERA was prepared for the Project which encompasses an HHRA and an EcoRA. The ERA was prepared to be compliant with Canadian Standards Association Group (CSA)

N288.6-22 *Environmental Risk Assessments for Nuclear Facilities and Uranium Mines and Mills* (CSA 2022). It also meets the ERA requirements outlined in Section 4.1 of Regulatory Document-2.9.1, *Environmental Principles, Assessments and Protection Measures* (CNSC 2020b). The ERA has been developed with current science and current regulatory attitudes in mind.

10.1.6.1 Summary of Human Health Risk Assessment

A summary of the HHRA is provided here; however, details can be found in the ERA Report (Appendix 10-A). The HHRA is comprised of the following steps as shown in Figure 10.1-6: problem formulation, exposure assessment, toxicity assessment, and risk characterization.

The intent of the problem formulation for the HHRA was to define the goals of the risk assessment, establish an understanding of existing conditions, and develop working hypotheses as to how potential exposure of people to COPCs may result in potential risks to human health. The problem formulation defined human receptors that may be present in the Project Area, the LSA, and RSA; defined exposure pathways based on the fate and transport of COPCs in the environment; and identified the COPCs to be assessed.

The exposure assessment included the identification of exposure locations and exposure factors for each human health receptor and the presentation of exposure concentrations and doses (i.e., non-radiological and radiological). The toxicity assessment considered potential adverse health effects from non-radiological and radiological exposures. In the toxicity assessment, toxicity reference values (TRVs) and dose limits were defined. A TRV is a toxicological index associating specific health effects with a level of exposure to a chemical. The TRVs used in this assessment include slope factors and unit risks for carcinogens, and reference doses, tolerable daily intakes, or acceptable daily intakes for non-carcinogens. Toxicity reference values are meant to protect the most sensitive individuals.

In the risk characterization, the results of the exposure and toxicity assessments were used for each receptor to estimate the overall risk to the receptor. Risks were evaluated using hazard quotients (HQs) for non-carcinogens and incremental lifetime cancer risks (ILCRs) for carcinogens as measurement indicators. An HQ is the ratio of the exposure concentration or dose divided by the TRV concentration or dose. An ILCR is the product of the average lifetime exposure dose and the cancer slope factor (i.e., the risk of cancer based on exposure).

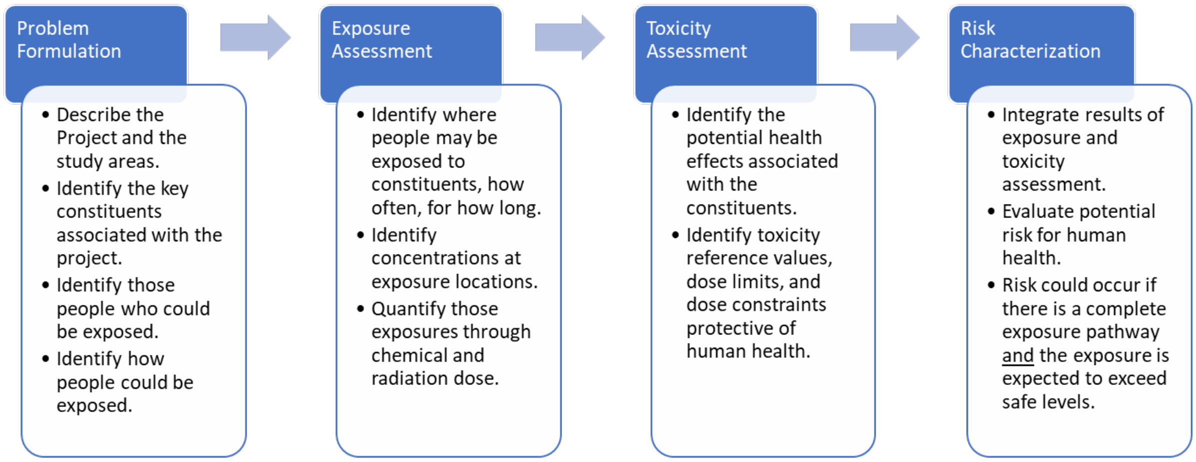


Figure 10.1-6: Human Health Risk Assessment Process

10.1.6.1.1 Human Receptors Selection and Characterization

The selection of human and ecological receptors for inclusion in the ERA (Appendix 10-A) was informed by IK and LK, information from baseline studies, as well as professional judgement. The human receptors for the HHRA were selected and characterized to represent potential exposures from both radiological and non-radiological COPCs. Human receptors would potentially be exposed to low levels of airborne or waterborne constituents being released during Project activities. Records within the Engagement Database indicate that community members are concerned about human health (21-EN-ERFNSUR-456.21, 21-EN-ERFNSUR-456.22) and the long-term impacts on drinking water quality as it relates to human health (22-EN-SUR-652.73, 18-EN-VB-4.38).

Nuclear Energy Workers (NEWs) and other workers on site (mine and mill) are not addressed for the radiological assessment because their radiation exposure is monitored and their doses are controlled through a Radiation Protection Plan. They are protected from non-radiological exposures through the Health and Safety Program. However, workers at the Denison Mine Camp (non-NEWs) will be assessed for both radiological and non-radiological exposures. This approach is consistent with CSA N288.6-22 (CSA 2022).

The human receptors selected for the HHRA included:

- camp worker during all Project phases;
- seasonal resident during all Project phases;
- recreational fisher/hunter during all Project phases;
- fisher/trapper during all Project phases; and
- future permanent resident in the future centuries.

Rationale for selection of the human receptors to be evaluated is described below and summarized in Table 10.1-6. The locations where the human receptors are assessed in the HHRA are shown on Figure 10.1-7.

During Post-Decommissioning, the Project area could be accessed intermittently by members of the public for various land use purposes. Any risks to these members of the public would be less than those assessed for the camp worker and therefore additional on-site receptors were not assessed during post-decommissioning.

Table 10.1-6: Rationale for Selection of Human Receptors for the Human Health Risk Assessment

Human Receptor Group	Location	Rationale for Selection
Camp Worker (adult)	Camp	• Camp worker, such as a camp cook, is located at the Denison camp 50% of the year. • Camp worker will occasionally consume traditional foods and will hunt, fish, or gather berries/plants in the area. Represents an average consumer of traditional foods (CanNorth 2017).
Seasonal Resident (adult, one-year old)	Russell Lake	• Resides near Russell Lake for approximately 30% of the year, based on known recreational leases surrounding Russell Lake (Denison 2020). • Traditional land use includes camping near Russell Lake • Represents an average consumer of traditional foods (CanNorth 2017).
Recreational Fisher, Hunter (adult, one-year old)	McGowan Lake Russell Lake	• Traditional land use includes hunting (large game and game birds), fishing, and firewood gathering. • Potential recreational lease identified at McGowan Lake, and traditional land use activities also reported in the Russell Lake area. • Cabin owner survey identified use of cabins in the area (KPI Program 2020). • Conservatively represents the two camps identified by local Indigenous groups as important for facilitation of traditional land-based activities and IK transfer (ERFN culture camp, Kineepik Métis [Pinehouse] camp). • Represents an average consumer of traditional foods (CanNorth 2017).
Fisher/Trapper (adult)	Russell Lake	• Based on resource use and residency information from a local adult fisher/trapper (KPI Program 2019). • Represents a high consumer of traditional foods (KPI Program 2019).
Future Permanent Resident (adult, one-year old)	Whitefish Lake/former camp	• Considered hypothetical as it is a possibility in the future centuries. • Assumes a resident living at the former Project footprint in the future centuries. • Represents an average consumer of traditional foods.

Camp Worker

The camp worker is a non-NEW worker such as a camp cook. A camp worker is an adult male or female. This receptor group is assumed to work and reside at the Denison camp for 50% of the year and away from the site for the other 50% of the year, based on a two-weeks in and two-weeks out schedule. The camp worker would be present during Construction, Operation, Decommissioning and Post-Decommissioning phases.

It is assumed that a camp worker will occasionally consume traditional foods and will hunt, fish, or gather berries/plants in the area. Drinking water and water for bathing would be obtained from local groundwater and surface water sources. A camp worker could come in direct contact with surface water through swimming, and with sediments through activities such as wading. Finally, a camp worker would be exposed to project-related COPCs through inhalation of air and dermal contact with and/or incidental ingestion of dust deposited to soil.

Seasonal Resident

Seasonal residents are adults and one-year-olds (male and female), who would visit and reside in the area for part of the year, every year, during all project phases. Their residence during that time would be at the nearest reasonable location to the site. Potential recreational leases occur at Russell Lake, McGowan Lake, and Whitefish Lake North, with the majority surrounding Russell Lake (Denison 2020). Traditional land use within the LSA and RSA also includes camping near Russell Lake. Therefore, the nearest reasonable location to the site for seasonal residents could be Russell Lake. The seasonal residents are assumed to reside at a lodge on Russell Lake for three months of the year during the tourist season, or approximately 30% of the year.

While at Russell Lake, seasonal residents may ingest local country foods fished, hunted, and gathered in the vicinity of Russell Lake as part of their diet while residing in the area. While at the lodge, water for drinking, bathing, and swimming would be obtained from Russell Lake. The seasonal resident could come in contact with the surface water of Russell Lake while swimming, and with sediments during the practice of activities such as wading. Finally, a seasonal resident may be exposed to project-related COPCs through inhalation of air and dermal contact and/or incidental ingestion of dust deposited to soil.

Recreational Fisher/Hunter

Recreational fishers/hunters are adults, male and female, who would visit and reside in the area for part of the year, every year, during all project phases. Traditional land uses that have been identified from available Traditional Land Use studies include hunting (large game and game birds), fishing, and firewood gathering. The traditional land use activities closest to the Project site are reported to occur in the Russell Lake area. Land use activities have also been reported farther west, outside the RSA, near the MacIntyre Lake and Holgar Lake areas, which are representative of background environmental conditions. These regions have also been identified as overnight tent sites (ERFN and SVS 2022b; YNLR 2022). Additionally, a potential recreational lease has been identified at McGowan Lake. A survey conducted by Denison determined a number of cabins used by local residents for recreational and outfitting/guiding purposes (KPI Program 2020).

Traditional land use studies of the region around the Project site identified two camps considered by local Indigenous groups to be important locations for the facilitation of traditional land-based activities and IK transfer. These camps include:

- The ERFN culture camp, located approximately 85 km southwest of Russell Lake. This camp is an area where recreational activities occur, in addition to youth education activities, traditional Indigenous games and activities, and contemporary gathering.
- The Kineepik Métis (Pinehouse) camp, located approximately 67 km north of the village of Pinehouse. This camp is situated in an area where hunting, fishing, and harvesting of country foods is commonly reported.

The two camps are situated well beyond the boundaries of the RSA; therefore, it is expected that the recreational fisher/hunter receptor, assumed to use Russell or McGowan Lake, will represent a highly conservative assessment of potential risk for Indigenous peoples engaging in traditional land-based activities at these culturally significant camp sites.

Recreational fishers/hunters may ingest local country foods fished, hunted, and gathered at and near Russell Lake or McGowan Lake; therefore, two recreational fishers/hunters were identified—one at McGowan Lake and one at Russell Lake.

They may also conserve local country foods collected from the area for consumption with their family throughout the year; therefore a one-year old is also assessed. While at the lodge, water for drinking, bathing, and swimming would be obtained from Russell Lake or McGowan Lake. The recreational fisher/hunter may come in contact with surface waters of Russell Lake or McGowan Lake while swimming, and with sediments during the practice of activities such as wading. In comparison to a seasonal resident, a recreational fisher/hunter would spend approximately the same amount of time annually in the study area, but obtain a higher portion of local country foods in their overall annual diet from the study area. Finally, a recreational fisher/hunter may be exposed to project-related COPCs through inhalation of air and dermal contact and/or incidental ingestion of dust deposited to soil.

The Wheeler River is considered both culturally and economically important to ERFN and is an area where traditional land activities such as hunting, fishing, and trapping occur year round. Members of ERFN have expressed the importance of protecting the area and managing effects to the environment to protect the ability for Indigenous residents to continue to engage in traditional land activities (ERFN and SVS 2022a). The recreational fisher/hunter receptor is expected to adequately represent the traditional land uses identified in the Traditional Land Use studies, and to capture any potential risk to local Indigenous and non-Indigenous hunters and fishers.

Fisher/Trapper

The adult fisher/trapper represents a member of the public who lives in the region year round and regularly consumes local country foods and water. The fisher/trapper will be assessed for all Project phases. Assumptions made about the fisher/trapper receptor were formed following consultation with local Indigenous community members. Denison recognizes that ERFN considers the fisher/trapper's use of the area as representative of current and future land users and expects that the relationship to the Project Area will be continued and strengthened through generations of future use.

The residency characteristics of the fisher/trapper have been developed from resource use information collected from a local trapper. The local fisher/trapper had:

- A primary cabin along the Wheeler River upstream of its confluence with Moon Creek at Bobby's Pond (represented by reference conditions);
- A secondary cabin at Russell Lake (which is downstream of the Icelander Creek drainage and represents a far-field exposure location); and,
- Two other minor residences away from the Project area (represented by reference conditions).

For assessment purposes, it is assumed that the fisher/trapper spends 6 months of the year at a primary residence (a reference location) and the other 6 months of the year at a secondary residence on Russell Lake. Subsistence hunting is assumed to occur while at both cabin locations. While at the Russell Lake cabin, the fisher/trapper is assumed to hunt mallard ducks as indicated by the resource use information. In contrast to the resource use information which suggests that subsistence fishing would occur at multiple locations including Russell Lake and reference lakes in the Project Area, it was conservatively assumed that 100% of the fish in the fisher/trapper's diet would be from the far-field exposure location at Russell Lake and no fish would be from the reference location.

In comparison to the other adult human receptor groups, the fisher/trapper consumes a greater proportion of country game and fish in his diet annually. The fisher/trapper is assumed to consume local country foods and store foods in equal proportions on an annual basis. Country game meats and fish sources are assumed to be equally distributed in the diet, each representing approximately 25% of the annual diet based on fresh weight.

Similar to the recreational fisher/hunter, the fisher/trapper receptor is expected to sufficiently represent the traditional land uses recognized in the Traditional Land Use studies, and to capture any potential risk to local Indigenous community members who live in the region year round, regularly partake in land-based traditional activities, and frequently consume a higher proportion of traditional foods in their diet.

Future Permanent Resident

The future permanent resident is a hypothetical adult and one-year-old (male or female) who would reside full time at the Denison camp site after the Post-Decommissioning phase has been fully implemented, in the future centuries. Currently, there are no permanent residents or communities within 150 km of the Project Area.

Permanent residents would have a diet similar to that of the seasonal resident and the recreational fisher/hunter but would ingest a higher proportion of local country foods fished, hunted, and gathered in the area because of their full-time residency in the Project Area. Local country foods would likely be sourced from drainages affected and not affected by the former operation. Drinking water and water for bathing would be obtained from a local surface water source, such as Whitefish Lake Middle and Whitefish Lake South. A permanent resident could come in direct contact with surface water through swimming, and with sediments through the practice of activities such as wading. It is anticipated that permanent residents would not be exposed to project-related COPCs through inhalation of air after Decommissioning; however, they could be exposed by dermal contact and/or incidental ingestion of dust deposited to soil for some time after Decommissioning. Assumptions for a permanent resident after Post-Decommissioning should be refined near the time of Decommissioning with community input where possible.

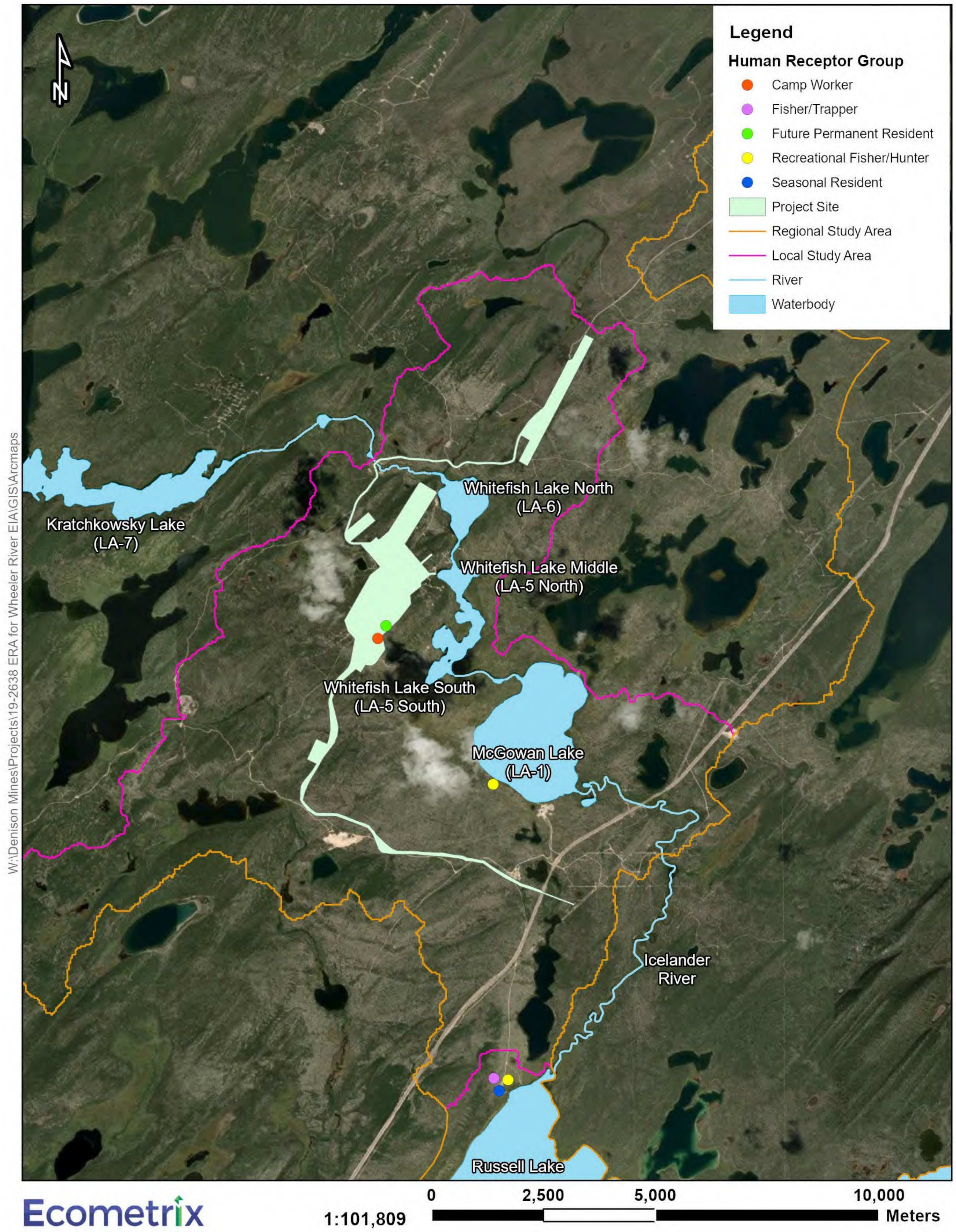


Figure 10.1-7: Human Receptor Locations for the Project Human Health Risk Assessment

10.1.6.1.2 Exposure Pathways and Conceptual Model

Radiological and non-radiological exposure pathways were assessed in the HHRA. The primary exposure routes for human health included:

- inhalation of airborne COPCs (outdoor air) for radionuclides only;
- dermal contact with soil while gardening or harvesting;
- ingestion of country foods (e.g., fish, vegetation, game), and ingestion of store-bought foods;
- ingestion of surface water as drinking water and incidental ingestion during bathing and swimming;
- incidental ingestion of soil (i.e., while harvesting) or sediment (i.e., while wading);
- dermal contact with surface water and sediment while swimming or doing other recreational activities; and
- external exposure to radiation from air, water, soil, and sediment.

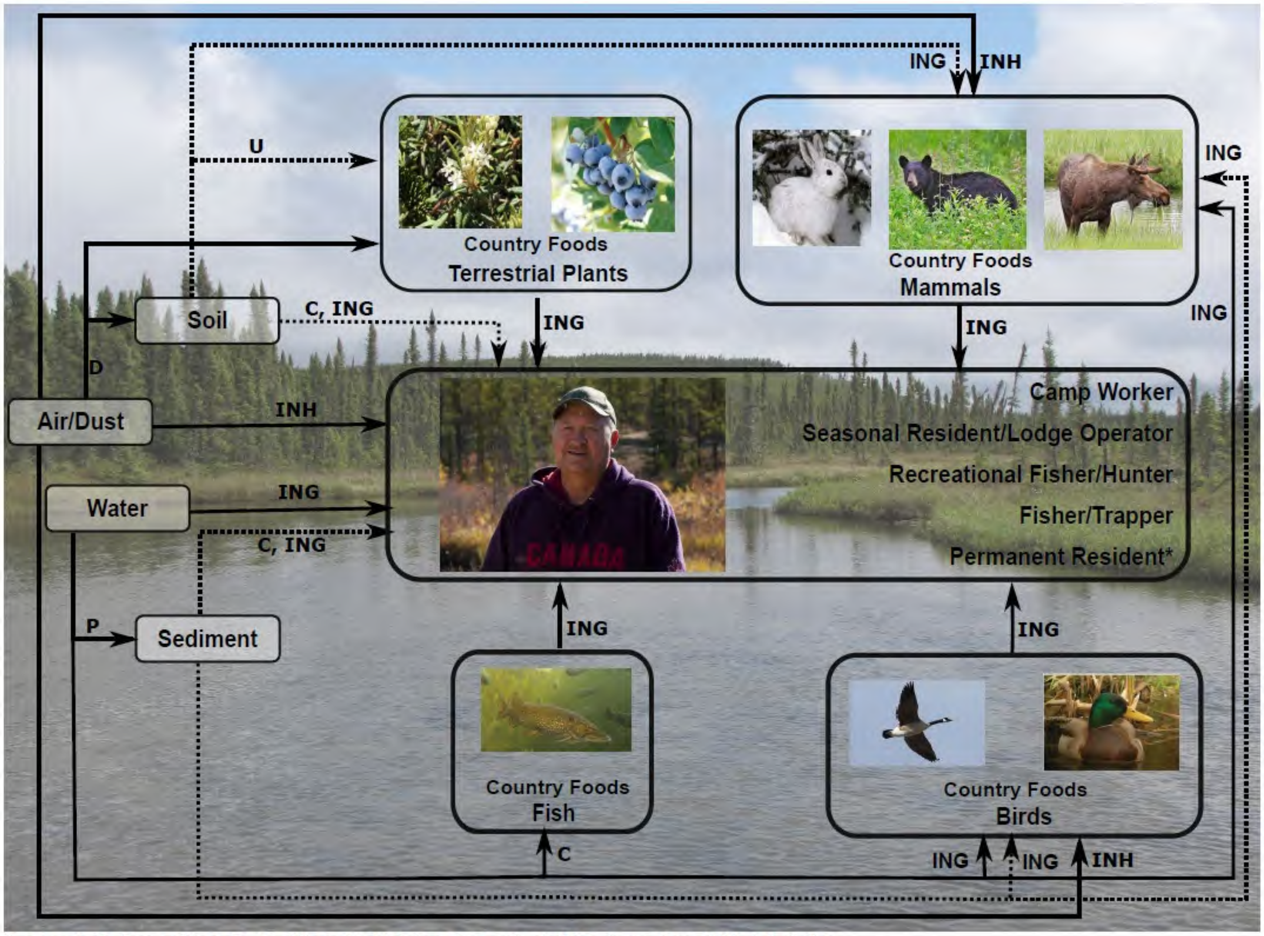
The exposure pathways are similar between most of the human receptors and are summarized in Table 10.1-7.

Table 10.1-7: Summary of Human Health Exposure Pathways

Human Receptor Group	Environmental Exposure Pathway				
	Air	Soil	Water	Sediment	Traditional Foods
Camp Worker	Inhalation[a]	Direct Contact Incidental Ingestion	Direct Contact Ingestion	Direct Contact Incidental Ingestion	Ingestion
Seasonal Resident	Inhalation[a]	Direct Contact Incidental Ingestion	Direct Contact Ingestion	Direct Contact Incidental Ingestion	Ingestion
Recreational Fisher, Hunter	Inhalation[a]	Direct Contact Incidental Ingestion	Direct Contact Ingestion	Direct Contact Incidental Ingestion	Ingestion
Fisher/Trapper	Inhalation[a]	Direct Contact Incidental Ingestion	Direct Contact Ingestion	Direct Contact Incidental Ingestion	Ingestion
Future Permanent Resident	Incomplete Pathway	Direct Contact Incidental Ingestion	Direct Contact Ingestion	Direct Contact Incidental Ingestion	Ingestion

Note: Inhalation pathway was only evaluated for radionuclides, as inhalation was not identified as a pathway of concern for non-radionuclides based on the atmospheric screening in Section 3.2 of the ERA (Appendix 10-A).

The human health conceptual model illustrates how receptors are exposed to COPCs. It represents the relationship between the source and receptors by identifying the source of constituents, the receptors, and the exposure pathways to be considered in the assessment for each receptor. Exposure pathways represent the various routes by which radionuclides and/or chemicals may enter the body of the receptor, or for radionuclides, how they may exert effects from outside the body. The complete exposure pathways for the human receptors that are considered in the HHRA are illustrated in Figure 10.1-8.



Legend: D: Deposition; **P:** Partition; **U:** Uptake; **C:** Contact; **ING:** Ingestion; **INH:** Inhalation;
⟶ Exposure pathway from primary media; ┈┈➤ Exposure pathway from secondary media.

* Human Receptors are assumed to be present during all project stages, except the Permanent Resident who is assumed to be present during future centuries.

Figure 10.1-8: Human Health Conceptual Site Model for the Project Human Health Risk Assessment

Note: Denison would like to gratefully acknowledge the contributions of Bobby John (shown in the centre of this image) to this EIS and extend a thank you to his family for granting permission to use his image herein.

10.1.6.1.3 Exposure Assessment and Pathways Modelling

An environmental transport and pathways model was used to evaluate the effects of COPCs on the local environment, including human and ecological receptors. The software used for the exposure pathways analysis and for the calculation of radiological doses was IMPACT Version 5.6.0, which is consistent with the COPC transport equations and radiological dose calculations outlined in CSA N288.1-20 (CSA 2020). The equations used for non-radiological dose calculations are consistent with those from CSA N288.6-22 (CSA 2022), which have generally been obtained from Health

Canada guidance. A more detailed description of the model, including all input parameters used, is provided in the ERA (Appendix 10-A) and associated IMPACT Model Report (Appendix A to Appendix 10-A).

Waterbodies from Whitefish Lake to the Russell Lake inlet were modelled in IMPACT to assess the effects of the Project on the downstream environment—Whitefish Lake, McGowan Lake, and Russell Lake. Kratchkowsky Lake and the north part of Whitefish Lake were modelled as reference locations.

Inputs into the IMPACT model included the release of treated effluent to the middle of Whitefish Lake at an expected discharge rate of 36.5 m^3/h and a reasonable upper bound effluent quality, during the Operation and Decommissioning phases of the Project. No effluent is expected to be released during Construction or Post-Decommissioning. Air concentrations at human receptor locations from the Air Quality Impact Assessment (Section 6 of this EIS) were input into the IMPACT model and subsequent deposition to soil and plants was modeled in IMPACT.

Outputs from the IMPACT model included radiological dose, non-radiological dose, and risk to human receptors.

10.1.6.1.4 Human Health Risk Assessment Results

Risk estimates were calculated to determine the potential for effects on the human receptors identified. The risk estimates were determined by comparing the predicted exposures, in terms of doses, with exposures that are known to be protective based on effects data (i.e., TRVs or radiation dose limits).

The risk estimate for non-carcinogens was quantified for the human receptor based on the calculation of a HQ. To account for uncertainty in pathways beyond Project activities (i.e., exposure to background sources unrelated to the Project), it was determined that, to be protective, a benchmark HQ value of 0.2 per medium (e.g., water, soil, food, air) would be considered acceptable for the assessment. This approach is consistent with the approach taken by Health Canada (2021) in its guidance on human health preliminary quantitative risk assessment.

Hazard quotients were calculated in IMPACT, as shown below:

$$HQ = \frac{Exposure\ (Dose)\ Estimate}{TRV}$$

For carcinogens (e.g., arsenic), the incremental risk (i.e., total risk minus background risk) of developing cancer over a lifetime was estimated by multiplying the predicted dose above background by the cancer slope factor, as shown below:

$$ILCR = \sum LADD_i \times SF \times ADAF_i$$

where,

ILCR	=	incremental lifetime cancer risk (unitless)
$ADAF_i$	=	age-dependent adjustment factors for life stage i
$LADD_i$	=	dose received during life stage i averaged over a lifetime (mg/kg/d)
SF	=	adult cancer slope factor (per mg/kg/d)

Health Canada recommends that for carcinogens where the mode of action is unknown or the burden of proof for a threshold mode of action is not met, that the assessment should follow the non-threshold approach (i.e., a linear dose-response relationship) (Health Canada 2013). The Canadian drinking water guideline technical document for arsenic indicates that there is limited data on the mode of action for arsenic and that the use of a non-linear relationship may overestimate cancer risks of internal organs (Health Canada 2006). Therefore, for this assessment, a linear approach for arsenic was used. Additionally, since the mode of action is unknown, and arsenic-specific data are not available on quantitative differences between early life stages and adults, Health Canada's default age-dependent adjustment factors for all life stages were not used (i.e., ADAF = 1 for all life stages).

Incremental lifetime cancer risks were compared to de minimis risk levels; de minimis risk levels are those that are considered essentially negligible compared to background cancer risks. Cancer risks that are considered acceptable can range from 1 in 10,000 to 1 in 1,000,000 in different jurisdictions. Health Canada (2021) considers an increase in lifetime cancer risk of 1 in 100,000 (or 0.00001) to be essentially negligible compared to the background cancer risk level in North America of approximately 5 in 10 (or 0.5).

Incremental radiation doses due to radionuclides in the uranium-238 decay series were compared to the regulatory public dose limit and dose limit for a non-NEW of 1 mSv/yr as described in the Radiation Protection Regulations under the *Nuclear Safety and Control Act*. The limit is incremental and is exclusive of natural background, such as natural levels of radon and medical exposures. A dose constraint of 0.3 mSv/yr was established for the public from all radionuclides and all pathways for the Project, as recommended by Health Canada (2010a). The dose constraint represents a dose lower than the public dose limit that ensures the combined dose from multiple sources does not result in exceedance of the public dose limit. Radon dose was added to the radiation doses due to radionuclides in the uranium-238 decay series and compared against the dose limit of 1 mSv/yr.

Non-carcinogens

While chloride and sulphate were identified as COPCs for further assessment in the ERA (Appendix 10-A), they were not considered further in the HHRA. These COPCs are associated with water ingestion. Chloride does not have a drinking water standard and is not considered to present a risk to human health at concentrations found in drinking water or at concentrations predicted for Whitefish Lake (6 mg/L in LA-5). Sulphate in drinking water is associated with adverse physiological effects such as diarrhoea or dehydration at concentrations above 500 mg/L. The predicted maximum concentration of sulphate in LA-5 is 39 mg/L, which is below 500 mg/L; therefore, concentrations at exposure points farther downstream would be less than those associated with adverse physiological effects. For these reasons, chloride and sulphate were not assessed further in the HHRA.

The HQs in Table 10.1-8 are presented as baseline HQs (based on existing risk prior to the Project), Project total HQs (includes the Project risk in addition to the baseline risk), as well as Project incremental HQs (includes the Project risk only with baseline component removed). The HQs represent the maximum HQ over the Project phase for the COPCs of interest, which is a conservative representation as exposure varies within each Project phase. HQs were evaluated for the adult and the one-year-old; however, for assessment of non-carcinogens, the one-year-old is typically considered the most sensitive receptor (Health Canada 2010b).

For the Project incremental HQs, there are no exceedances of the HQ benchmark (HQ<0.2) for human receptors for non-carcinogens (cadmium, copper, chromium, cobalt, molybdenum, uranium, vanadium, and zinc) during all phases of the Project, with the exception of selenium for the fisher/trapper at Russell Lake. The incremental Project HQ for the fisher/trapper from fish ingestion (northern pike and white sucker) was predicted to be 0.81. The Project incremental HQ represents an incremental HQ with existing baseline risk removed.

Since baseline risk includes all exposures not associated with the Project (including store-bought foods), it is also appropriate to discuss the Project total HQ (baseline plus Project) and compare against a HQ benchmark of 1. The Project total HQ is below 1 for all receptors and COPCS with the exception of selenium for the fisher/trapper.

The Project total HQ for the fisher/trapper for selenium is predicted to be greater than 1; and as previously indicated, the Project incremental HQs for the fish ingestion pathway for selenium are predicted to be above 0.2. This indicates that the Project is expected to contribute to selenium in the environment and the food chain; however, the assessment is conservative as discussed further.

The traditional foods diet assumptions for the fisher/trapper are conservative and are based on engagement with a local fisher/trapper. The diet of the fisher/trapper is representative of one person, who consumes a unique composition and quantity of traditional foods. Most people fishing, hunting, and trapping in the Project Area would consume traditional foods more consistent with the average traditional foods consumer diet which was developed from the ERFN country foods study (CanNorth 2017).

The ingestion rate for caribou based on engagement with a local fisher/trapper was 175 kg/yr of caribou (equivalent to approximately 2 to 3 servings per day). This ingestion rate is conservative compared to an annual caribou ingestion rate of 2.6 kg/yr (1 to 2 servings per month) from the ERFN's Country Food Study (CanNorth 2017) and 54.4 kg/yr for the total game diet for a high traditional foods consumer in the Boreal Shield in the First Nations Food, Nutrition and Environment Study for Saskatchewan (Chan et al. 2018). Thus, the local fisher/trapper represents an intensive land user. Denison recognizes that the ERFN considers the fisher/trapper's use of the area as representative of current and future land users and expects that the relationship to the Project Area will be continued and strengthened through generations of future use.

Additionally, the traditional foods diet for the fisher/trapper is conservative for fish as it assumes that all fish consumed in the diet is obtained from Russell Lake, whereas it is likely that someone would fish from many different lakes including those outside of the RSA. The annual fish consumption based on engagement with a local fisher/trapper was estimated as 183 kg/yr (approximately 1 to 2 servings per day), which is conservative compared to an annual fish consumption of 27 kg/yr (2 servings per week) from the ERFN's Country Food Study (CanNorth 2017) and 88 kg/yr (approximately 1 serving per day) for the high traditional foods consumer for the Boreal Shield in the First Nations Food, Nutrition and Environment Study for Saskatchewan (Chan et al. 2018). Thus, the local fisher/trapper is relatively extreme with respect to local fish consumption.

The HQs for the future centuries (beyond the Project timeline) are presented in Table 10.1-9. During the future centuries a permanent resident is included on the former mine site instead of a camp worker. For the Project incremental HQs, there are no predicted exceedances of the HQ benchmark (HQ<0.2) for human receptors for all non-carcinogens evaluated during the future centuries.

Table 10.1-8: Estimated Non-radiological Risk to Human Receptors – Project Phases

Human Receptor	COPC	HQs during Project Phases									
		Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
Camp Worker Adult (Whitefish Lake)		Average Baseline HQ									
	Cadmium	4.25E-04	9.44E-06	4.32E-05	2.94E-06	1.35E-05	0.00E+00	4.46E-05	4.39E-03	2.56E-01	2.61E-01
	Chromium	5.08E-06	4.62E-08	2.11E-06	2.72E-08	1.25E-06	0.00E+00	9.78E-06	3.72E-06	1.00E-05	3.20E-05
	Cobalt	1.48E-04	5.55E-07	2.54E-06	1.76E-07	8.04E-07	0.00E+00	6.25E-05	3.14E-03	1.64E-02	1.97E-02
	Copper	2.13E-05	7.15E-08	1.96E-06	3.02E-08	8.30E-07	0.00E+00	3.74E-04	5.13E-03	4.83E-02	5.38E-02
	Molybdenum	5.61E-05	8.58E-08	3.93E-07	8.40E-08	3.84E-07	0.00E+00	1.97E-07	9.24E-04	9.05E-02	9.15E-02
	Selenium	8.32E-05	3.93E-07	1.80E-06	7.59E-07	3.48E-06	0.00E+00	1.47E-02	3.85E-03	2.96E-01	3.14E-01
	Uranium	7.35E-04	1.33E-05	6.10E-04	6.71E-06	3.07E-04	0.00E+00	5.14E-04	2.27E-02	6.12E-02	8.62E-02
	Vanadium	1.01E-03	4.80E-05	2.20E-03	3.71E-05	1.70E-03	0.00E+00	3.39E-03	1.71E-03	1.72E-01	1.82E-01
	Zinc	1.75E-05	1.95E-07	8.92E-06	1.21E-07	5.56E-06	0.00E+00	1.23E-03	9.38E-03	2.12E-01	2.23E-01
		Project Total HQ - Project Phases									
	Cadmium	5.70E-04	9.44E-06	4.32E-05	3.64E-06	1.67E-05	0.00E+00	6.26E-05	4.39E-03	2.56E-01	2.61E-01
	Chromium	6.13E-06	4.62E-08	2.11E-06	3.13E-08	1.43E-06	0.00E+00	1.23E-05	3.72E-06	1.09E-05	3.66E-05
	Cobalt	1.68E-04	5.56E-07	2.54E-06	1.94E-07	8.88E-07	0.00E+00	7.34E-05	3.15E-03	1.64E-02	1.98E-02
	Copper	2.48E-05	7.22E-08	1.98E-06	3.40E-08	9.34E-07	0.00E+00	4.52E-04	5.15E-03	4.83E-02	5.40E-02
	Molybdenum	6.41E-03	8.59E-08	3.93E-07	7.17E-06	3.28E-05	0.00E+00	2.84E-05	9.24E-04	9.20E-02	9.94E-02
	Selenium	5.98E-04	3.94E-07	1.80E-06	3.73E-06	1.71E-05	0.00E+00	9.45E-02	3.85E-03	3.07E-01	4.06E-01
	Uranium	7.39E-03	3.60E-05	1.65E-03	4.51E-05	2.06E-03	0.00E+00	5.59E-03	5.04E-02	6.54E-02	1.33E-01
	Vanadium	2.79E-03	4.80E-05	2.20E-03	8.03E-05	3.68E-03	0.00E+00	7.57E-03	1.72E-03	1.76E-01	1.94E-01
	Zinc	2.22E-05	1.95E-07	8.93E-06	1.44E-07	6.59E-06	0.00E+00	1.61E-03	9.38E-03	2.13E-01	2.24E-01
		Project Incremental HQ - Project Phases									
	Cadmium	1.45E-04	1.42E-09	6.48E-09	6.95E-07	3.18E-06	0.00E+00	1.80E-05	2.07E-06	1.53E-04	3.22E-04
	Chromium	1.05E-06	4.44E-12	2.03E-10	4.05E-09	1.85E-07	0.00E+00	2.48E-06	4.42E-09	8.57E-07	4.58E-06
	Cobalt	1.99E-05	5.98E-10	2.74E-09	1.85E-08	8.46E-08	0.00E+00	1.09E-05	1.72E-06	3.71E-05	6.98E-05
	Copper	3.45E-06	6.38E-10	1.75E-08	3.78E-09	1.04E-07	0.00E+00	7.83E-05	1.94E-05	8.46E-05	1.86E-04
	Molybdenum	6.35E-03	6.60E-11	3.02E-10	7.08E-06	3.24E-05	0.00E+00	2.82E-05	3.31E-07	1.47E-03	7.89E-03
	Selenium	5.15E-04	4.18E-10	1.91E-09	2.98E-06	1.36E-05	0.00E+00	7.98E-02	2.42E-06	1.12E-02	9.15E-02

Human Receptor	COPC	Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
		HQs during Project Phases									
	Uranium	6.66E-03	2.26E-05	1.04E-03	3.84E-05	1.76E-03	0.00E+00	5.08E-03	2.77E-02	4.17E-03	4.65E-02
	Vanadium	1.77E-03	1.45E-08	6.61E-07	4.32E-05	1.98E-03	0.00E+00	4.18E-03	5.34E-06	3.64E-03	1.16E-02
	Zinc	4.64E-06	1.67E-10	7.64E-09	2.27E-08	1.04E-06	0.00E+00	3.88E-04	3.28E-06	1.77E-04	5.74E-04
Rec F/H Adult (McGowan Lake)		**Average Baseline HQ**									
	Cadmium	4.25E-04	9.44E-06	4.32E-06	2.94E-06	1.35E-06	0.00E+00	8.92E-05	8.78E-03	2.48E-01	2.57E-01
	Chromium	5.08E-06	4.62E-08	2.11E-07	2.72E-08	1.25E-07	0.00E+00	1.96E-05	7.43E-06	2.02E-05	5.27E-05
	Cobalt	1.48E-04	5.55E-07	2.54E-07	1.76E-07	8.04E-08	0.00E+00	1.25E-04	6.29E-03	1.77E-02	2.42E-02
	Copper	2.13E-05	7.15E-08	1.96E-07	3.02E-08	8.30E-08	0.00E+00	7.48E-04	1.03E-02	5.98E-02	7.08E-02
	Molybdenum	5.61E-05	8.58E-08	3.93E-08	8.40E-08	3.84E-08	0.00E+00	3.94E-07	1.85E-03	8.62E-02	8.81E-02
	Selenium	8.32E-05	3.93E-07	1.80E-07	7.59E-07	3.48E-07	0.00E+00	2.94E-02	7.70E-03	2.89E-01	3.26E-01
	Uranium	7.35E-04	1.33E-05	6.10E-05	6.71E-06	3.07E-05	0.00E+00	1.03E-03	4.55E-02	5.86E-02	1.06E-01
	Vanadium	1.01E-03	4.80E-05	2.20E-04	3.71E-05	1.70E-04	0.00E+00	6.78E-03	3.43E-03	1.72E-01	1.83E-01
	Zinc	1.75E-05	1.95E-07	8.92E-07	1.21E-07	5.56E-07	0.00E+00	2.45E-03	1.88E-02	2.34E-01	2.55E-01
		Project Total HQ - Project Phases									
	Cadmium	4.78E-04	9.44E-06	4.32E-06	3.22E-06	1.47E-06	0.00E+00	1.25E-04	8.79E-03	2.48E-01	2.58E-01
	Chromium	5.50E-06	4.62E-08	2.11E-07	2.89E-08	1.32E-07	0.00E+00	2.45E-05	7.44E-06	2.19E-05	5.98E-05
	Cobalt	1.56E-04	5.55E-07	2.54E-07	1.84E-07	8.40E-08	0.00E+00	1.47E-04	6.29E-03	1.77E-02	2.43E-02
	Copper	2.26E-05	7.16E-08	1.97E-07	3.19E-08	8.75E-08	0.00E+00	9.05E-04	1.03E-02	6.00E-02	7.12E-02
	Molybdenum	2.52E-03	8.59E-08	3.93E-08	3.13E-06	1.43E-06	0.00E+00	5.68E-05	1.85E-03	8.91E-02	9.36E-02
	Selenium	2.56E-04	3.94E-07	1.80E-07	1.90E-06	8.67E-07	0.00E+00	1.89E-01	7.70E-03	3.12E-01	5.09E-01
	Uranium	2.98E-03	1.68E-05	7.68E-05	2.14E-05	9.78E-05	0.00E+00	1.12E-02	1.01E-01	6.70E-02	1.82E-01
	Vanadium	1.49E-03	4.80E-05	2.20E-04	4.81E-05	2.20E-04	0.00E+00	1.51E-02	3.44E-03	1.79E-01	1.99E-01
	Zinc	1.93E-05	1.95E-07	8.93E-07	1.30E-07	5.97E-07	0.00E+00	3.23E-03	1.88E-02	2.34E-01	2.56E-01
		Project Incremental HQ - Project Phases									
	Cadmium	5.28E-05	1.97E-10	9.00E-11	2.75E-07	1.26E-07	0.00E+00	3.60E-05	4.14E-06	3.08E-04	4.01E-04
	Chromium	4.16E-07	6.86E-13	3.14E-12	1.64E-09	7.53E-09	0.00E+00	4.96E-06	8.84E-09	1.72E-06	7.12E-06
	Cobalt	7.28E-06	8.29E-11	3.80E-11	8.01E-09	3.66E-09	0.00E+00	2.18E-05	3.44E-06	7.40E-05	1.07E-04
	Copper	1.25E-06	8.90E-11	2.44E-10	1.63E-09	4.48E-09	0.00E+00	1.57E-04	3.88E-05	1.69E-04	3.66E-04
	Molybdenum	2.47E-03	6.62E-12	3.03E-12	3.05E-06	1.40E-06	0.00E+00	5.64E-05	6.63E-07	2.93E-03	5.46E-03

Human Receptor	COPC	HQs during Project Phases									
		Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
	Selenium	1.73E-04	5.85E-11	2.68E-11	1.14E-06	5.20E-07	0.00E+00	1.60E-01	4.83E-06	2.24E-02	1.82E-01
	Uranium	2.24E-03	3.45E-06	1.58E-05	1.46E-05	6.70E-05	0.00E+00	1.02E-02	5.54E-02	8.36E-03	7.63E-02
	Vanadium	4.72E-04	2.01E-09	9.18E-09	1.10E-05	5.03E-05	0.00E+00	8.36E-03	1.07E-05	7.29E-03	1.62E-02
	Zinc	1.81E-06	2.32E-11	1.06E-10	9.00E-09	4.12E-08	0.00E+00	7.76E-04	6.57E-06	3.54E-04	1.14E-03
Rec F/H One-year-old (McGowan Lake)		Average Baseline HQ									
	Cadmium	4.75E-04	6.17E-04	7.39E-06	1.92E-04	2.30E-06	0.00E+00	8.45E-05	1.97E-02	6.29E-01	6.50E-01
	Chromium	5.67E-06	3.02E-06	3.62E-07	1.78E-06	2.13E-07	0.00E+00	1.85E-05	1.72E-05	1.17E-05	5.85E-05
	Cobalt	1.66E-04	3.63E-05	4.35E-07	1.15E-05	1.37E-07	0.00E+00	1.18E-04	1.46E-02	3.78E-02	5.27E-02
	Copper	2.38E-05	4.67E-06	3.36E-07	1.98E-06	1.42E-07	0.00E+00	7.09E-04	2.37E-02	1.01E-01	1.25E-01
	Molybdenum	7.63E-05	6.83E-06	8.18E-08	6.68E-06	8.00E-08	0.00E+00	4.54E-07	5.20E-03	2.73E-01	2.79E-01
	Selenium	9.63E-05	2.66E-05	3.19E-07	5.14E-05	6.16E-07	0.00E+00	2.88E-02	1.87E-02	7.51E-01	7.98E-01
	Uranium	8.21E-04	8.71E-04	1.04E-04	4.38E-04	5.25E-05	0.00E+00	9.73E-04	1.04E-01	1.52E-01	2.59E-01
	Vanadium	1.13E-03	3.13E-03	3.76E-04	2.42E-03	2.91E-04	0.00E+00	6.42E-03	6.21E-03	4.18E-01	4.38E-01
	Zinc	2.28E-05	1.48E-05	1.78E-06	9.23E-06	1.11E-06	0.00E+00	2.70E-03	5.01E-02	5.63E-01	6.16E-01
		Project Total HQ - Project Phases									
	Cadmium	5.34E-04	6.17E-04	7.39E-06	2.10E-04	2.52E-06	0.00E+00	1.19E-04	1.97E-02	6.29E-01	6.50E-01
	Chromium	6.14E-06	3.02E-06	3.62E-07	1.89E-06	2.26E-07	0.00E+00	2.32E-05	1.72E-05	1.29E-05	6.49E-05
	Cobalt	1.74E-04	3.63E-05	4.35E-07	1.20E-05	1.44E-07	0.00E+00	1.39E-04	1.46E-02	3.78E-02	5.28E-02
	Copper	2.52E-05	4.68E-06	3.36E-07	2.08E-06	1.50E-07	0.00E+00	8.57E-04	2.38E-02	1.01E-01	1.26E-01
	Molybdenum	3.43E-03	6.83E-06	8.18E-08	2.49E-04	2.99E-06	0.00E+00	6.55E-05	5.20E-03	2.75E-01	2.84E-01
	Selenium	2.96E-04	2.66E-05	3.19E-07	1.28E-04	1.54E-06	0.00E+00	1.86E-01	1.87E-02	7.66E-01	9.70E-01
	Uranium	3.32E-03	1.10E-03	1.31E-04	1.40E-03	1.67E-04	0.00E+00	1.06E-02	2.14E-01	1.57E-01	3.88E-01
	Vanadium	1.66E-03	3.13E-03	3.76E-04	3.14E-03	3.77E-04	0.00E+00	1.43E-02	6.22E-03	4.22E-01	4.51E-01
	Zinc	2.51E-05	1.48E-05	1.78E-06	9.91E-06	1.19E-06	0.00E+00	3.56E-03	5.01E-02	5.64E-01	6.17E-01
		Project Incremental HQ - Project Phases									
	Cadmium	5.89E-05	1.29E-08	1.55E-10	1.80E-05	2.16E-07	0.00E+00	3.41E-05	8.55E-06	2.13E-04	3.33E-04
	Chromium	4.64E-07	4.50E-11	5.37E-12	1.07E-07	1.29E-08	0.00E+00	4.70E-06	1.15E-08	1.14E-06	6.44E-06
	Cobalt	8.13E-06	5.42E-09	6.50E-11	5.23E-07	6.27E-09	0.00E+00	2.07E-05	7.64E-06	4.22E-05	7.92E-05
	Copper	1.40E-06	5.81E-09	4.18E-10	1.07E-07	7.67E-09	0.00E+00	1.48E-04	9.07E-05	9.83E-05	3.39E-04

Human Receptor	COPC	HQs during Project Phases									
		Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
	Molybdenum	3.35E-03	5.27E-10	6.31E-12	2.43E-04	2.91E-06	0.00E+00	6.51E-05	1.80E-06	2.03E-03	5.70E-03
	Selenium	2.00E-04	3.96E-09	4.74E-11	7.69E-05	9.22E-07	0.00E+00	1.57E-01	1.14E-05	1.48E-02	1.72E-01
	Uranium	2.50E-03	2.25E-04	2.70E-05	9.57E-04	1.15E-04	0.00E+00	9.62E-03	1.10E-01	5.28E-03	1.29E-01
	Vanadium	5.27E-04	1.31E-07	1.57E-08	7.18E-04	8.61E-05	0.00E+00	7.91E-03	1.37E-05	4.03E-03	1.33E-02
	Zinc	2.35E-06	1.77E-09	2.12E-10	6.84E-07	8.20E-08	0.00E+00	8.54E-04	1.78E-05	2.07E-04	1.08E-03
Rec F/H Adult (Russell Lake)		Average Baseline HQ									
	Cadmium	4.25E-04	9.44E-06	4.32E-06	2.94E-06	1.35E-06	0.00E+00	8.92E-05	8.78E-03	2.48E-01	2.57E-01
	Chromium	5.08E-06	4.62E-08	2.11E-07	2.72E-08	1.25E-07	0.00E+00	1.96E-05	7.43E-06	2.02E-05	5.27E-05
	Cobalt	1.48E-04	5.55E-07	2.54E-07	1.76E-07	8.04E-08	0.00E+00	1.25E-04	6.29E-03	1.77E-02	2.42E-02
	Copper	2.13E-05	7.15E-08	1.96E-07	3.02E-08	8.30E-08	0.00E+00	7.48E-04	1.03E-02	5.98E-02	7.08E-02
	Molybdenum	5.61E-05	8.58E-08	3.93E-08	8.40E-08	3.84E-08	0.00E+00	3.94E-07	1.85E-03	8.62E-02	8.81E-02
	Selenium	8.32E-05	3.93E-07	1.80E-07	7.59E-07	3.48E-07	0.00E+00	2.94E-02	7.70E-03	2.89E-01	3.26E-01
	Uranium	7.35E-04	1.33E-05	6.10E-05	6.71E-06	3.07E-05	0.00E+00	1.03E-03	4.55E-02	5.86E-02	1.06E-01
	Vanadium	1.01E-03	4.80E-05	2.20E-04	3.71E-05	1.70E-04	0.00E+00	6.78E-03	3.43E-03	1.72E-01	1.83E-01
	Zinc	1.75E-05	1.95E-07	8.92E-07	1.21E-07	5.56E-07	0.00E+00	2.45E-03	1.88E-02	2.34E-01	2.55E-01
		Project Total HQ - Project Phases									
	Cadmium	4.68E-04	9.44E-06	4.32E-06	3.15E-06	1.44E-06	0.00E+00	1.15E-04	8.78E-03	2.48E-01	2.58E-01
	Chromium	5.42E-06	4.62E-08	2.11E-07	2.84E-08	1.30E-07	0.00E+00	2.32E-05	7.44E-06	2.15E-05	5.80E-05
	Cobalt	1.54E-04	5.55E-07	2.54E-07	1.82E-07	8.31E-08	0.00E+00	1.41E-04	6.29E-03	1.77E-02	2.43E-02
	Copper	2.23E-05	7.16E-08	1.97E-07	3.15E-08	8.64E-08	0.00E+00	8.66E-04	1.03E-02	5.99E-02	7.11E-02
	Molybdenum	1.91E-03	8.58E-08	3.93E-08	2.40E-06	1.10E-06	0.00E+00	4.28E-05	1.85E-03	8.84E-02	9.22E-02
	Selenium	2.07E-04	3.93E-07	1.80E-07	1.59E-06	7.27E-07	0.00E+00	1.47E-01	7.70E-03	3.06E-01	4.60E-01
	Uranium	2.35E-03	1.42E-05	6.52E-05	1.74E-05	7.97E-05	0.00E+00	8.35E-03	6.03E-02	6.36E-02	1.35E-01
	Vanadium	1.38E-03	4.80E-05	2.20E-04	4.41E-05	2.02E-04	0.00E+00	1.24E-02	3.43E-03	1.76E-01	1.94E-01
	Zinc	1.90E-05	1.95E-07	8.92E-07	1.28E-07	5.86E-07	0.00E+00	3.02E-03	1.88E-02	2.34E-01	2.56E-01
		Project Incremental HQ - Project Phases									
	Cadmium	4.28E-05	5.09E-11	2.32E-11	2.03E-07	9.30E-08	0.00E+00	2.62E-05	1.07E-06	2.29E-04	2.99E-04
	Chromium	3.42E-07	1.78E-13	8.10E-13	1.22E-09	5.60E-09	0.00E+00	3.64E-06	2.30E-09	1.30E-06	5.29E-06
	Cobalt	5.45E-06	2.13E-11	9.75E-12	6.09E-09	2.79E-09	0.00E+00	1.64E-05	8.85E-07	5.35E-05	7.63E-05
	Copper	9.39E-07	2.29E-11	6.29E-11	1.24E-09	3.41E-09	0.00E+00	1.18E-04	9.99E-06	9.25E-05	2.21E-04

Human Receptor	COPC	HQs during Project Phases									
		Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
Rec F/H One-year-old (Russell Lake)	Molybdenum	1.85E-03	1.32E-12	6.04E-13	2.31E-06	1.06E-06	0.00E+00	4.24E-05	1.33E-07	2.22E-03	4.12E-03
	Selenium	1.24E-04	1.50E-11	6.88E-12	8.29E-07	3.80E-07	0.00E+00	1.17E-01	1.24E-06	1.65E-02	1.34E-01
	Uranium	1.61E-03	9.20E-07	4.21E-06	1.07E-05	4.90E-05	0.00E+00	7.33E-03	1.48E-02	4.92E-03	2.87E-02
	Vanadium	3.63E-04	5.17E-10	2.36E-09	6.98E-06	3.20E-05	0.00E+00	5.62E-03	2.75E-06	4.91E-03	1.09E-02
	Zinc	1.49E-06	5.97E-12	2.74E-11	6.64E-09	3.04E-08	0.00E+00	5.64E-04	1.69E-06	2.59E-04	8.26E-04
		Average Baseline HQ									
	Cadmium	4.75E-04	6.17E-04	7.39E-06	1.92E-04	2.30E-06	0.00E+00	8.45E-05	1.97E-02	6.29E-01	6.50E-01
	Chromium	5.67E-06	3.02E-06	3.62E-07	1.78E-06	2.13E-07	0.00E+00	1.85E-05	1.72E-05	1.17E-05	5.85E-05
	Cobalt	1.66E-04	3.63E-05	4.35E-07	1.15E-05	1.37E-07	0.00E+00	1.18E-04	1.46E-02	3.78E-02	5.27E-02
	Copper	2.38E-05	4.67E-06	3.36E-07	1.98E-06	1.42E-07	0.00E+00	7.09E-04	2.37E-02	1.01E-01	1.25E-01
	Molybdenum	7.63E-05	6.83E-06	8.18E-08	6.68E-06	8.00E-08	0.00E+00	4.54E-07	5.20E-03	2.73E-01	2.79E-01
	Selenium	9.63E-05	2.66E-05	3.19E-07	5.14E-05	6.16E-07	0.00E+00	2.88E-02	1.87E-02	7.51E-01	7.98E-01
	Uranium	8.21E-04	8.71E-04	1.04E-04	4.38E-04	5.25E-05	0.00E+00	9.73E-04	1.04E-01	1.52E-01	2.59E-01
	Vanadium	1.13E-03	3.13E-03	3.76E-04	2.42E-03	2.91E-04	0.00E+00	6.42E-03	6.21E-03	4.18E-01	4.38E-01
	Zinc	2.28E-05	1.48E-05	1.78E-06	9.23E-06	1.11E-06	0.00E+00	2.70E-03	5.01E-02	5.63E-01	6.16E-01
		Project Total HQ - Project Phases									
	Cadmium	5.22E-04	6.17E-04	7.39E-06	2.06E-04	2.46E-06	0.00E+00	1.09E-04	1.97E-02	6.29E-01	6.50E-01
	Chromium	6.06E-06	3.02E-06	3.62E-07	1.86E-06	2.23E-07	0.00E+00	2.20E-05	1.72E-05	1.26E-05	6.33E-05
	Cobalt	1.72E-04	3.63E-05	4.35E-07	1.19E-05	1.42E-07	0.00E+00	1.34E-04	1.46E-02	3.78E-02	5.27E-02
	Copper	2.49E-05	4.68E-06	3.36E-07	2.06E-06	1.48E-07	0.00E+00	8.20E-04	2.38E-02	1.01E-01	1.25E-01
	Molybdenum	2.59E-03	6.83E-06	8.18E-08	1.91E-04	2.29E-06	0.00E+00	4.93E-05	5.20E-03	2.75E-01	2.83E-01
	Selenium	2.40E-04	2.66E-05	3.19E-07	1.08E-04	1.29E-06	0.00E+00	1.44E-01	1.87E-02	7.62E-01	9.25E-01
	Uranium	2.62E-03	9.31E-04	1.12E-04	1.14E-03	1.36E-04	0.00E+00	7.91E-03	1.34E-01	1.55E-01	3.01E-01
	Vanadium	1.54E-03	3.13E-03	3.76E-04	2.88E-03	3.45E-04	0.00E+00	1.17E-02	6.21E-03	4.21E-01	4.47E-01
	Zinc	2.47E-05	1.48E-05	1.78E-06	9.73E-06	1.17E-06	0.00E+00	3.32E-03	5.01E-02	5.64E-01	6.17E-01
		Project Incremental HQ - Project Phases									
	Cadmium	4.78E-05	3.32E-09	3.96E-11	1.33E-05	1.59E-07	0.00E+00	2.48E-05	2.20E-06	1.58E-04	2.46E-04
	Chromium	3.81E-07	1.18E-11	1.39E-12	7.99E-08	9.58E-09	0.00E+00	3.44E-06	3.00E-09	8.57E-07	4.77E-06
	Cobalt	6.08E-06	1.39E-09	1.67E-11	3.98E-07	4.77E-09	0.00E+00	1.55E-05	1.96E-06	3.06E-05	5.46E-05
	Copper	1.05E-06	1.50E-09	1.08E-10	8.10E-08	5.83E-09	0.00E+00	1.11E-04	2.33E-05	5.58E-05	1.92E-04

Human Receptor	COPC	Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
		HQs during Project Phases									
Seasonal Resident (Russell Lake)	Molybdenum	2.52E-03	1.06E-10	1.26E-12	1.84E-04	2.21E-06	0.00E+00	4.89E-05	3.61E-07	1.54E-03	4.29E-03
	Selenium	1.44E-04	1.02E-09	1.22E-11	5.62E-05	6.73E-07	0.00E+00	1.15E-01	2.93E-06	1.09E-02	1.26E-01
	Uranium	1.80E-03	6.01E-05	7.21E-06	6.99E-04	8.38E-05	0.00E+00	6.94E-03	2.94E-02	3.10E-03	4.21E-02
	Vanadium	4.05E-04	3.38E-08	4.05E-09	4.56E-04	5.47E-05	0.00E+00	5.32E-03	3.54E-06	2.70E-03	8.94E-03
	Zinc	1.94E-06	4.55E-10	5.45E-11	5.05E-07	6.05E-08	0.00E+00	6.21E-04	4.58E-06	1.52E-04	7.80E-04
		Average Baseline HQ									
	Cadmium	4.25E-04	9.44E-06	4.32E-06	2.94E-06	1.35E-06	0.00E+00	8.92E-05	8.78E-03	2.48E-01	2.57E-01
	Chromium	5.08E-06	4.62E-08	2.11E-07	2.72E-08	1.25E-07	0.00E+00	1.96E-05	7.43E-06	2.02E-05	5.27E-05
	Cobalt	1.48E-04	5.55E-07	2.54E-07	1.76E-07	8.04E-08	0.00E+00	1.25E-04	6.29E-03	1.77E-02	2.42E-02
	Copper	2.13E-05	7.15E-08	1.96E-07	3.02E-08	8.30E-08	0.00E+00	7.48E-04	1.03E-02	5.98E-02	7.08E-02
	Molybdenum	5.61E-05	8.58E-08	3.93E-08	8.40E-08	3.84E-08	0.00E+00	3.94E-07	1.85E-03	8.62E-02	8.81E-02
	Selenium	8.32E-05	3.93E-07	1.80E-07	7.59E-07	3.48E-07	0.00E+00	2.94E-02	7.70E-03	2.89E-01	3.26E-01
	Uranium	7.35E-04	1.33E-05	6.10E-05	6.71E-06	3.07E-05	0.00E+00	1.03E-03	4.55E-02	5.86E-02	1.06E-01
	Vanadium	1.01E-03	4.80E-05	2.20E-04	3.71E-05	1.70E-04	0.00E+00	6.78E-03	3.43E-03	1.72E-01	1.83E-01
	Zinc	1.75E-05	1.95E-07	8.92E-07	1.21E-07	5.56E-07	0.00E+00	2.45E-03	1.88E-02	2.34E-01	2.55E-01
		Project Total HQ - Project Phases									
	Cadmium	4.68E-04	9.44E-06	4.32E-06	3.15E-06	1.44E-06	0.00E+00	9.78E-05	8.78E-03	2.48E-01	2.58E-01
	Chromium	5.42E-06	4.62E-08	2.11E-07	2.84E-08	1.30E-07	0.00E+00	2.08E-05	7.43E-06	2.06E-05	5.47E-05
	Cobalt	1.54E-04	5.55E-07	2.54E-07	1.82E-07	8.31E-08	0.00E+00	1.30E-04	6.29E-03	1.77E-02	2.42E-02
	Copper	2.23E-05	7.16E-08	1.97E-07	3.15E-08	8.64E-08	0.00E+00	7.81E-04	1.03E-02	5.98E-02	7.09E-02
	Molybdenum	1.91E-03	8.58E-08	3.93E-08	2.40E-06	1.10E-06	0.00E+00	1.31E-05	1.85E-03	8.69E-02	9.06E-02
	Selenium	2.07E-04	3.93E-07	1.80E-07	1.59E-06	7.27E-07	0.00E+00	6.39E-02	7.70E-03	2.94E-01	3.66E-01
	Uranium	2.35E-03	1.42E-05	6.52E-05	1.74E-05	7.97E-05	0.00E+00	3.20E-03	4.99E-02	6.09E-02	1.17E-01
	Vanadium	1.38E-03	4.80E-05	2.20E-04	4.41E-05	2.02E-04	0.00E+00	9.08E-03	3.43E-03	1.73E-01	1.88E-01
	Zinc	1.90E-05	1.95E-07	8.92E-07	1.28E-07	5.86E-07	0.00E+00	2.65E-03	1.88E-02	2.34E-01	2.55E-01
		Project Incremental HQ - Project Phases									
	Cadmium	4.28E-05	5.09E-11	2.32E-11	2.03E-07	9.30E-08	0.00E+00	8.62E-06	3.21E-07	7.37E-05	1.26E-04
	Chromium	3.42E-07	1.78E-13	8.10E-13	1.22E-09	5.60E-09	0.00E+00	1.26E-06	6.97E-10	4.24E-07	2.03E-06
	Cobalt	5.45E-06	2.13E-11	9.75E-12	6.09E-09	2.79E-09	0.00E+00	4.55E-06	2.66E-07	1.49E-05	2.51E-05

Human Receptor	COPC	Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
		HQs during Project Phases									
	Copper	9.39E-07	2.29E-11	6.29E-11	1.24E-09	3.41E-09	0.00E+00	3.26E-05	3.00E-06	2.73E-05	6.39E-05
	Molybdenum	1.85E-03	1.32E-12	6.04E-13	2.31E-06	1.06E-06	0.00E+00	1.27E-05	3.99E-08	6.64E-04	2.53E-03
	Selenium	1.24E-04	1.50E-11	6.88E-12	8.29E-07	3.80E-07	0.00E+00	3.45E-02	3.73E-07	5.25E-03	3.99E-02
	Uranium	1.61E-03	9.20E-07	4.21E-06	1.07E-05	4.90E-05	0.00E+00	2.17E-03	4.45E-03	2.22E-03	1.05E-02
	Vanadium	3.63E-04	5.17E-10	2.36E-09	6.98E-06	3.20E-05	0.00E+00	2.30E-03	8.33E-07	1.89E-03	4.59E-03
	Zinc	1.49E-06	5.97E-12	2.74E-11	6.64E-09	3.04E-08	0.00E+00	1.99E-04	5.07E-07	1.00E-04	3.01E-04
Seasonal Resident One-year-old (Russell Lake)		Average Baseline HQ									
	Cadmium	4.75E-04	6.17E-04	7.39E-06	1.92E-04	2.30E-06	0.00E+00	8.45E-05	1.97E-02	6.29E-01	6.50E-01
	Chromium	5.67E-06	3.02E-06	3.62E-07	1.78E-06	2.13E-07	0.00E+00	1.85E-05	1.72E-05	1.17E-05	5.85E-05
	Cobalt	1.66E-04	3.63E-05	4.35E-07	1.15E-05	1.37E-07	0.00E+00	1.18E-04	1.46E-02	3.78E-02	5.27E-02
	Copper	2.38E-05	4.67E-06	3.36E-07	1.98E-06	1.42E-07	0.00E+00	7.09E-04	2.37E-02	1.01E-01	1.25E-01
	Molybdenum	7.63E-05	6.83E-06	8.18E-08	6.68E-06	8.00E-08	0.00E+00	4.54E-07	5.20E-03	2.73E-01	2.79E-01
	Selenium	9.63E-05	2.66E-05	3.19E-07	5.14E-05	6.16E-07	0.00E+00	2.88E-02	1.87E-02	7.51E-01	7.98E-01
	Uranium	8.21E-04	8.71E-04	1.04E-04	4.38E-04	5.25E-05	0.00E+00	9.73E-04	1.04E-01	1.52E-01	2.59E-01
	Vanadium	1.13E-03	3.13E-03	3.76E-04	2.42E-03	2.91E-04	0.00E+00	6.42E-03	6.21E-03	4.18E-01	4.38E-01
	Zinc	2.28E-05	1.48E-05	1.78E-06	9.23E-06	1.11E-06	0.00E+00	2.70E-03	5.01E-02	5.63E-01	6.16E-01
		Project Total HQ - Project Phases									
	Cadmium	5.22E-04	6.17E-04	7.39E-06	2.06E-04	2.46E-06	0.00E+00	9.26E-05	1.97E-02	6.29E-01	6.50E-01
	Chromium	6.06E-06	3.02E-06	3.62E-07	1.86E-06	2.23E-07	0.00E+00	1.97E-05	1.72E-05	1.20E-05	6.04E-05
	Cobalt	1.72E-04	3.63E-05	4.35E-07	1.19E-05	1.42E-07	0.00E+00	1.23E-04	1.46E-02	3.78E-02	5.27E-02
	Copper	2.49E-05	4.68E-06	3.36E-07	2.06E-06	1.48E-07	0.00E+00	7.40E-04	2.37E-02	1.01E-01	1.25E-01
	Molybdenum	2.59E-03	6.83E-06	8.18E-08	1.91E-04	2.29E-06	0.00E+00	1.51E-05	5.20E-03	2.74E-01	2.82E-01
	Selenium	2.40E-04	2.66E-05	3.19E-07	1.08E-04	1.29E-06	0.00E+00	6.27E-02	1.87E-02	7.54E-01	8.36E-01
	Uranium	2.62E-03	9.31E-04	1.12E-04	1.14E-03	1.36E-04	0.00E+00	3.03E-03	1.13E-01	1.53E-01	2.74E-01
	Vanadium	1.54E-03	3.13E-03	3.76E-04	2.88E-03	3.45E-04	0.00E+00	8.60E-03	6.21E-03	4.19E-01	4.42E-01
	Zinc	2.47E-05	1.48E-05	1.78E-06	9.73E-06	1.17E-06	0.00E+00	2.92E-03	5.01E-02	5.63E-01	6.17E-01
		Project Incremental HQ - Project Phases									
	Cadmium	4.78E-05	3.32E-09	3.96E-11	1.33E-05	1.59E-07	0.00E+00	8.17E-06	6.59E-07	4.84E-05	1.18E-04
	Chromium	3.81E-07	1.18E-11	1.39E-12	7.99E-08	9.58E-09	0.00E+00	1.19E-06	8.93E-10	2.69E-07	1.93E-06

Human Receptor	COPC	HQs during Project Phases									
		Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
	Cobalt	6.08E-06	1.39E-09	1.67E-11	3.98E-07	4.77E-09	0.00E+00	4.31E-06	5.89E-07	8.26E-06	1.96E-05
	Copper	1.05E-06	1.50E-09	1.08E-10	8.10E-08	5.83E-09	0.00E+00	3.09E-05	7.00E-06	1.60E-05	5.50E-05
	Molybdenum	2.52E-03	1.06E-10	1.26E-12	1.84E-04	2.21E-06	0.00E+00	1.47E-05	1.08E-07	4.46E-04	3.16E-03
	Selenium	1.44E-04	1.02E-09	1.22E-11	5.62E-05	6.73E-07	0.00E+00	3.39E-02	8.77E-07	3.36E-03	3.75E-02
	Uranium	1.80E-03	6.01E-05	7.21E-06	6.99E-04	8.38E-05	0.00E+00	2.06E-03	8.80E-03	1.34E-03	1.48E-02
	Vanadium	4.05E-04	3.38E-08	4.05E-09	4.56E-04	5.47E-05	0.00E+00	2.18E-03	1.05E-06	1.04E-03	4.14E-03
	Zinc	1.94E-06	4.55E-10	5.45E-11	5.05E-07	6.05E-08	0.00E+00	2.19E-04	1.37E-06	6.00E-05	2.83E-04
Fisher/Trapper (Russell Lake)		**Average Baseline HQ**									
	Cadmium	4.25E-04	9.44E-06	4.32E-06	2.94E-06	1.35E-06	0.00E+00	6.14E-04	0.00E+00	2.01E-01	2.02E-01
	Chromium	5.08E-06	4.62E-08	2.11E-07	2.72E-08	1.25E-07	0.00E+00	1.35E-04	0.00E+00	5.51E-04	6.91E-04
	Cobalt	1.48E-04	5.55E-07	2.54E-07	1.76E-07	8.04E-08	0.00E+00	8.60E-04	0.00E+00	7.79E-03	8.80E-03
	Copper	2.13E-05	7.15E-08	1.96E-07	3.02E-08	8.30E-08	0.00E+00	5.15E-03	0.00E+00	2.80E-02	3.32E-02
	Molybdenum	5.61E-05	8.58E-08	3.93E-08	8.40E-08	3.84E-08	0.00E+00	2.71E-06	0.00E+00	4.58E-02	4.59E-02
	Selenium	8.32E-05	3.93E-07	1.80E-07	7.59E-07	3.48E-07	0.00E+00	2.02E-01	0.00E+00	2.77E-01	4.79E-01
	Uranium	7.35E-04	1.33E-05	6.10E-05	6.71E-06	3.07E-05	0.00E+00	7.07E-03	0.00E+00	3.64E-02	4.44E-02
	Vanadium	1.01E-03	4.80E-05	2.20E-04	3.71E-05	1.70E-04	0.00E+00	4.67E-02	0.00E+00	3.67E-01	4.16E-01
	Zinc	1.75E-05	1.95E-07	8.92E-07	1.21E-07	5.56E-07	0.00E+00	1.69E-02	0.00E+00	5.40E-01	5.57E-01
		Project Total HQ - Project Phases									
	Cadmium	4.88E-04	9.44E-06	4.32E-06	3.28E-06	1.50E-06	0.00E+00	7.94E-04	0.00E+00	2.02E-01	2.03E-01
	Chromium	5.57E-06	4.62E-08	2.11E-07	2.93E-08	1.34E-07	0.00E+00	1.60E-04	0.00E+00	5.58E-04	7.24E-04
	Cobalt	1.58E-04	5.55E-07	2.54E-07	1.86E-07	8.50E-08	0.00E+00	9.73E-04	0.00E+00	7.80E-03	8.94E-03
	Copper	2.30E-05	7.16E-08	1.97E-07	3.23E-08	8.87E-08	0.00E+00	5.96E-03	0.00E+00	2.82E-02	3.42E-02
	Molybdenum	3.14E-03	8.59E-08	3.93E-08	3.94E-06	1.80E-06	0.00E+00	2.94E-04	0.00E+00	4.70E-02	5.05E-02
	Selenium	2.92E-04	3.93E-07	1.80E-07	2.14E-06	9.80E-07	0.00E+00	1.01E+00	0.00E+00	3.36E-01	**1.35E+00**
	Uranium	3.44E-03	1.49E-05	6.80E-05	2.45E-05	1.12E-04	0.00E+00	5.75E-02	0.00E+00	1.62E-01	2.23E-01
	Vanadium	1.52E-03	4.80E-05	2.20E-04	4.87E-05	2.23E-04	0.00E+00	8.53E-02	0.00E+00	4.07E-01	4.94E-01
	Zinc	1.97E-05	1.95E-07	8.93E-07	1.32E-07	6.06E-07	0.00E+00	2.08E-02	0.00E+00	5.42E-01	5.63E-01
		Project Incremental HQ - Project Phases									
	Cadmium	6.30E-05	8.46E-11	3.87E-11	3.39E-07	1.55E-07	0.00E+00	1.80E-04	0.00E+00	7.17E-04	9.60E-04

Human Receptor	COPC	HQs during Project Phases									
		Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
	Chromium	4.92E-07	2.98E-13	1.35E-12	2.04E-09	9.33E-09	0.00E+00	2.50E-05	0.00E+00	6.74E-06	3.23E-05
	Cobalt	9.49E-06	3.55E-11	1.63E-11	1.01E-08	4.64E-09	0.00E+00	1.13E-04	0.00E+00	1.37E-05	1.36E-04
	Copper	1.63E-06	3.81E-11	1.05E-10	2.06E-09	5.67E-09	0.00E+00	8.09E-04	0.00E+00	1.48E-04	9.59E-04
	Molybdenum	3.08E-03	2.20E-12	1.01E-12	3.86E-06	1.76E-06	0.00E+00	2.92E-04	0.00E+00	1.21E-03	4.59E-03
	Selenium	2.09E-04	2.51E-11	1.15E-11	1.38E-06	6.33E-07	0.00E+00	8.07E-01	0.00E+00	5.87E-02	8.66E-01
	Uranium	2.70E-03	1.53E-06	7.02E-06	1.78E-05	8.16E-05	0.00E+00	5.04E-02	0.00E+00	1.25E-01	1.79E-01
	Vanadium	5.01E-04	8.62E-10	3.94E-09	1.16E-05	5.32E-05	0.00E+00	3.87E-02	0.00E+00	3.95E-02	7.88E-02
	Zinc	2.13E-06	9.96E-12	4.56E-11	1.11E-08	5.06E-08	0.00E+00	3.88E-03	0.00E+00	1.87E-03	5.75E-03

Underlined values indicate exceedance of the HQ of 0.2 for a given exposure pathway; **Bolded** values indicate exceedance of the HQ of 1 for all exposure pathways.

n/a = not applicable; HQ = hazard quotient; COPC = constituent of potential concern.

Table 10.1-9: Estimated Non-radiological Risk to Human Receptors – Future Centuries

Human Receptor	COPC	HQ during Future Centuries									
		Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
		Baseline HQ									
Permanent Resident Adult (Whitefish Lake)	Cadmium	4.26E-04	9.44E-06	4.32E-06	2.95E-06	1.35E-06	0.00E+00	8.94E-05	8.78E-03	2.48E-01	2.57E-01
	Chromium	5.09E-06	4.62E-08	2.11E-07	2.73E-08	1.25E-07	0.00E+00	1.96E-05	7.43E-06	2.02E-05	5.27E-05
	Cobalt	1.49E-04	5.55E-07	2.54E-07	1.76E-07	8.04E-08	0.00E+00	1.25E-04	6.29E-03	1.77E-02	2.42E-02
	Copper	2.13E-05	7.15E-08	1.96E-07	3.02E-08	8.31E-08	0.00E+00	7.49E-04	1.03E-02	5.98E-02	7.08E-02
	Molybdenum	5.61E-05	8.58E-08	3.93E-08	8.40E-08	3.85E-08	0.00E+00	3.94E-07	1.85E-03	8.62E-02	8.81E-02
	Selenium	8.34E-05	3.93E-07	1.80E-07	7.61E-07	3.48E-07	0.00E+00	2.94E-02	7.70E-03	2.89E-01	3.26E-01
	Uranium	7.37E-04	1.33E-05	6.10E-05	6.72E-06	3.08E-05	0.00E+00	1.03E-03	4.55E-02	5.86E-02	1.06E-01
	Vanadium	1.02E-03	4.80E-05	2.20E-04	3.72E-05	1.70E-04	0.00E+00	6.81E-03	3.43E-03	1.72E-01	1.83E-01
	Zinc	1.76E-05	1.95E-07	8.92E-07	1.22E-07	5.56E-07	0.00E+00	2.46E-03	1.88E-02	2.34E-01	2.55E-01
		Project Total HQ - Future Centuries									
	Cadmium	4.28E-04	9.44E-06	4.32E-06	2.96E-06	1.36E-06	0.00E+00	8.99E-05	8.78E-03	2.48E-01	2.57E-01
	Chromium	5.16E-06	4.62E-08	2.11E-07	2.76E-08	1.26E-07	0.00E+00	1.98E-05	7.43E-06	2.03E-05	5.32E-05
	Cobalt	1.56E-04	5.56E-07	2.54E-07	1.85E-07	8.47E-08	0.00E+00	1.32E-04	6.30E-03	1.77E-02	2.43E-02
	Copper	2.16E-05	7.16E-08	1.97E-07	3.06E-08	8.42E-08	0.00E+00	7.59E-04	1.03E-02	5.98E-02	7.09E-02
	Molybdenum	6.12E-05	8.58E-08	3.93E-08	9.16E-08	4.19E-08	0.00E+00	4.29E-07	1.85E-03	8.62E-02	8.81E-02
	Selenium	1.11E-04	3.93E-07	1.80E-07	1.01E-06	4.64E-07	0.00E+00	3.82E-02	7.70E-03	2.91E-01	3.37E-01
	Uranium	9.01E-04	1.59E-05	7.27E-05	8.22E-06	3.76E-05	0.00E+00	1.26E-03	6.15E-02	5.88E-02	1.23E-01
	Vanadium	1.03E-03	4.80E-05	2.20E-04	3.76E-05	1.72E-04	0.00E+00	6.87E-03	3.43E-03	1.72E-01	1.83E-01
	Zinc	1.91E-05	1.95E-07	8.93E-07	1.32E-07	6.04E-07	0.00E+00	2.67E-03	1.88E-02	2.34E-01	2.55E-01
		Project Incremental HQ - Future Centuries									
	Cadmium	2.47E-06	1.57E-10	7.19E-11	1.71E-08	7.81E-09	0.00E+00	5.17E-07	2.86E-07	5.25E-06	8.54E-06
	Chromium	6.59E-08	0.00E+00	0.00E+00	3.53E-10	1.62E-09	0.00E+00	2.54E-07	0.00E+00	1.05E-07	4.27E-07
	Cobalt	7.89E-06	5.50E-10	2.52E-10	9.33E-09	4.27E-09	0.00E+00	6.64E-06	1.29E-05	1.80E-05	4.55E-05
	Copper	2.84E-07	4.03E-11	1.11E-10	4.02E-10	1.10E-09	0.00E+00	9.94E-06	1.09E-05	7.76E-06	2.89E-05
	Molybdenum	5.07E-06	0.00E+00	0.00E+00	7.59E-09	3.48E-09	0.00E+00	3.56E-08	0.00E+00	1.66E-06	6.78E-06
	Selenium	2.77E-05	4.12E-12	1.89E-12	2.53E-07	1.16E-07	0.00E+00	8.71E-03	1.69E-07	1.31E-03	1.00E-02
	Uranium	1.64E-04	2.56E-06	1.17E-05	1.50E-06	6.87E-06	0.00E+00	2.30E-04	1.60E-02	1.72E-04	1.66E-02

Human Receptor	COPC	HQ during Future Centuries									
		Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
	Vanadium	9.19E-06	4.00E-09	1.83E-08	3.35E-07	1.54E-06	0.00E+00	6.14E-05	3.08E-07	5.90E-05	1.32E-04
	Zinc	1.52E-06	1.86E-11	8.53E-11	1.05E-08	4.82E-08	0.00E+00	2.13E-04	3.19E-06	9.73E-05	3.15E-04
Permanent Resident One-year-old (Whitefish Lake)		Baseline HQ									
	Cadmium	4.76E-04	6.17E-04	7.39E-06	1.93E-04	2.31E-06	0.00E+00	8.46E-05	1.97E-02	6.29E-01	6.50E-01
	Chromium	5.68E-06	3.02E-06	3.62E-07	1.78E-06	2.13E-07	0.00E+00	1.86E-05	1.72E-05	1.17E-05	5.85E-05
	Cobalt	1.66E-04	3.63E-05	4.35E-07	1.15E-05	1.38E-07	0.00E+00	1.18E-04	1.46E-02	3.78E-02	5.27E-02
	Copper	2.38E-05	4.67E-06	3.36E-07	1.98E-06	1.42E-07	0.00E+00	7.09E-04	2.37E-02	1.01E-01	1.25E-01
	Molybdenum	7.63E-05	6.83E-06	8.18E-08	6.68E-06	8.01E-08	0.00E+00	4.54E-07	5.20E-03	2.73E-01	2.79E-01
	Selenium	9.65E-05	2.66E-05	3.19E-07	5.15E-05	6.17E-07	0.00E+00	2.89E-02	1.87E-02	7.51E-01	7.99E-01
	Uranium	8.23E-04	8.71E-04	1.04E-04	4.39E-04	5.26E-05	0.00E+00	9.75E-04	1.04E-01	1.52E-01	2.59E-01
	Vanadium	1.14E-03	3.13E-03	3.76E-04	2.43E-03	2.92E-04	0.00E+00	6.45E-03	6.21E-03	4.18E-01	4.38E-01
	Zinc	2.28E-05	1.48E-05	1.78E-06	9.24E-06	1.11E-06	0.00E+00	2.71E-03	5.01E-02	5.63E-01	6.16E-01
		Project Total HQ - Future Centuries									
	Cadmium	4.78E-04	6.17E-04	7.39E-06	1.94E-04	2.32E-06	0.00E+00	8.51E-05	1.97E-02	6.29E-01	6.50E-01
	Chromium	5.76E-06	3.02E-06	3.62E-07	1.80E-06	2.16E-07	0.00E+00	1.88E-05	1.72E-05	1.18E-05	5.90E-05
	Cobalt	1.75E-04	3.63E-05	4.35E-07	1.21E-05	1.45E-07	0.00E+00	1.25E-04	1.46E-02	3.78E-02	5.27E-02
	Copper	2.42E-05	4.68E-06	3.36E-07	2.00E-06	1.44E-07	0.00E+00	7.18E-04	2.38E-02	1.01E-01	1.25E-01
	Molybdenum	8.32E-05	6.83E-06	8.18E-08	7.29E-06	8.73E-08	0.00E+00	4.95E-07	5.20E-03	2.73E-01	2.79E-01
	Selenium	1.29E-04	2.66E-05	3.19E-07	6.86E-05	8.22E-07	0.00E+00	3.74E-02	1.87E-02	7.52E-01	8.08E-01
	Uranium	1.01E-03	1.04E-03	1.24E-04	5.37E-04	6.44E-05	0.00E+00	1.19E-03	1.42E-01	1.52E-01	2.98E-01
	Vanadium	1.15E-03	3.13E-03	3.76E-04	2.45E-03	2.94E-04	0.00E+00	6.51E-03	6.21E-03	4.18E-01	4.38E-01
	Zinc	2.48E-05	1.48E-05	1.78E-06	1.00E-05	1.20E-06	0.00E+00	2.94E-03	5.01E-02	5.63E-01	6.17E-01
		Project Incremental HQ - Future Centuries									
	Cadmium	2.75E-06	1.03E-08	1.23E-10	1.12E-06	1.34E-08	0.00E+00	4.90E-07	6.48E-07	3.64E-06	8.67E-06
	Chromium	7.36E-08	0.00E+00	0.00E+00	2.31E-08	2.76E-09	0.00E+00	2.40E-07	0.00E+00	6.99E-08	4.10E-07
	Cobalt	8.81E-06	3.59E-08	4.30E-10	6.10E-07	7.31E-09	0.00E+00	6.29E-06	3.03E-05	1.06E-05	5.67E-05
	Copper	3.17E-07	2.63E-09	1.89E-10	2.62E-08	1.89E-09	0.00E+00	9.42E-06	2.56E-05	4.80E-06	4.02E-05
	Molybdenum	6.90E-06	0.00E+00	0.00E+00	6.04E-07	7.24E-09	0.00E+00	4.10E-08	0.00E+00	1.16E-06	8.71E-06
	Selenium	3.21E-05	2.78E-10	3.33E-12	1.71E-05	2.05E-07	0.00E+00	8.55E-03	4.10E-07	8.92E-04	9.49E-03

Human Receptor	COPC	HQ during Future Centuries									
		Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
	Uranium	1.84E-04	1.67E-04	2.00E-05	9.80E-05	1.17E-05	0.00E+00	2.18E-04	3.77E-02	1.20E-04	3.85E-02
	Vanadium	1.03E-05	2.61E-07	3.13E-08	2.19E-05	2.63E-06	0.00E+00	5.81E-05	7.25E-07	3.29E-05	1.27E-04
	Zinc	1.97E-06	1.42E-09	1.70E-10	8.00E-07	9.58E-08	0.00E+00	2.34E-04	8.70E-06	5.74E-05	3.03E-04
Rec F/H Adult (McGowan Lake)		Baseline HQ									
	Cadmium	4.26E-04	9.44E-06	4.32E-06	2.95E-06	1.35E-06	0.00E+00	8.94E-05	8.78E-03	2.48E-01	2.57E-01
	Chromium	5.09E-06	4.62E-08	2.11E-07	2.73E-08	1.25E-07	0.00E+00	1.96E-05	7.43E-06	2.02E-05	5.27E-05
	Cobalt	1.49E-04	5.55E-07	2.54E-07	1.76E-07	8.04E-08	0.00E+00	1.25E-04	6.29E-03	1.77E-02	2.42E-02
	Copper	2.13E-05	7.15E-08	1.96E-07	3.02E-08	8.31E-08	0.00E+00	7.49E-04	1.03E-02	5.98E-02	7.08E-02
	Molybdenum	5.61E-05	8.58E-08	3.93E-08	8.40E-08	3.85E-08	0.00E+00	3.94E-07	1.85E-03	8.62E-02	8.81E-02
	Selenium	8.34E-05	3.93E-07	1.80E-07	7.61E-07	3.48E-07	0.00E+00	2.94E-02	7.70E-03	2.89E-01	3.26E-01
	Uranium	7.37E-04	1.33E-05	6.10E-05	6.72E-06	3.08E-05	0.00E+00	1.03E-03	4.55E-02	5.86E-02	1.06E-01
	Vanadium	1.02E-03	4.80E-05	2.20E-04	3.72E-05	1.70E-04	0.00E+00	6.81E-03	3.43E-03	1.72E-01	1.83E-01
	Zinc	1.76E-05	1.95E-07	8.92E-07	1.22E-07	5.56E-07	0.00E+00	2.46E-03	1.88E-02	2.34E-01	2.55E-01
		Project Total HQ - Future Centuries									
	Cadmium	4.26E-04	9.44E-06	4.32E-06	2.95E-06	1.35E-06	0.00E+00	8.97E-05	8.78E-03	2.48E-01	2.57E-01
	Chromium	5.10E-06	4.62E-08	2.11E-07	2.73E-08	1.25E-07	0.00E+00	1.98E-05	7.43E-06	2.03E-05	5.30E-05
	Cobalt	1.50E-04	5.55E-07	2.54E-07	1.78E-07	8.13E-08	0.00E+00	1.30E-04	6.29E-03	1.77E-02	2.42E-02
	Copper	2.14E-05	7.15E-08	1.96E-07	3.03E-08	8.33E-08	0.00E+00	7.56E-04	1.03E-02	5.98E-02	7.09E-02
	Molybdenum	5.73E-05	8.58E-08	3.93E-08	8.57E-08	3.92E-08	0.00E+00	4.20E-07	1.85E-03	8.62E-02	8.81E-02
	Selenium	8.89E-05	3.93E-07	1.80E-07	8.11E-07	3.71E-07	0.00E+00	3.53E-02	7.70E-03	2.90E-01	3.33E-01
	Uranium	7.70E-04	1.35E-05	6.19E-05	7.02E-06	3.21E-05	0.00E+00	1.18E-03	4.76E-02	5.87E-02	1.08E-01
	Vanadium	1.02E-03	4.80E-05	2.20E-04	3.73E-05	1.71E-04	0.00E+00	6.84E-03	3.43E-03	1.72E-01	1.83E-01
	Zinc	1.79E-05	1.95E-07	8.92E-07	1.24E-07	5.66E-07	0.00E+00	2.60E-03	1.88E-02	2.34E-01	2.55E-01
		Project Incremental HQ - Future Centuries									
	Cadmium	5.08E-07	1.09E-11	5.00E-12	3.52E-09	1.61E-09	0.00E+00	3.55E-07	3.17E-08	3.80E-06	4.70E-06
	Chromium	1.39E-08	0.00E+00	0.00E+00	7.45E-11	3.41E-10	0.00E+00	1.78E-07	0.00E+00	7.72E-08	2.70E-07
	Cobalt	1.77E-06	3.81E-11	1.75E-11	2.10E-09	9.61E-10	0.00E+00	4.98E-06	1.40E-06	1.68E-05	2.49E-05
	Copper	6.35E-08	2.81E-12	7.72E-12	9.00E-11	2.47E-10	0.00E+00	7.43E-06	1.18E-06	6.22E-06	1.49E-05
	Molybdenum	1.14E-06	0.00E+00	0.00E+00	1.70E-09	7.78E-10	0.00E+00	2.66E-08	0.00E+00	1.53E-06	2.70E-06

Human Receptor	COPC	Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
		HQ during Future Centuries									
	Selenium	5.52E-06	2.84E-13	1.28E-13	5.03E-08	2.30E-08	0.00E+00	5.81E-03	1.82E-08	9.02E-04	6.72E-03
	Uranium	3.28E-05	1.94E-07	8.90E-07	2.99E-07	1.37E-06	0.00E+00	1.53E-04	2.09E-03	7.56E-05	2.36E-03
	Vanadium	1.21E-06	2.80E-10	1.27E-09	4.42E-08	2.02E-07	0.00E+00	2.70E-05	3.35E-08	2.73E-05	5.57E-05
	Zinc	3.13E-07	1.29E-12	5.97E-12	2.17E-09	9.92E-09	0.00E+00	1.46E-04	3.45E-07	6.69E-05	2.14E-04
Rec F/H One-year-old (McGowan Lake)		**Baseline HQ**									
	Cadmium	4.76E-04	6.17E-04	7.39E-06	1.93E-04	2.31E-06	0.00E+00	8.46E-05	1.97E-02	6.29E-01	6.50E-01
	Chromium	5.68E-06	3.02E-06	3.62E-07	1.78E-06	2.13E-07	0.00E+00	1.86E-05	1.72E-05	1.17E-05	5.85E-05
	Cobalt	1.66E-04	3.63E-05	4.35E-07	1.15E-05	1.38E-07	0.00E+00	1.18E-04	1.46E-02	3.78E-02	5.27E-02
	Copper	2.38E-05	4.67E-06	3.36E-07	1.98E-06	1.42E-07	0.00E+00	7.09E-04	2.37E-02	1.01E-01	1.25E-01
	Molybdenum	7.63E-05	6.83E-06	8.18E-08	6.68E-06	8.01E-08	0.00E+00	4.54E-07	5.20E-03	2.73E-01	2.79E-01
	Selenium	9.65E-05	2.66E-05	3.19E-07	5.15E-05	6.17E-07	0.00E+00	2.89E-02	1.87E-02	7.51E-01	7.99E-01
	Uranium	8.23E-04	8.71E-04	1.04E-04	4.39E-04	5.26E-05	0.00E+00	9.75E-04	1.04E-01	1.52E-01	2.59E-01
	Vanadium	1.14E-03	3.13E-03	3.76E-04	2.43E-03	2.92E-04	0.00E+00	6.45E-03	6.21E-03	4.18E-01	4.38E-01
	Zinc	2.28E-05	1.48E-05	1.78E-06	9.24E-06	1.11E-06	0.00E+00	2.71E-03	5.01E-02	5.63E-01	6.16E-01
		Project Total HQ - Future Centuries									
	Cadmium	4.76E-04	6.17E-04	7.39E-06	1.93E-04	2.31E-06	0.00E+00	8.50E-05	1.97E-02	6.29E-01	6.50E-01
	Chromium	5.70E-06	3.02E-06	3.62E-07	1.79E-06	2.14E-07	0.00E+00	1.87E-05	1.72E-05	1.18E-05	5.88E-05
	Cobalt	1.68E-04	3.63E-05	4.35E-07	1.16E-05	1.39E-07	0.00E+00	1.23E-04	1.46E-02	3.78E-02	5.27E-02
	Copper	2.39E-05	4.67E-06	3.36E-07	1.98E-06	1.43E-07	0.00E+00	7.16E-04	2.37E-02	1.01E-01	1.25E-01
	Molybdenum	7.78E-05	6.83E-06	8.18E-08	6.82E-06	8.17E-08	0.00E+00	4.84E-07	5.20E-03	2.73E-01	2.79E-01
	Selenium	1.03E-04	2.66E-05	3.19E-07	5.49E-05	6.58E-07	0.00E+00	3.46E-02	1.87E-02	7.51E-01	8.05E-01
	Uranium	8.59E-04	8.84E-04	1.06E-04	4.59E-04	5.50E-05	0.00E+00	1.12E-03	1.09E-01	1.52E-01	2.64E-01
	Vanadium	1.14E-03	3.13E-03	3.76E-04	2.44E-03	2.92E-04	0.00E+00	6.48E-03	6.21E-03	4.18E-01	4.38E-01
	Zinc	2.32E-05	1.48E-05	1.78E-06	9.40E-06	1.13E-06	0.00E+00	2.87E-03	5.01E-02	5.63E-01	6.16E-01
		Project Incremental HQ - Future Centuries									
	Cadmium	5.67E-07	7.57E-10	8.64E-12	2.30E-07	2.75E-09	0.00E+00	3.37E-07	7.08E-08	2.68E-06	3.89E-06
	Chromium	1.55E-08	0.00E+00	0.00E+00	4.87E-09	5.83E-10	0.00E+00	1.69E-07	0.00E+00	5.12E-08	2.41E-07
	Cobalt	1.98E-06	2.49E-09	2.99E-11	1.37E-07	1.64E-09	0.00E+00	4.72E-06	3.29E-06	9.69E-06	1.98E-05
	Copper	7.09E-08	1.83E-10	1.32E-11	5.88E-09	4.23E-10	0.00E+00	7.03E-06	2.77E-06	3.81E-06	1.37E-05

Human Receptor	COPC	Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
		HQ during Future Centuries									
	Molybdenum	1.54E-06	0.00E+00	0.00E+00	1.35E-07	1.62E-09	0.00E+00	3.06E-08	0.00E+00	1.07E-06	2.78E-06
	Selenium	6.39E-06	1.82E-11	2.27E-13	3.41E-06	4.09E-08	0.00E+00	5.70E-03	4.28E-08	6.10E-04	6.32E-03
	Uranium	3.66E-05	1.27E-05	1.52E-06	1.95E-05	2.34E-06	0.00E+00	1.45E-04	4.91E-03	5.50E-05	5.19E-03
	Vanadium	1.35E-06	1.82E-08	2.18E-09	2.89E-06	3.46E-07	0.00E+00	2.55E-05	7.87E-08	1.52E-05	4.54E-05
	Zinc	4.07E-07	9.91E-11	1.18E-11	1.65E-07	1.97E-08	0.00E+00	1.61E-04	9.42E-07	3.95E-05	2.02E-04
Rec F/H Adult (Russell Lake)		Baseline HQ									
	Cadmium	4.26E-04	9.44E-06	4.32E-06	2.95E-06	1.35E-06	0.00E+00	8.94E-05	8.78E-03	2.48E-01	2.57E-01
	Chromium	5.09E-06	4.62E-08	2.11E-07	2.73E-08	1.25E-07	0.00E+00	1.96E-05	7.43E-06	2.02E-05	5.27E-05
	Cobalt	1.49E-04	5.55E-07	2.54E-07	1.76E-07	8.04E-08	0.00E+00	1.25E-04	6.29E-03	1.77E-02	2.42E-02
	Copper	2.13E-05	7.15E-08	1.96E-07	3.02E-08	8.31E-08	0.00E+00	7.49E-04	1.03E-02	5.98E-02	7.08E-02
	Molybdenum	5.61E-05	8.58E-08	3.93E-08	8.40E-08	3.85E-08	0.00E+00	3.94E-07	1.85E-03	8.62E-02	8.81E-02
	Selenium	8.34E-05	3.93E-07	1.80E-07	7.61E-07	3.48E-07	0.00E+00	2.94E-02	7.70E-03	2.89E-01	3.26E-01
	Uranium	7.37E-04	1.33E-05	6.10E-05	6.72E-06	3.08E-05	0.00E+00	1.03E-03	4.55E-02	5.86E-02	1.06E-01
	Vanadium	1.02E-03	4.80E-05	2.20E-04	3.72E-05	1.70E-04	0.00E+00	6.81E-03	3.43E-03	1.72E-01	1.83E-01
	Zinc	1.76E-05	1.95E-07	8.92E-07	1.22E-07	5.56E-07	0.00E+00	2.46E-03	1.88E-02	2.34E-01	2.55E-01
		Project Total HQ - Future Centuries									
	Cadmium	4.26E-04	9.44E-06	4.32E-06	2.95E-06	1.35E-06	0.00E+00	8.96E-05	8.78E-03	2.48E-01	2.57E-01
	Chromium	5.10E-06	4.62E-08	2.11E-07	2.73E-08	1.25E-07	0.00E+00	1.97E-05	7.43E-06	2.03E-05	5.29E-05
	Cobalt	1.50E-04	5.55E-07	2.54E-07	1.77E-07	8.11E-08	0.00E+00	1.29E-04	6.29E-03	1.77E-02	2.42E-02
	Copper	2.14E-05	7.15E-08	1.96E-07	3.03E-08	8.32E-08	0.00E+00	7.54E-04	1.03E-02	5.98E-02	7.09E-02
	Molybdenum	5.70E-05	8.58E-08	3.93E-08	8.53E-08	3.90E-08	0.00E+00	4.14E-07	1.85E-03	8.62E-02	8.81E-02
	Selenium	8.75E-05	3.93E-07	1.80E-07	7.98E-07	3.65E-07	0.00E+00	3.37E-02	7.70E-03	2.90E-01	3.31E-01
	Uranium	7.61E-04	1.34E-05	6.12E-05	6.94E-06	3.18E-05	0.00E+00	1.14E-03	4.61E-02	5.87E-02	1.07E-01
	Vanadium	1.02E-03	4.80E-05	2.20E-04	3.73E-05	1.71E-04	0.00E+00	6.83E-03	3.43E-03	1.72E-01	1.83E-01
	Zinc	1.78E-05	1.95E-07	8.92E-07	1.23E-07	5.64E-07	0.00E+00	2.57E-03	1.88E-02	2.34E-01	2.55E-01
		Project Incremental HQ - Future Centuries									
	Cadmium	3.77E-07	2.73E-12	9.09E-13	2.61E-09	1.19E-09	0.00E+00	2.64E-07	8.38E-09	2.85E-06	3.50E-06
	Chromium	1.04E-08	0.00E+00	0.00E+00	5.57E-11	2.55E-10	0.00E+00	1.33E-07	0.00E+00	5.85E-08	2.03E-07
	Cobalt	1.35E-06	9.78E-12	4.46E-12	1.60E-09	7.32E-10	0.00E+00	3.80E-06	3.59E-07	1.26E-05	1.81E-05
	Copper	4.84E-08	7.18E-13	1.99E-12	6.85E-11	1.88E-10	0.00E+00	5.66E-06	3.04E-07	4.08E-06	1.01E-05

Human Receptor	COPC	HQ during Future Centuries									
		Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
Rec F/H One-year-old (Russell Lake)	Molybdenum	8.64E-07	0.00E+00	0.00E+00	1.29E-09	5.92E-10	0.00E+00	2.02E-08	0.00E+00	1.17E-06	2.06E-06
	Selenium	4.05E-06	8.53E-14	2.84E-14	3.70E-08	1.69E-08	0.00E+00	4.28E-03	4.66E-09	6.71E-04	4.95E-03
	Uranium	2.41E-05	5.19E-08	2.37E-07	2.20E-07	1.00E-06	0.00E+00	1.12E-04	5.58E-04	5.06E-05	7.46E-04
	Vanadium	7.74E-07	7.28E-11	3.20E-10	2.83E-08	1.29E-07	0.00E+00	1.72E-05	8.61E-09	1.82E-05	3.64E-05
	Zinc	2.32E-07	3.27E-13	1.53E-12	1.61E-09	7.36E-09	0.00E+00	1.08E-04	8.75E-08	5.07E-05	1.59E-04
		Baseline HQ									
	Cadmium	4.76E-04	6.17E-04	7.39E-06	1.93E-04	2.31E-06	0.00E+00	8.46E-05	1.97E-02	6.29E-01	6.50E-01
	Chromium	5.68E-06	3.02E-06	3.62E-07	1.78E-06	2.13E-07	0.00E+00	1.86E-05	1.72E-05	1.17E-05	5.85E-05
	Cobalt	1.66E-04	3.63E-05	4.35E-07	1.15E-05	1.38E-07	0.00E+00	1.18E-04	1.46E-02	3.78E-02	5.27E-02
	Copper	2.38E-05	4.67E-06	3.36E-07	1.98E-06	1.42E-07	0.00E+00	7.09E-04	2.37E-02	1.01E-01	1.25E-01
	Molybdenum	7.63E-05	6.83E-06	8.18E-08	6.68E-06	8.01E-08	0.00E+00	4.54E-07	5.20E-03	2.73E-01	2.79E-01
	Selenium	9.65E-05	2.66E-05	3.19E-07	5.15E-05	6.17E-07	0.00E+00	2.89E-02	1.87E-02	7.51E-01	7.99E-01
	Uranium	8.23E-04	8.71E-04	1.04E-04	4.39E-04	5.26E-05	0.00E+00	9.75E-04	1.04E-01	1.52E-01	2.59E-01
	Vanadium	1.14E-03	3.13E-03	3.76E-04	2.43E-03	2.92E-04	0.00E+00	6.45E-03	6.21E-03	4.18E-01	4.38E-01
	Zinc	2.28E-05	1.48E-05	1.78E-06	9.24E-06	1.11E-06	0.00E+00	2.71E-03	5.01E-02	5.63E-01	6.16E-01
		Project Total HQ - Future Centuries									
	Cadmium	4.76E-04	6.17E-04	7.39E-06	1.93E-04	2.31E-06	0.00E+00	8.49E-05	1.97E-02	6.29E-01	6.50E-01
	Chromium	5.69E-06	3.02E-06	3.62E-07	1.78E-06	2.14E-07	0.00E+00	1.87E-05	1.72E-05	1.18E-05	5.87E-05
	Cobalt	1.67E-04	3.63E-05	4.35E-07	1.16E-05	1.39E-07	0.00E+00	1.22E-04	1.46E-02	3.78E-02	5.27E-02
	Copper	2.39E-05	4.67E-06	3.36E-07	1.98E-06	1.42E-07	0.00E+00	7.14E-04	2.37E-02	1.01E-01	1.25E-01
	Molybdenum	7.75E-05	6.83E-06	8.18E-08	6.79E-06	8.13E-08	0.00E+00	4.77E-07	5.20E-03	2.73E-01	2.79E-01
	Selenium	1.01E-04	2.66E-05	3.19E-07	5.40E-05	6.47E-07	0.00E+00	3.31E-02	1.87E-02	7.51E-01	8.03E-01
	Uranium	8.50E-04	8.74E-04	1.05E-04	4.53E-04	5.43E-05	0.00E+00	1.08E-03	1.05E-01	1.52E-01	2.61E-01
	Vanadium	1.14E-03	3.13E-03	3.76E-04	2.43E-03	2.92E-04	0.00E+00	6.47E-03	6.21E-03	4.18E-01	4.38E-01
	Zinc	2.31E-05	1.48E-05	1.78E-06	9.36E-06	1.12E-06	0.00E+00	2.83E-03	5.01E-02	5.63E-01	6.16E-01
		Project Incremental HQ - Future Centuries									
	Cadmium	4.21E-07	1.75E-10	2.27E-12	1.71E-07	2.04E-09	0.00E+00	2.50E-07	1.86E-08	2.03E-06	2.89E-06
	Chromium	1.16E-08	0.00E+00	0.00E+00	3.64E-09	4.36E-10	0.00E+00	1.26E-07	0.00E+00	3.87E-08	1.81E-07
	Cobalt	1.51E-06	6.37E-10	7.67E-12	1.05E-07	1.25E-09	0.00E+00	3.60E-06	8.43E-07	7.26E-06	1.33E-05
	Copper	5.40E-08	4.68E-11	3.38E-12	4.48E-09	3.22E-10	0.00E+00	5.36E-06	7.13E-07	2.56E-06	8.69E-06

Human Receptor	COPC	HQ during Future Centuries									
		Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
Seasonal Resident Adult (Russell Lake)	Molybdenum	1.18E-06	0.00E+00	0.00E+00	1.03E-07	1.23E-09	0.00E+00	2.33E-08	0.00E+00	8.05E-07	2.11E-06
	Selenium	4.69E-06	3.64E-12	5.68E-14	2.50E-06	3.00E-08	0.00E+00	4.20E-03	1.12E-08	4.52E-04	4.66E-03
	Uranium	2.69E-05	3.39E-06	4.06E-07	1.43E-05	1.72E-06	0.00E+00	1.06E-04	1.31E-03	3.75E-05	1.50E-03
	Vanadium	8.65E-07	4.66E-09	5.53E-10	1.85E-06	2.21E-07	0.00E+00	1.63E-05	2.05E-08	1.01E-05	2.94E-05
	Zinc	3.02E-07	2.55E-11	2.96E-12	1.22E-07	1.47E-08	0.00E+00	1.19E-04	2.38E-07	2.99E-05	1.50E-04
		Baseline HQ									
	Cadmium	4.26E-04	9.44E-06	4.32E-06	2.95E-06	1.35E-06	0.00E+00	8.94E-05	8.78E-03	2.48E-01	2.57E-01
	Chromium	5.09E-06	4.62E-08	2.11E-07	2.73E-08	1.25E-07	0.00E+00	1.96E-05	7.43E-06	2.02E-05	5.27E-05
	Cobalt	1.49E-04	5.55E-07	2.54E-07	1.76E-07	8.04E-08	0.00E+00	1.25E-04	6.29E-03	1.77E-02	2.42E-02
	Copper	2.13E-05	7.15E-08	1.96E-07	3.02E-08	8.31E-08	0.00E+00	7.49E-04	1.03E-02	5.98E-02	7.08E-02
	Molybdenum	5.61E-05	8.58E-08	3.93E-08	8.40E-08	3.85E-08	0.00E+00	3.94E-07	1.85E-03	8.62E-02	8.81E-02
	Selenium	8.34E-05	3.93E-07	1.80E-07	7.61E-07	3.48E-07	0.00E+00	2.94E-02	7.70E-03	2.89E-01	3.26E-01
	Uranium	7.37E-04	1.33E-05	6.10E-05	6.72E-06	3.08E-05	0.00E+00	1.03E-03	4.55E-02	5.86E-02	1.06E-01
	Vanadium	1.02E-03	4.80E-05	2.20E-04	3.72E-05	1.70E-04	0.00E+00	6.81E-03	3.43E-03	1.72E-01	1.83E-01
	Zinc	1.76E-05	1.95E-07	8.92E-07	1.22E-07	5.56E-07	0.00E+00	2.46E-03	1.88E-02	2.34E-01	2.55E-01
		Project Total HQ - Future Centuries									
	Cadmium	4.26E-04	9.44E-06	4.32E-06	2.95E-06	1.35E-06	0.00E+00	8.94E-05	8.78E-03	2.48E-01	2.57E-01
	Chromium	5.10E-06	4.62E-08	2.11E-07	2.73E-08	1.25E-07	0.00E+00	1.96E-05	7.43E-06	2.02E-05	5.28E-05
	Cobalt	1.50E-04	5.55E-07	2.54E-07	1.77E-07	8.11E-08	0.00E+00	1.26E-04	6.29E-03	1.77E-02	2.42E-02
	Copper	2.14E-05	7.15E-08	1.96E-07	3.03E-08	8.32E-08	0.00E+00	7.50E-04	1.03E-02	5.98E-02	7.08E-02
	Molybdenum	5.70E-05	8.58E-08	3.93E-08	8.53E-08	3.90E-08	0.00E+00	4.00E-07	1.85E-03	8.62E-02	8.81E-02
	Selenium	8.75E-05	3.93E-07	1.80E-07	7.98E-07	3.65E-07	0.00E+00	3.07E-02	7.70E-03	2.89E-01	3.28E-01
	Uranium	7.61E-04	1.34E-05	6.12E-05	6.94E-06	3.18E-05	0.00E+00	1.06E-03	4.57E-02	5.87E-02	1.06E-01
	Vanadium	1.02E-03	4.80E-05	2.20E-04	3.73E-05	1.71E-04	0.00E+00	6.82E-03	3.43E-03	1.72E-01	1.83E-01
	Zinc	1.78E-05	1.95E-07	8.92E-07	1.23E-07	5.64E-07	0.00E+00	2.49E-03	1.88E-02	2.34E-01	2.55E-01
		Project Incremental HQ - Future Centuries									
	Cadmium	3.77E-07	2.73E-12	9.09E-13	2.61E-09	1.19E-09	0.00E+00	7.91E-08	2.79E-09	9.09E-07	1.37E-06
	Chromium	1.04E-08	0.00E+00	0.00E+00	5.57E-11	2.55E-10	0.00E+00	4.00E-08	0.00E+00	1.90E-08	6.98E-08
	Cobalt	1.35E-06	9.78E-12	4.46E-12	1.60E-09	7.32E-10	0.00E+00	1.14E-06	1.08E-07	3.73E-06	6.33E-06

Human Receptor	COPC	HQ during Future Centuries									
		Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
	Copper	4.84E-08	7.18E-13	1.99E-12	6.85E-11	1.88E-10	0.00E+00	1.70E-06	9.13E-08	1.23E-06	3.07E-06
	Molybdenum	8.64E-07	0.00E+00	0.00E+00	1.29E-09	5.92E-10	0.00E+00	6.06E-09	0.00E+00	3.50E-07	1.22E-06
	Selenium	4.05E-06	8.53E-14	2.84E-14	3.70E-08	1.69E-08	0.00E+00	1.28E-03	1.40E-09	2.14E-04	1.50E-03
	Uranium	2.41E-05	5.19E-08	2.37E-07	2.20E-07	1.00E-06	0.00E+00	3.36E-05	1.67E-04	1.57E-05	2.42E-04
	Vanadium	7.74E-07	7.28E-11	3.20E-10	2.83E-08	1.29E-07	0.00E+00	5.17E-06	2.56E-09	6.32E-06	1.24E-05
	Zinc	2.32E-07	3.27E-13	1.53E-12	1.61E-09	7.36E-09	0.00E+00	3.25E-05	2.61E-08	1.69E-05	4.97E-05
Seasonal Resident One-year-old (Russell Lake)		Baseline HQ									
	Cadmium	4.76E-04	6.17E-04	7.39E-06	1.93E-04	2.31E-06	0.00E+00	8.46E-05	1.97E-02	6.29E-01	6.50E-01
	Chromium	5.68E-06	3.02E-06	3.62E-07	1.78E-06	2.13E-07	0.00E+00	1.86E-05	1.72E-05	1.17E-05	5.85E-05
	Cobalt	1.66E-04	3.63E-05	4.35E-07	1.15E-05	1.38E-07	0.00E+00	1.18E-04	1.46E-02	3.78E-02	5.27E-02
	Copper	2.38E-05	4.67E-06	3.36E-07	1.98E-06	1.42E-07	0.00E+00	7.09E-04	2.37E-02	1.01E-01	1.25E-01
	Molybdenum	7.63E-05	6.83E-06	8.18E-08	6.68E-06	8.01E-08	0.00E+00	4.54E-07	5.20E-03	2.73E-01	2.79E-01
	Selenium	9.65E-05	2.66E-05	3.19E-07	5.15E-05	6.17E-07	0.00E+00	2.89E-02	1.87E-02	7.51E-01	7.99E-01
	Uranium	8.23E-04	8.71E-04	1.04E-04	4.39E-04	5.26E-05	0.00E+00	9.75E-04	1.04E-01	1.52E-01	2.59E-01
	Vanadium	1.14E-03	3.13E-03	3.76E-04	2.43E-03	2.92E-04	0.00E+00	6.45E-03	6.21E-03	4.18E-01	4.38E-01
	Zinc	2.28E-05	1.48E-05	1.78E-06	9.24E-06	1.11E-06	0.00E+00	2.71E-03	5.01E-02	5.63E-01	6.16E-01
		Project Total HQ - Future Centuries									
	Cadmium	4.76E-04	6.17E-04	7.39E-06	1.93E-04	2.31E-06	0.00E+00	8.47E-05	1.97E-02	6.29E-01	6.50E-01
	Chromium	5.69E-06	3.02E-06	3.62E-07	1.78E-06	2.14E-07	0.00E+00	1.86E-05	1.72E-05	1.18E-05	5.86E-05
	Cobalt	1.67E-04	3.63E-05	4.35E-07	1.16E-05	1.39E-07	0.00E+00	1.19E-04	1.46E-02	3.78E-02	5.27E-02
	Copper	2.39E-05	4.67E-06	3.36E-07	1.98E-06	1.42E-07	0.00E+00	7.11E-04	2.37E-02	1.01E-01	1.25E-01
	Molybdenum	7.75E-05	6.83E-06	8.18E-08	6.79E-06	8.13E-08	0.00E+00	4.61E-07	5.20E-03	2.73E-01	2.79E-01
	Selenium	1.01E-04	2.66E-05	3.19E-07	5.40E-05	6.47E-07	0.00E+00	3.02E-02	1.87E-02	7.51E-01	8.00E-01
	Uranium	8.50E-04	8.74E-04	1.05E-04	4.53E-04	5.43E-05	0.00E+00	1.01E-03	1.05E-01	1.52E-01	2.60E-01
	Vanadium	1.14E-03	3.13E-03	3.76E-04	2.43E-03	2.92E-04	0.00E+00	6.46E-03	6.21E-03	4.18E-01	4.38E-01
	Zinc	2.31E-05	1.48E-05	1.78E-06	9.36E-06	1.12E-06	0.00E+00	2.74E-03	5.01E-02	5.63E-01	6.16E-01
		Project Incremental HQ - Future Centuries									
	Cadmium	4.21E-07	1.75E-10	2.27E-12	1.71E-07	2.04E-09	0.00E+00	7.49E-08	5.59E-09	5.96E-07	1.27E-06
	Chromium	1.16E-08	0.00E+00	0.00E+00	3.64E-09	4.36E-10	0.00E+00	3.79E-08	0.00E+00	1.21E-08	6.57E-08

Human Receptor	COPC	HQ during Future Centuries									
		Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
	Cobalt	1.51E-06	6.37E-10	7.67E-12	1.05E-07	1.25E-09	0.00E+00	1.08E-06	2.52E-07	2.08E-06	5.03E-06
	Copper	5.40E-08	4.68E-11	3.38E-12	4.48E-09	3.22E-10	0.00E+00	1.61E-06	2.14E-07	7.38E-07	2.62E-06
	Molybdenum	1.18E-06	0.00E+00	0.00E+00	1.03E-07	1.23E-09	0.00E+00	6.99E-09	0.00E+00	2.38E-07	1.52E-06
	Selenium	4.69E-06	3.64E-12	5.68E-14	2.50E-06	3.00E-08	0.00E+00	1.26E-03	1.86E-09	1.39E-04	1.41E-03
	Uranium	2.69E-05	3.39E-06	4.06E-07	1.43E-05	1.72E-06	0.00E+00	3.19E-05	3.93E-04	1.10E-05	4.83E-04
	Vanadium	8.65E-07	4.66E-09	5.53E-10	1.85E-06	2.21E-07	0.00E+00	4.90E-06	6.05E-09	3.55E-06	1.14E-05
	Zinc	3.02E-07	2.55E-11	2.96E-12	1.22E-07	1.47E-08	0.00E+00	3.58E-05	7.08E-08	1.04E-05	4.67E-05
Fisher/Trapper Adult (Russell Lake)		Baseline HQ									
	Cadmium	4.26E-04	9.44E-06	4.32E-06	2.95E-06	1.35E-06	0.00E+00	6.15E-04	0.00E+00	2.01E-01	2.02E-01
	Chromium	5.09E-06	4.62E-08	2.11E-07	2.73E-08	1.25E-07	0.00E+00	1.35E-04	0.00E+00	5.51E-04	6.92E-04
	Cobalt	1.49E-04	5.55E-07	2.54E-07	1.76E-07	8.04E-08	0.00E+00	8.61E-04	0.00E+00	7.79E-03	8.80E-03
	Copper	2.13E-05	7.15E-08	1.96E-07	3.02E-08	8.31E-08	0.00E+00	5.15E-03	0.00E+00	2.80E-02	3.32E-02
	Molybdenum	5.61E-05	8.58E-08	3.93E-08	8.40E-08	3.85E-08	0.00E+00	2.71E-06	0.00E+00	4.58E-02	4.59E-02
	Selenium	8.34E-05	3.93E-07	1.80E-07	7.61E-07	3.48E-07	0.00E+00	2.03E-01	0.00E+00	2.77E-01	4.80E-01
	Uranium	7.37E-04	1.33E-05	6.10E-05	6.72E-06	3.08E-05	0.00E+00	7.09E-03	0.00E+00	3.64E-02	4.44E-02
	Vanadium	1.02E-03	4.80E-05	2.20E-04	3.72E-05	1.70E-04	0.00E+00	4.69E-02	0.00E+00	3.68E-01	4.16E-01
	Zinc	1.76E-05	1.95E-07	8.92E-07	1.22E-07	5.56E-07	0.00E+00	1.69E-02	0.00E+00	5.41E-01	5.57E-01
		Project Total HQ - Future Centuries									
	Cadmium	4.26E-04	9.44E-06	4.32E-06	2.95E-06	1.35E-06	0.00E+00	6.17E-04	0.00E+00	2.01E-01	2.02E-01
	Chromium	5.11E-06	4.62E-08	2.11E-07	2.73E-08	1.25E-07	0.00E+00	1.36E-04	0.00E+00	5.51E-04	6.93E-04
	Cobalt	1.51E-04	5.55E-07	2.54E-07	1.78E-07	8.16E-08	0.00E+00	8.87E-04	0.00E+00	7.79E-03	8.83E-03
	Copper	2.14E-05	7.15E-08	1.96E-07	3.04E-08	8.34E-08	0.00E+00	5.19E-03	0.00E+00	2.80E-02	3.32E-02
	Molybdenum	5.76E-05	8.58E-08	3.93E-08	8.62E-08	3.94E-08	0.00E+00	2.85E-06	0.00E+00	4.58E-02	4.59E-02
	Selenium	9.02E-05	3.93E-07	1.80E-07	8.22E-07	3.76E-07	0.00E+00	2.32E-01	0.00E+00	2.79E-01	5.12E-01
	Uranium	7.77E-04	1.34E-05	6.14E-05	7.09E-06	3.24E-05	0.00E+00	7.86E-03	0.00E+00	3.65E-02	4.53E-02
	Vanadium	1.02E-03	4.80E-05	2.20E-04	3.73E-05	1.71E-04	0.00E+00	4.70E-02	0.00E+00	3.68E-01	4.16E-01
	Zinc	1.80E-05	1.95E-07	8.92E-07	1.24E-07	5.69E-07	0.00E+00	1.77E-02	0.00E+00	5.41E-01	5.59E-01
		Project Incremental HQ - Future Centuries									
	Cadmium	6.28E-07	4.55E-12	1.82E-12	4.35E-09	1.99E-09	0.00E+00	1.82E-06	0.00E+00	8.06E-06	1.05E-05

Human Receptor	COPC	HQ during Future Centuries									
		Water (internal)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic Plants	Aquatic Animals	Terrestrial Plants	Terrestrial Animals	Total by COPC
	Chromium	1.73E-08	0.00E+00	0.00E+00	9.28E-11	4.25E-10	0.00E+00	9.19E-07	0.00E+00	2.51E-07	1.19E-06
	Cobalt	2.26E-06	1.63E-11	7.45E-12	2.67E-09	1.22E-09	0.00E+00	2.61E-05	0.00E+00	2.61E-06	3.10E-05
	Copper	8.06E-08	1.20E-12	3.31E-12	1.14E-10	3.14E-10	0.00E+00	3.89E-05	0.00E+00	2.52E-06	4.15E-05
	Molybdenum	1.44E-06	0.00E+00	0.00E+00	2.16E-09	9.87E-10	0.00E+00	1.39E-07	0.00E+00	6.59E-07	2.24E-06
	Selenium	6.76E-06	1.14E-13	5.68E-14	6.16E-08	2.82E-08	0.00E+00	2.94E-02	0.00E+00	2.30E-03	3.17E-02
	Uranium	4.01E-05	8.65E-08	3.96E-07	3.66E-07	1.67E-06	0.00E+00	7.72E-04	0.00E+00	9.41E-05	9.09E-04
	Vanadium	1.29E-06	1.20E-10	5.38E-10	4.71E-08	2.16E-07	0.00E+00	1.19E-04	0.00E+00	1.50E-04	2.70E-04
	Zinc	3.87E-07	5.40E-13	2.56E-12	2.68E-09	1.23E-08	0.00E+00	7.46E-04	0.00E+00	3.13E-04	1.06E-03

Underlined values indicate exceedance of the HQ of 0.2 for a given exposure pathway; **Bolded** values indicate exceedance of the HQ of 1 for all exposure pathways.

n/a = not applicable; HQ = hazard quotient; COPC = constituent of potential concern.

Carcinogens

The cancer risk (ILCR) was not predicted to exceed the negligible cancer risk level of 1 in 100,000 for the camp worker, recreational fisher/hunter, and seasonal resident at any locations during the Project phases, as shown in Table 10.1-10. The recreational fisher/hunter and seasonal resident were assessed as composite receptors throughout all life stages. The arsenic ILCR is essentially equal to the negligible cancer risk level of 1 in 100,000 for the adult fisher/trapper at Russell Lake during the Project phases. In the future centuries, a permanent resident was assessed instead of a camp worker – the cancer risk was not predicted to exceed the negligible cancer risk level for any of the receptors assessed in the future centuries (Table 10.1-10). Health Canada (2021) considers a risk level of 1 in 100,000 to be negligible compared to background cancer risk level in North America of approximately 5 in 10.

The main ingestion exposure pathway for arsenic for all human receptors was consumption of local terrestrial animals including muskrat (*Ondatra zibethicus*), Canada Goose (*Branta canadensis*), Mallard (*Anas platyrhynchos*), moose (*Alces americanus*), moose organs, and Woodland caribou (*Rangifer tarandus caribou*), as well as locally caught fish represented in the HHRA by northern pike and white sucker.

The main contribution to the arsenic cancer risk for the fisher/trapper at Russell Lake is from ingestion of caribou. The predicted tissue concentration of arsenic in caribou in the Russell Lake area was 0.07 mg/kg fw, compared to a measured average value in barren-ground caribou (*Rangifer tarandus groenlandicus*) of 0.02 mg/kg fw or maximum of 0.04 mg/kg fw from the Eastern Athabasca Regional Monitoring Program from 2011 to 2017 (CanNorth 2018).

The diet assumptions for the fisher/trapper are conservative and are based on engagement with a local fisher/trapper. The diet of the fisher/trapper is representative of one person, who consumes a unique composition and quantity of traditional foods (e.g., ingestion rate of 175 kg/yr of caribou). Most people fishing, hunting, and trapping in the LSA and RSA would consume traditional foods more consistent with the average traditional foods consumer diet which was developed from the ERFN country foods study (CanNorth 2017); see the discussion on non-carcinogenic risk for more details on ingestion rates.

The potential for arsenic to represent health risks for consumers of traditional foods was assessed for the Eastern Athabasca Region by CanNorth (2018). The Eastern Athabasca Region HHRA used a high consumer of traditional foods with a caribou ingestion rate of approximately 132 kg/yr (from the Hatchet Lake Dietary Survey [CanNorth 2000]) and concluded that arsenic did not pose a significant risk to high consumers of traditional foods.

Table 10.1-10: Estimated Incremental Lifetime Cancer Risk from Arsenic to Human Receptors

Receptor	Project Phases Cancer Risk (per 100,000)	Future Centuries Cancer Risk (per 100,000)
Camp Worker	0.1	N/A
Recreational Fisher/Hunter (LA-1)	0.4	0.1
Recreational Fisher/Hunter (Russell Lake)	0.3	0.04
Seasonal Resident (Russell Lake)	0.1	0.01
Fisher/Trapper (Russell Lake)	1.2	0.2
Permanent Resident	N/A	0.1

Radiation Dose and Radon

The incremental radiation dose to all human receptors in the Project Area, LSA, or RSA during all phases of the Project was predicted to be below the dose limit of 1 mSv/yr and the dose constraint of 0.3 mSv/yr (Table 10.1-11). Therefore, it is unlikely that there would be significant adverse effects on human receptors as a result of radionuclide releases from the Project.

The predicted highest dose during the Project phases is to the fisher/trapper at Russell Lake (0.06 mSv/yr for the adult, as shown in Table 10.1-11). The main contributor to total dose would be from Po-210 due to ingestion of fish from Russell Lake (inlet) and ingestion of animals (mallard and woodland caribou) harvested in the area around Russell Lake who eat from the aquatic environment. The mallard consumes benthic invertebrates and aquatic plants (macrophytes). The woodland caribou consumes aquatic plants (macrophytes) as the aquatic component of its diet.

During the future centuries, the predicted highest dose would be 0.04 mSv/yr to the permanent resident (one-year old) at Whitefish Lake, as shown in Table 10.1-12.

Overall, since the radiation dose estimates were below the dose limit, no discernable health effects would be anticipated due to exposure of these receptors to radioactive releases from the Project. The presence and concentrations of radionuclides in the receiving environment would be monitored and the associated radiation dose estimates would be periodically reassessed in accordance with the processes outlined in the Environmental Management System.

The maximum incremental radon dose to the camp worker was estimated to be 0.13 mSv/yr during Operation. The assessment is conservative in that it assumes that the camp worker spends 100% of the time indoors. Radon outdoors is expected to dissipate quickly and exposure is negligible. The total incremental dose to the camp worker from all radionuclides in the U-238 decay chain including radon would be 0.16 mSv/year (Table 10.1-13), which is below the dose limit for a non-NEW of 1 mSv/yr.

Table 10.1-11: Summary of Estimated Total Radiation Dose to Human Receptors – Project Phases

Human Receptor	Location	Maximum Total Incremental Dose (mSv/yr)	% of Dose Limit	% of Dose Constraint
Camp Worker (Adult)	Whitefish Lake	0.03	3%	8%
Recreational Fisher/Hunter (Adult)	McGowan Lake	0.04	4%	12%
Recreational Fisher/Hunter (One-year-old)	McGowan Lake	0.05	5%	16%
Recreational Fisher/Hunter (Adult)	Russell Lake	0.02	2%	8%
Recreational Fisher/Hunter (One-year-old)	Russell Lake	0.03	3%	10%
Seasonal Resident (Adult)	Russell Lake	0.01	1%	4%
Seasonal Resident (One-year-old)	Russell Lake	0.02	2%	6%
Fisher/Trapper (Adult)	Russell Lake	0.06	6%	19%

Note: The public dose limit and dose limit for a non-NEW is 1 mSv/yr and the dose constraint is 0.3 mSv/yr.

Table 10.1-12: Summary of Estimated Total Radiation Dose to Human Receptors – Future Centuries

Human Receptor	Location	Maximum Total Incremental Dose (mSv/yr)	% of Dose Limit	% of Dose Constraint
Permanent Resident (Adult)	Whitefish Lake	0.03	3%	9%
Permanent Resident (One-year-old)	Whitefish Lake	0.04	4%	12%
Recreational Fisher/Hunter (Adult)	McGowan Lake	0.01	1%	3%
Recreational Fisher/Hunter (One-year-old)	McGowan Lake	0.01	1%	5%
Recreational Fisher/Hunter (Adult)	Russell Lake	0.01	1%	2%
Recreational Fisher/Hunter (One-year-old)	Russell Lake	0.01	1%	3%
Seasonal Resident (Adult)	Russell Lake	0.002	0%	1%
Seasonal Resident (One-year-old)	Russell Lake	0.003	0%	1%
Fisher/Trapper (Adult)	Russell Lake	0.01	1%	4%

Note: The public dose limit is 1 mSv/yr and the dose constraint is 0.3 mSv/yr. The camp worker is not assessed in the future centuries.

Table 10.1-13: Total Radiation Dose to Camp Worker from all Radionuclides including Radon Progeny – Project Phases

Human Receptor	Location	Maximum Total Incremental Dose - U-238 decay chain (mSv/yr)	Maximum Radon Dose (mSv/yr)	Maximum Total Dose (mSv/yr)	% of Dose Limit for non-NEW
Camp Worker (Adult)	Whitefish Lake	0.03	0.13	0.16	16%

10.1.6.2 Residual Effects Characterization

General definitions of the residual effects characteristics are provided in Table 5.8-1 in Section 5. Residual effects characteristics specific to the Human Health VC are defined in Table 10.1-14. The results of the HHRA are further interpreted in terms of the residual effects characteristics identified in Table 10.1-14.

Based on the results of the HHRA, the predicted radiation dose to all human receptors are all below the regulatory public dose limit of 1 mSv/yr and the dose constraint of 0.3 mSv/yr, indicating that no residual effect is anticipated to Human Health from exposure to radionuclides from the Project during all Project phases and in the future centuries.

The cancer risk for arsenic was not predicted to exceed the negligible cancer risk level of 1 in 100,000 for the camp worker, recreational fisher/hunter, and seasonal resident, and was essentially equal to the negligible cancer risk level of 1 in 100,000 for the adult fisher/trapper at Russell Lake during the Project phases. During the future centuries the cancer risk was not predicted to exceed the negligible cancer risk level of 1 in 100,000 for all human receptors including the permanent resident Therefore, no residual effect is anticipated to Human Health from exposure to arsenic from the Project.

For non-carcinogens, the results of the HHRA predicted that there are no exceedances of the HQ benchmark (HQ<0.2) for human receptors for non-carcinogens (cadmium, copper, chromium, cobalt, molybdenum, uranium, vanadium, and zinc) during all phases of the Project, with the exception of selenium for the fisher/trapper at Russell Lake, where the incremental Project HQ for the fisher/trapper from fish ingestion (northern pike and white sucker) was predicted to be 0.81. Many people fishing, hunting, and trapping in the Project Area would consume traditional foods more consistent with the average traditional foods consumer diet which was developed from the ERFN country foods study (CanNorth 2017). Denison recognizes that the ERFN considers the fisher/trapper's use of the area as representative of current and future land users and expects that the relationship to the Project Area will be continued and strengthened through generations of future use.

Based on the results, there is potential for a residual effect to Human Health from exposure to selenium from the Project, and the characterization of this potential residual effect is provided in Table 10.1-15. During the future centuries there are no predicted exceedances of the HQ benchmark (HQ<0.2) for human receptors including the permanent resident for all non-carcinogens.

During Post-Decommissioning, the Project area could be accessed intermittently by members of the public for various land use purposes. Any risks to these members of the public would be less than those assessed for the camp work and therefore the Project area would be safe for periodic land use after year 38.

Table 10.1-14: Human Health – Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Negative effect or effect is not desirable. **Positive** – Beneficial effect or effect is desirable.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Low** – Minimal amount of change relative to baseline. **Moderate** – HQ is greater than 0.2 per exposure pathway, cancer risk level is greater than $1x10^{-05}$, radiation dose is greater than regulatory public dose limit of 1 mSv/yr.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the VC LSA. **Regional** – Effect extends beyond the VC LSA into the VC RSA. **Beyond Regional** – Effect extends beyond VC RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions **Partially Reversible** – A residual effect that partially diminishes to baseline conditions **Irreversible** – A residual effect that will not diminish to baseline conditions
Context	The extent to which the VC or KI has been affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its ability to recover from that effect (i.e., resilience)	**Low** – VC/KI has high resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or a lack of historic and ongoing anthropogenic or natural disturbance. **Moderate** – VC/KI has moderate resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or ecosystem, and/or an intermediate level of historic or ongoing anthropogenic or natural disturbance with the capacity to assimilate more change. **High** – VC/KI has weak resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the species or

Residual Effect Characteristic	Definition	Rating
		ecosystem, and/or a high level of historic or ongoing anthropogenic or natural disturbance.
Likelihood	Likelihood that the residual effect will occur including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability that the residual effect will occur. **Unlikely** – A low probability that the residual effect will occur.

Table 10.1-15: Human Health – Summary of the Characteristics Ratings for Residual Effect 1 (Exposure of the Fisher/Trapper to Selenium)

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project, particularly, the release of treated effluent into Whitefish Lake will have a negative effect on Human Health due to exposure to selenium from ingestion of fish.
Magnitude	Moderate	The magnitude of the residual effects is “moderate”. The Project incremental HQ (with baseline removed) is higher than 0.2 for the fisher/trapper for selenium due to ingestion of fish. All other COPCs have Project incremental HQs below 0.2 per pathway for all human receptors.
Geographic Extent	Regional	The geographic extent is regional since the fisher/trapper is located at Russell Lake.
Duration	Medium-term	Effects are expected to last during the time that treated effluent is released to Whitefish Lake. No effluent will be released during Construction and Post-Decommissioning.
Frequency	Continuous	Treated effluent discharge has been considered as continuous over the Operation and Decommissioning phases of the Project.
Reversibility	Reversible	The exposure of the fisher/trapper to selenium at levels that will result in an HQ greater than 0.2 will only occur during the Operation and Decommissioning phases of the Project. Exposure will be reduced during Post-Decommissioning and beyond.
Context	Low	Humans have a high resiliency to stress or ecological change.
Likelihood	Likely	There is a moderate to high probability that this residual effect will occur; however, the likelihood may be overestimated due to conservatism in the assessment.

10.1.6.3 Significance and Confidence

Based on the residual effects characterization, the residual effect on the Human Health VC is predicted to be not significant. The only aspect that required a residual effects characterization was exposure of the fisher/trapper to selenium through fish ingestion; however, the conservatism in the traditional foods diet would indicate that the overall risk from the Project is low.

The annual fish consumption based on engagement with a local fisher/trapper was assumed to be 183 kg/yr (approximately 1 to 2 servings per day), which is conservative compared to an annual fish consumption of 27 kg/yr (2 servings per week) from the English River First Nation's Country Food Study (CanNorth 2017) and 88 kg/yr (approximately 1 serving per day) for the high consumer for the Boreal Shield in the First Nations Food, Nutrition and Environment Study for Saskatchewan (Chan et al. 2018).

In this EIS, a precautionary approach to the evaluation of potential effects was adopted, recognizing areas of uncertainty and using conservative assumptions and approaches within the assessment process, where appropriate. Areas of uncertainty in the process and in predictions are identified for Human Health. Some of the uncertainties include model uncertainty and uncertainty in the exposure factors selected. Where possible, site-specific and regional information was incorporated into the IMPACT model, and where information was lacking, conservative assumptions were made. Baseline concentrations of COPCs in water, sediment, soil, plants, and fish were compared against model predicted concentrations to confirm good agreement between measured and modelled concentrations. Effluent flowrate is another area of uncertainty. The expected effluent flow rate of 36.5 m^3/hr was used as the EA modelling case; however, the upper bound flow rate of 81 m^3/hr was assessed in a sensitivity analysis in the ERA (Appendix 10-A) to determine the change in surface water and sediment concentrations of COPCs at the upper bound flow rate.

The uncertainties in the toxicity assessment include conservatisms built into the toxicity reference values and radiation dose limits, and the use of a dose constraint below the dose limit. Taken together, the approaches to exposure and toxicity assessments have been undertaken in a manner that should not underestimate dose or risk to Human Health.

The assumptions to address uncertainties in the HHRA are anticipated to produce conservative exposure and risk estimates for human receptors. The risk that the HHRA underestimated potential exposure of human health receptors to COPCs from the Project is low.

10.1.7 Cumulative Effects

The cumulative effects assessment considers whether residual adverse effects of the Project on Human Health VC will overlap spatially and/or temporally with the same kind of residual adverse effects on the VC resulting from other past, present, and reasonably foreseeable projects or activities.

The existing, as well as reasonably foreseeable projects within the Wheeler River system that have been considered for potential to interact with the Human Health VC, include the following existing mines and mills: Cameco Cigar Lake Mine, Cameco Key Lake Operation, and Cameco McArthur River Operation.

Potential pathways for cumulative effects are related to air emissions and waterborne effluent. The effects of potential air emissions from the Project are expected to be localized and unlikely to overlap with the existing or predicted emissions from existing and reasonably foreseeable projects.

Therefore, the cumulative effects on air quality and its effect on the Human Health VC are not discussed further.

The Project is situated 35 km southwest of the McArthur River Operation and approximately 85 kilometres southwest of the Cigar Lake operation. The McArthur River Operation discharges into the Read Creek drainage system, which is not connected to the Wheeler River. The Cigar Lake mine is located within the MacKenzie River basin. These projects do not spatially overlap with the LSA or RSA for the Project's Human Health VC and are not further considered under cumulative effects.

The Project is situated approximately 35 km (straight distance) northeast of the Key Lake Operation. Treated water from the Key Lake mill is discharged into the David Creek drainage system, which discharges into the Wheeler River and into Russell Lake in the Wheeler River. However, Russell Lake is considered to be downstream of all influences from the Key Lake Operation and the Key Lake Extension Project. Based on the assessment of effects on human health in the Key Lake Extension Project EIS, the spatial extent of effects on human health are localized and do not extend downstream to Wheeler River and Russell Lake during any phase of the Key Lake Extension Project (Cameco 2013).

Local resource users at Russell Lake could be influenced potentially by cumulative effects from the, the Key Lake Extension Project, and this Project. Local resource users consume traditional foods including fish and wildlife. However, fish and wildlife at Russell Lake are not anticipated to have any substantial exposures related to the Key Lake operation, including the Key Lake Extension Project. Potential residual effects from releases of treated mine water from the Key Lake Operation (including the Key Lake Extension Project) are expected to be spatially limited in proximity to the mine site and are not expected to extend to the Wheeler River.

Overall, no cumulative effects are expected for human receptors consuming traditional foods at Russell Lake; therefore, no cumulative effects on the Human Health VC are anticipated.

10.1.7.1 Climate Change Considerations

Climate change was evaluated qualitatively for the Human Health VC. As discussed in Section 8.1.3.3 in the EIS, a number of parameters influence the water balance for the Project including: mean annual temperature, surface wind speed, total precipitation and snow depth. The mean annual temperature and surface wind speed affect evaporation and the total precipitation and snow depth affect local runoff. In a scenario of increased precipitation and decreased or constant evaporation, climate change would result in potentially greater flow in the Wheeler River drainage system (see Section 8.1.7.6 in the EIS). An increase in available water through additional precipitation and runoff would result in more water available for dilution. The results of the HHRA would be similar or improved under this climate change scenario compared to the EA case. Overall, the cumulative effects on Human Health from climate change would be minimal.

10.1.8 Monitoring and Follow-up

The ERA (Appendix 10-A), which includes the HHRA, was developed based on best available information for the Project, including baseline monitoring data, assumptions on source-terms, and traditional foods diet (intake rates and food types).

Monitoring should focus on collecting data to verify ERA model predictions, as well as provide data to improve model predictions as the Project begins. Recommended monitoring would support Denison's environmental protection framework with the goal of reducing uncertainty over time through an iterative process:

Air quality: With the exception of uranium, there were no predicted exceedances of annual screening values for any COPCs, indicating that unacceptable chronic effects from direct exposure to air are not expected. Uranium exceeded its annual screening value at the on-site ecological receptor location, but not at the camp. Some short-term exceedances, based on maximum predicted concentrations, were predicted to occur at the camp and at the fence line for nitrogen dioxide (1 hour) and particulate matter (24 hour), and for uranium in TSP and PM_{10}. The predicted exceedances would be infrequent, short-term, and limited spatially. Any public visits to these locations would be very infrequent. Unacceptable levels of risk are not expected from infrequent, short-term exposures to these COPCs in air. However, it is recommended that these COPCs be monitored in accordance with provincial and federal guidelines and standards (i.e., CAAQS) as part of any air emissions monitoring plan. Additionally, for NO_2, monthly collection of passive samplers will be performed.

Environmental monitoring: Denison is implementing an environmental monitoring program consistent with requirements and guidance in CSA N288.4-19: *Environmental monitoring programs at nuclear facilities and uranium mines and mills* (CSA 2019). Monitoring would focus on providing data to verify the predictions made by the ERA, to refine the models used in the ERA, and to reduce the uncertainty in the predictions made by the ERA. The environmental monitoring program should include collection of surface water, sediment, and soil samples as well as fish tissue samples, benthic invertebrate tissue samples, and country foods such as blueberries. Monitoring locations would be focused on Whitefish Lake, McGowan Lake and Russell Lake. Monitoring COPCs would include those identified as COPCs in the ERA, including metals and uranium-238 series radionuclides, and chloride and sulphate in lake waters. Monitoring could extend to include other COPCs for other purposes, such as meeting regulatory requirements for monitoring, or addressing COPCs of public interest based on experience at other uranium mines and process plants.

10.1.9 Human Health Summary

The Human Health VC was evaluated using an ERA (Appendix 10-A), which included an HHRA and an EcoRA.

The selection of human receptors for evaluation of the Human Health VC was informed by IK and LK, information from baseline studies, as well as professional judgement. The assumptions made for the traditional foods diet (i.e., amounts consumed and food types) was informed by an existing ERFN country foods study and through engagement with a local fisher/trapper. Denison recognizes that the ERFN considers the fisher/trapper's use of the area as representative of current and future land users and expects that the relationship to the Project Area will be continued and strengthened through generations of future use.

The HHRA focused on COPCs that exceeded screening values in air and water based on predicted atmospheric releases and aqueous releases (treated effluent) from the Project. The final list of COPCs included: arsenic, cadmium, chromium, cobalt, copper, molybdenum, selenium, uranium, vanadium, zinc, sulphate, chloride, and TDS. However, chloride and sulphate were not considered further in the HHRA since they were not identified as associated with human health risks. Additionally, TDS was assessed through the Surface Water Quality VC (see Section 8.2). Radionuclides of the uranium-238 series, including radon, were included as COPCs because these COPCs are of public interest.

The HHRA estimated dose and risk during all Project phases to the following receptors: camp worker, seasonal resident, recreational fisher/hunter, fisher/trapper. In the future centuries a hypothetical permanent resident was assessed at the former mine site instead of a camp worker.

For assessment of non-carcinogens, risk was estimated based on Project total HQs (includes the Project risk in addition to the baseline risk) and Project incremental HQs (includes the Project risk only with baseline component removed). Project incremental HQs were compared to a benchmark HQ value of 0.2 because total background exposures (e.g., store-bought foods) were not included in the incremental HQ. This approach is consistent with Health Canada's guidance on human health preliminary quantitative risk assessment (Health Canada 2021).

The Project incremental HQ was predicted to remain below 0.2 for human receptors for all non-carcinogens and all pathways during all phases of the Project, with the exception of selenium for fisher/trapper at Russell Lake from the fish ingestion pathway. The traditional foods diet for the fisher/trapper is conservative as it assumes a high annual fish consumption rate of 183 kg/yr (approximately 1 to 2 servings per day) and assumes that all fish consumed in the diet is obtained from Russell Lake, whereas it is likely that someone would fish from many different lakes including those outside of the RSA. The diet of the fisher/trapper is representative of one person, who consumes a unique composition and quantity of traditional foods. Most people fishing, hunting, and trapping in the LSA and RSA would consume traditional foods more consistent with the average traditional foods consumer diet which was developed from the ERFN country foods study (CanNorth 2017). During the future centuries there are no precited exceedances of the HQ benchmark (HQ<0.2) for human receptors including the permanent resident for all non-carcinogens.

For the assessment of carcinogens (arsenic), the ILCR was estimated and compared against the cancer risk level of 1 in 100,000 recommended by Health Canada (2021). The ILCR was predicted to remain below the negligible cancer risk level of 1 in 100,000 for the camp worker, recreational fisher/hunter, and seasonal resident during the Project phases. The ILCR was predicted to be essentially equal to the negligible cancer risk level of 1 in 100,000 for the adult fisher/trapper at Russell Lake. These findings for the fisher/trapper are based on the conservative assumption of high consumption of traditional foods including fish and caribou in the LSA and RSA. As indicated above, the diet of the fisher/trapper is representative of one person, who consumes a unique composition and quantity of traditional foods. During the future centuries the cancer risk was not predicted to exceed the negligible cancer risk level of 1 in 100,000 for all human receptors including the permanent resident.

The incremental radiation dose to all human receptors during all Project phases is predicted to be below the regulatory public dose limit of 1 mSv/yr and the dose constraint of 0.3 mSv/yr during all Project phases and in the future centuries. The maximum incremental radiological dose is predicted to be 0.06 mSv/yr to the fisher/trapper at Russell Lake. The maximum incremental dose to the camp worker from all radionuclides in the U-238 decay chain including radon would be 0.16 mSv/year, which is below the dose limit for a non-NEW of 1 mSv/yr.

Overall, since the radiation dose estimates would be below the public dose limit, no discernable health effects are anticipated due to exposure of these receptors to radioactive releases from the Project.

Overall, based on the residual effects characterization and determination of significance, the results of the HHRA suggest that residual effects to the Human Health VC are not significant.

Future environmental monitoring would focus on providing data to improve model predictions through the phases of the Project, as well as verify model predictions. Environmental monitoring would follow requirements and guidance in CSA N288.4-19 (CSA 2019) as well as engagement with local communities.

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10.2 Worker Health and Safety

This subsection addresses potential effects from the Project on the Worker Health and Safety VC. This section comprises the following steps as part of the assessment:

- scope of the assessment;
- summary of existing conditions relevant to the VC;
- identification and description of potential interactions between the Project and the VC;
- identification and description of mitigation measures applicable to the VC to eliminate, reduce, or control the potential adverse Project-related effects);
- identification and characterization of predicted Project residual effects (i.e., after mitigation), including characterization of significance and assignment of the level of confidence in the predictions; and
- identification and characterization of potential cumulative effects.

Figure 10.2-1 is a graphic representation of the assessment process used in this EIS.

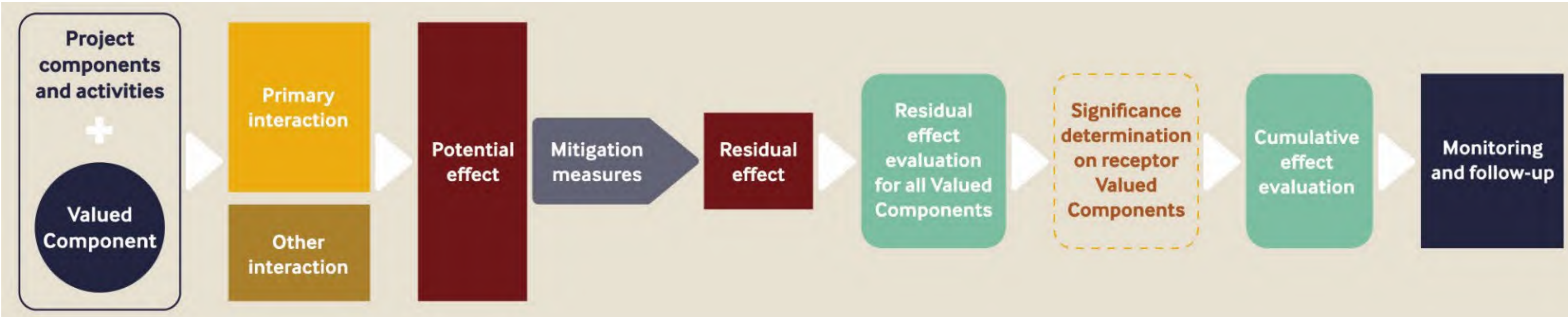


Figure 10.2-1: Environmental Assessment Process for the Wheeler River Project

10.2.1 Scope of the Assessment

10.2.1.1 Valued Component Selection

Valued components refer to environmental features that may be affected by a project and that have been identified to be of concern by the proponent, government agencies, Indigenous Peoples, the scientific community, or the public (CEAA 2018).

Worker Health and Safety has been selected as a VC because there is the potential that workers may be directly or indirectly exposed to radiation. The ISR operations are briefly described below:

- The ISR operations involve a wellfield, where uranium is dissolved from the ore body in a circulating lixiviant (mining solution) solution, and the ISR plant, where uranium is precipitated out of solution to make the yellowcake product. The fresh yellowcake will be dried and potentially calcined, and then packaged for transport.
- Prior to uranium precipitation, unwanted constituents, particularly iron (Fe) and radium (Ra), will be removed from solution by precipitation. The resulting precipitate will be stored at a precipitate pond. As it contains enough uranium to be considered an asset, it is expected to be sent off site for processing at an eligible licensed facility.
- Other stored waste includes drill cuttings from the wellfield. Drill cuttings from the ore body will be segregated and stored at a special waste pad. The intent is to take this ore material to a conventional uranium mill for processing, during operations and/or at the end of mining.

Workers engaged in the operation of the Project will be occupationally exposed to radiation sources in several work areas in the process of drilling, lixiviant (mining solution) recovery, and processing to yellowcake. Expected exposure pathways are through inhalation of dust and radon, as well as external exposure to gamma radiation from process solids and liquids containing radionuclides of the U-238 decay chain.

In uranium mining, the main sources of radiation dose include:

- external gamma radiation, received while in proximity to radioactive sources;
- long-lived radioactive dust (U-238, U-234, Th-230, Ra-226, Pb-210, Po-210); and
- radon (Rn-222) and short-lived progeny (polonium-218 [Po-218], lead-214 [Pb-214], bismuth-214 [Bi-214], polonium-214 [Po-214]).

Workers will also be subject to conventional workplace hazards. These will be managed through a conventional health and safety plan, in compliance with applicable federal and provincial legislation, and are not addressed in detail within this assessment.

Figure 10.2-2 is a graphic representation of the main linkages among the Worker Health and Safety VC and other VCs, illustrating the flow of assessment information from the Worker Health and Safety VC.

Figure 10.2-2: Integrated Assessment Approach - Key Connections between Worker Health and Safety and Other Valued Components

10.2.1.2 Key Indicators and Measurable Parameters

Key indicators and MPs were outlined in Section 5.3, which described the approach and methodology of the EIS. The KIs and MPs relevant for Worker Health and Safety are show in Table 10.2-1 below.

Table 10.2-1: Key Indicators and Measurable Parameters for Worker Health and Safety

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Worker Health	Project activities and by-products could affect the health and safety of Project employees and contractors	Change in the risk of exposure to COPCs. Radiological exposure values.

10.2.1.3 Spatial and Temporal Boundaries

The spatial boundaries for Worker Health and Safety are defined by the boundary of the Project Area. Workers are expected to remain within the boundary of the Project Area during the relevant phases of the Project.

The Project Area is the area within which the Project and all components/activities are located (i.e., the Project footprint; the area of maximum physical disturbance). This area is not VC-specific, but is consistent throughout the EA for all VCs.

The temporal boundaries for Worker Health and Safety are defined as the timeframe that the Project is likely to interact with and potentially affect the VC, which are:

- Construction;
- Operation; and
- Decommissioning.

The Project development schedule is shown in Table 10.2-2. Post-Decommissioning is not considered applicable to Worker Health and Safety as workers are not likely to be present during Post-Decommissioning.

Table 10.2-2: Phases of the Project

Phase and Year	Description of Activities	
Construction Year 1 to 3	• Development of access roads and air strip • Site preparation and earthworks; clearing, leveling and grading of the project area • Power generation – generators • Installation of main substation and distribution of power around site • Wellfield and freeze hole drilling; ground freezing • Batch plant operation (concrete); crusher at borrow area • Development of surface infrastructure (camp, operations centre, plants, ponds, pads and support facilities)	• Waste management (composting, domestic and industrial landfill operation, recycling) • Water management (including treatment and site run-off) • Groundwater supply • Surface water withdrawal • Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel) • On-site and off-site operation of vehicles and transport of materials • Air transportation for workers • Regulatory site inspections • Engagement - site visit from Interested Parties
Operation Year 3 to 18	• Operation of the ISR wellfield • Wellfield and freeze wall drilling • Operation and expansion of freeze wall • Batch plant operation (grout and cement); crusher at borrow area • Expansion of pond and pads • Operation of the processing plant and production of uranium concentrate • Water withdrawal from groundwater or surface water body • Management of surface water (including seepage and site run-off) • Water treatment, both domestic and industrial	• Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates • On-site and off-site operation of vehicles and transport of materials • Power supply – primarily power from the grid, also generators and back-up generators • Package and transport of nuclear substances • Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel) • Air transportation for workers • Progressive decommissioning and reclamation

Phase and Year	Description of Activities	
	• Water release to surface water body • Waste management (composting, domestic and industrial landfill operation, recycling) • Hazardous waste management (temporary storage, handling, and off-site transportation)	• Regulatory site inspections • Engagement - site visit from Interested Parties
Decommissioning Year 18 to 23	• Site water management, treatment and release • Mining horizon remediation and thawing of freeze wall • Process water treatment and release • Closure of ISR and freeze wells and related infrastructure • Decontamination of surface facilities and injection, recovery and monitoring wells • Asset removal (including site power transmission lines and electrical infrastructure) • Demolition and disposal of non-salvageable surface infrastructure and materials • Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	• Power generation – generators • Waste management (composting and landfill operation) • Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal) • On-site and off-site operation of vehicles and transport of materials • Reclamation of disturbed areas • Regulatory site inspections • Engagement - site visit from Interested Parties
Post-Decommissioning Year 23 to 38	• Environmental monitoring • Regulatory site inspections	• Engagement - site visit from Interested Parties

10.2.2 Existing Environment

The existing environment that is relevant for worker health is the environment that workers are exposed to prior to the start of the project. Prior to the project, workers involved in baseline and feasibility studies are expected to be exposed to levels of radiation similar to background levels. Incremental (i.e., above background) radiation doses to workers will not exceed the public dose limit of 1 millisievert per year (mSv/yr), an amount that is less than typical background doses.

Background radiation and radioactivity is present in the environment due to natural and anthropogenic (i.e., human-caused) sources. The four primary sources of natural radiation are cosmic radiation, terrestrial radiation, and intake of naturally occurring radionuclides through inhalation and ingestion (CNSC 2020). Exposure to natural radiation can occur both indoors and outdoors.

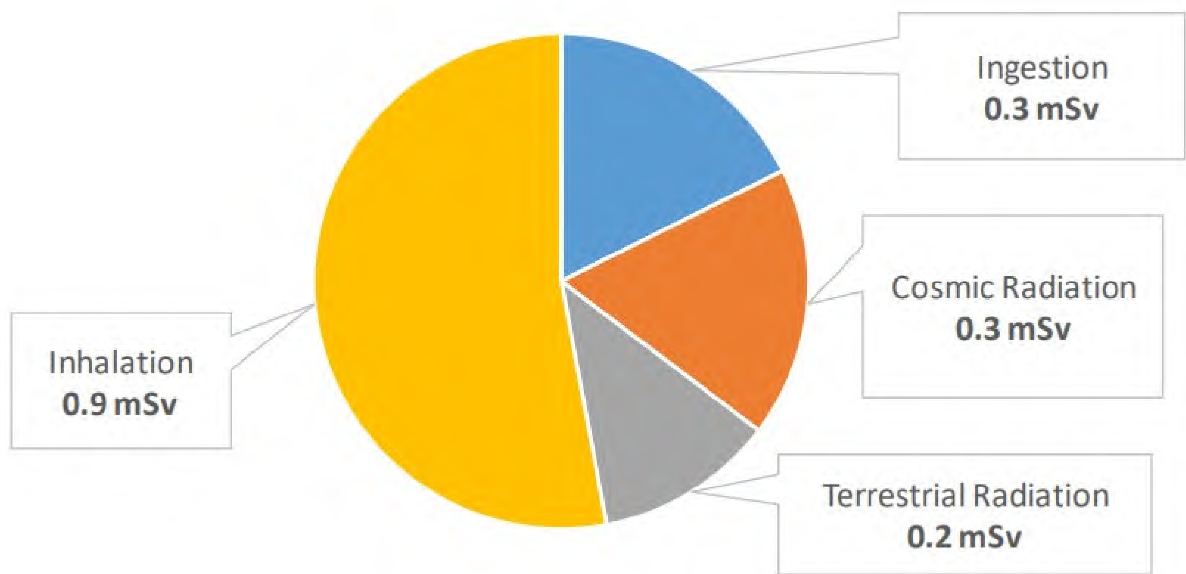
Cosmic radiation originates from the sun and celestial events. Some of the ionizing radiation can penetrate through the Earth’s atmosphere and result in an external radiation dose at the Earth’s surface. Terrestrial radiation results from the natural composition of the Earth's crust such as deposits of uranium, potassium, and thorium present in soils, rocks, and building materials, which can release small amounts of ionizing radiation during the natural decay process, resulting in an external radiation dose (CNSC 2020).

Naturally occurring radionuclides are also incorporated into plants, animals, and water from surrounding soils and rocks. Ingesting these foodstuffs and water results in an internal radiation dose due to exposure to natural radiation.

Radioactive gases can be produced from radioactive minerals found in soil and bedrock. Radon gas, a product of the decay of uranium in soil, typically disperses rapidly once it reaches the atmosphere; however, it can also accumulate inside buildings and when inhaled contributes to an internal radiation dose. Indoor radon levels in Canada average 45 Bq/m^3 (Health Canada 2014).

The annual effective dose from natural background radiation is approximately 1.8 mSv (Figure 10.2-3) in Canada and 2.4 mSv worldwide (CNSC 2020). The effective dose represents the amount of energy absorbed by tissue from ionizing radiation.

No known anthropogenic sources of radiation or radioactivity exist in the LSA and RSA.



Source: CNSC 2020

Figure 10.2-3: Breakdown of Doses from Natural Background Radiation

10.2.3 Assessment of Project Related Effects

10.2.3.1 Potential Interactions Between the Project and Valued Component/Key Indicators

Each of the potential interactions between the Project and Worker Health and Safety (KI: Worker Health) are shown in Table 10.2-3.

Potential interactions in the summary table are ranked as:

- **Primary Interaction** (✓): Project activity is expected to interact with the VC/KI which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- **Other Interaction** (✓): Project activity is expected to interact with the VC/KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- **No Interaction:** Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

Additionally, the activities listed in the table with a check and an asterisk (*) are those for which exposure to non-radionuclides will be mitigated through a worker health and safety plan. The Project activities for which radionuclide exposure may be possible are given a check without an asterisk, and are assessed further in the EIS.

Table 10.2-3: Potential Project Interactions for Worker Health and Safety

Project Phase/Activity	Worker Health and Safety
	Key Indicator: Worker Health
Construction Activities	
Development of access roads and air strip	✓*
Site preparation and earthworks; Clearing, level and grading of the project site, laydown area	✓*
Power generation – generators	
Installation of main substation and distribution of power around site	
Wellfield and freeze hole drilling; ground freezing	✓
Batch plant operation (concrete); crusher at borrow area	✓*
Development of surface infrastructure (camp, operations centre, plants, ponds, pads, and support facilities)	
Waste management (composting, domestic and industrial landfill operation, recycling)	
Water management (including treatment and site runoff)	✓*
Groundwater supply	
Surface water withdrawal	✓*
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	

Project Phase/Activity	Worker Health and Safety
	Key Indicator: Worker Health
On-site and off-site operation of vehicles and transport of materials	✓*
Air transportation for workers	✓*
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Operation Activities	
Operation of the ISR wellfield	✓
Wellfield and freeze wall drilling	✓
Operation and expansion of freeze wall	
Batch plant operation (grout and cement); crusher in borrow area	✓*
Expansion of pond and pads	
Operation of the processing plant and production of uranium concentrate	✓
Water withdrawal from groundwater or surface water body	✓*
Management of surface water (including seepage and site runoff)	
Water treatment, both domestic and industrial	
Water release to surface water body	✓*
Waste management (composting, domestic and industrial landfill operation, recycling)	✓*
Hazardous waste management (temporary storage, handling, and off-site transportation)	✓*
Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates	✓
On-site and off-site operation of vehicles and transport of materials	✓*
Power supply – primarily power from the grid, also generators and back-up generators	
Package and transport of nuclear substances	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	
Air transportation for workers	✓*
Progressive decommissioning and reclamation	
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Decommissioning Activities	
Site water management, treatment, and release	✓
Mining horizon remediation and thawing of freeze wall	✓
Process water treatment and release	
Closure of ISR and freeze wells and related infrastructure	

Project Phase/Activity	Worker Health and Safety
	Key Indicator: Worker Health
Asset removal (including site power transmission lines and electrical infrastructure)	✓*
Demolition and disposal of non-salvageable surface infrastructure and materials	
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	✓
Generators	
Waste management (incineration and landfill operation)	
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)	
On-site and off-site operation of vehicles and transportation of materials	✓*
Reclamation disturbed areas	✓*
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Post-Decommissioning Activities	
Environmental monitoring	
Regulatory site inspections	
Engagement - Site visit from interested parties	

10.2.3.2 Potential Project Related Effects

The Radiation Protection Regulations (Government of Canada 2021) under the *Nuclear Safety and Control Act* (NSCA) outline the regulatory requirements with respect to control of radiation doses to both workers and members of the public. Workers subject to radiation exposure from the Project will be designated as NEWs and as such their radiation doses will be monitored and controlled so as not to exceed radiation dose limits for workers. These dose limits were used to assess the potential project-related effects on worker health. These dose limits are:

- 50 mSv/yr annual effective dose in any year;
- 100 mSv as a 5-year effective dose (implies 20 mSv/yr average annual effective dose);
- 50 mSv/yr equivalent dose to lens of eye; and
- 500 mSv/yr equivalent dose to skin.

For any NEW who is pregnant, the effective dose limit is lowered to 4 mSv/yr for the duration of the pregnancy, after the licensee has been informed, and doses must be managed accordingly.

The Radiation Protection Regulations (Government of Canada 2021) require monitoring and control of radon exposure, as well as total effective dose and equivalent dose. While radon concentration limits are not specified in the regulation, other workplace standards may be considered relevant.

Health Canada (2014) guidelines call for a Radiation Protection Plan if annual average radon in the workplace exceeds 800 Bq/m^3 and specify that the annual average should not exceed 3,000 Bq/m^3.

Potential radiation doses to workers as a result of operation activities were estimated in the Worker Dose Assessment (Ecometrix 2022a in Appendix 10-C), for comparison to relevant dose limits, and results are summarized in the appropriate subsections below. Denison is preparing a Radiation Protection Program (RPP) which will include workplace monitoring and mitigation measures designed to ensure that worker doses are kept as low as reasonably achievable (ALARA). Mitigation measures are summarized in Section 10.2.4.

Based on the Project interactions with Worker Health and Safety, the potential project-related effect anticipated is worker exposure to radionuclides during Construction, Operation, and Decommissioning of the Project. Activities that will result in potential radiation exposure to workers are described in the following subsections.

10.2.3.2.1 Construction Activities: Wellfield and Freeze Hole Drilling; Ground Freezing

Drillers on the wellfield will be exposed to radiation from ore cuttings stored in drums at the well head. Drillers will be exposed to low levels of radon in outdoor air due to venting at the wellfield. Total effective doses to drillers on the wellfield during Construction will be bounded by those estimated for drillers during Operation (10.26 mSv/yr, see below).

10.2.3.2.2 Operation Activities: Operation of the In Situ Recovery Wellfield

Wellfield operators/workers will be exposed to radiation from uranium bearing solution (UBS) in pipes and at the pumphouse and at the UBS storage pond. Wellfield operators will be exposed to low levels of radon in outdoor air due to venting at the wellfield, from piping and from the UBS pond. Wellfield operators will be exposed to low levels of uranium dust in air from the ISR stack. Wellfield operators were estimated to have total effective doses ranging from 0.16 to 0.64 mSv/yr, which are below the annual effective dose limit of 20 mSv/yr. Therefore, potential residual effects to worker health are not expected from this Project activity.

10.2.3.2.3 Operation Activities: Wellfield and Freeze Wall Drilling

Drillers on the wellfield will be exposed to radiation from ore cuttings stored in drums at the well head. Drillers (as described for wellfield operators) will be exposed to low levels of radon in outdoor air due to venting at the wellfield, from piping, and from the UBS pond. Drillers will be exposed to low levels of uranium dust in air from the ISR stack.

Drillers on the wellfield were estimated to have a total effective dose of 10.26 mSv/yr, which is below the annual effective dose limit of 20 mSv/yr. Therefore, potential residual effects to worker health are not expected from this Project activity.

10.2.3.2.4 Operation Activities: Operation of the Processing Plant and Production of Uranium Concentrate

The ISR processing plant consists of several areas that each have multiple sources for occupational radiation exposure, as follows:

- Plant operators/workers in the precipitate removal area will be exposed to radiation from the UBS feed tank and the precipitate thickener. Additionally, it is expected that up to three totes of filter cake will be intermittently stored in this area before it is taken to the precipitate pond. Plant operators/workers in the precipitate removal will be exposed to radon arising from different sources—the open solution in the thickener and the filter cake. Radon levels were estimated at up to 762 Bq/m^3.
- During the yellowcake precipitation, plant operators/workers in this area will be exposed to radiation from the precipitation tank and the yellowcake thickener. Additionally, there will be yellowcake in the conveyor that transports yellowcake to the drying area. Plant operators/workers in the yellowcake precipitation area will be exposed to radon arising from the open solution in the thickener. Radon levels were estimated at 496 Bq/m^3.
- The water treatment process involves three clarifiers which will be sources of radiation exposure for plant operators/workers in the water treatment area. Precipitated solids from first stage treatment will be conveyed to the precipitate pond; second stage solids will be conveyed to the gypsum pond. Plant operators/workers in the water treatment area will be exposed to radon arising from the open solution in the clarifiers, estimated at 128 Bq/m^3.
- In the drying area plant operators/maintenance workers will be exposed to radiation from yellowcake in the drier and in the possible calciner. In addition, they will be potentially exposed to uranium dust in the air from the dried yellowcake product. Activity levels in respirable dust were estimated at 3.9 Bq/m^3.Plant operators at the precipitate removal area, yellowcake precipitation, water treatment, and drying area were estimated to have total effective doses ranging from 1.66 to 14.88 mSv/yr, which are below the annual effective dose limit of 20 mSv/yr. Therefore, potential residual effects to worker health are not expected from these Project activities.

10.2.3.2.5 Operation Activities: Storage and Disposal of Drill Waste Rock, Process Precipitates, and Industrial Wastewater Treatment

The core shack will hold up to three cores that will constitute a source of radiation exposure for geologists and geotech loggers working in this area. In addition, the cores will be a source of both radioactive dust and radon to the air in the core shack, resulting in exposures to the workers in this area. Radon in the core shack was estimated at up to 1,180 Bq/m^3.

Geologists and geotech loggers were estimated to have a total effective dose of 10.97 mSv/yr, which is below the annual effective dose limit of 20 mSv/yr. Therefore, potential residual effects to worker health are not expected from this Project activity.

Several waste pads and ponds on site are considered as sources of radiation exposure for the equipment operator tending these facilities and the industrial landfill. The radiation sources include the special waste pad for drill cuttings from the ore zone, and the precipitate pond. The equipment operator in these areas will also be exposed to radon in outdoor air from various sources, including the wellfield and the precipitate, and to low levels of uranium dust in air from the ISR stack.

The equipment operator at the special waste pad, the precipitate pond, and industrial landfill was estimated to have a total effective dose of 6.11 mSv/yr, which is below the annual effective dose limit of 20 mSv/yr. Therefore, potential residual effects to worker health are not expected from this Project activity.

There is presently no plan for permanent disposal of radioactive waste on site because both special waste and precipitate have valuable uranium content and are expected to be sent off site for processing at an eligible licensed facility.

10.2.3.2.6 Operation Activities: Package and Transport of Nuclear Substances

In the packaging area of the ISR, plant operators/workers will be exposed to radiation from drums of yellowcake product in the loading bay. In addition, they will be potentially exposed to radioactive dust in the air from the dried yellowcake product. Activity levels in respirable dust were estimated at 3.9 Bq/m^3.

Plant operators involved in packaging of nuclear substances were estimated to have a total effective dose of 11.78 mSv/yr, which is below the annual effective dose limit of 20 mSv/yr. Therefore, potential residual effects to worker health are not expected from this Project activity.

Transportation of uranium concentrate off site (40 drums in a truck trailer) is expected to be associated with doses that are well within the public dose limit of 1 mSv/yr, since the external dose to a worker in the drum packaging area (assuming 350 drums) was estimated at 0.01 mSv/yr.

10.2.3.2.7 Decommissioning Activities: Site Water Management, Treatment, and Release

Site water will be managed to limit waste contact, and water treatment systems will remain available for treatment of any contact water during decommissioning.

Levels of radioactive contamination in site water during Decommissioning are expected to be no greater than during Operation, so Decommissioning activities can be readily managed such that worker doses remain below the 20 mSv/yr limit. Work planning will be in accordance with the RPP. With proper work planning, potential residual effects to worker health are not expected from this Project activity.

10.2.3.2.8 Decommissioning Activities: Mining Horizon Remediation and Thawing of Freeze Wall

Remediation of the mining area is expected to involve less exposure to radioactive material than the original drilling of wells into the ore zone, since no ore cuttings are created at this time, and since uranium bearing solution is not being extracted. The freeze wall wells were not extended into the ore zone and should have no radioactive contamination. As such, worker exposures in the wellfield during Decommissioning will be much lower than those during Operation, and worker doses at this time will be easily kept below the 20 mSv/yr limit. Therefore, potential residual effects to worker health are not expected from this Project activity.

10.2.3.2.9 Decommissioning Activities: Remediation of Contaminated Areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)

The wellfield, waste pads, ponds, water treatment location, and process plant area are all expected to be contaminated by nuclear substances; therefore, workers remediating these areas will be potentially exposed to radiation and to radioactive dust. Direct contact with radionuclides is also possible through direct handling of contaminated materials.

Levels of radioactive contamination in these areas during Decommissioning are expected to be no greater than during Operation, so Decommissioning activities can be readily managed such that worker doses remain below the 20 mSv/yr limit. Work planning will be in accordance with the RPP, using personal protective equipment (PPE) as appropriate. Care will be taken when handling special waste for transport off site, since these ore cuttings will have higher radioactivity than other waste materials. With proper work planning, and use of PPE as needed, potential residual effects to worker health are not expected from this Project activity.

10.2.3.2.10 Summary of Assessment

As discussed above, potential residual effects to worker health during Construction and Operation are expected to be negligible given that the predicted radiation doses are less than the annual allowable effective dose of 20 mSv/yr, and radon is predicted to be within the range that is manageable under an RPP. In-design measures, and use of PPE as needed, will be in place during these phases of the Project, in accordance with the RPP. During Decommissioning, in-design measures are no longer in place; however, the RPP will continue to be in place through Decommissioning to make sure that radiation exposures remain below the annual allowable effective dose of 20 mSv/yr.

Conventional workplace hazards will be managed through a conventional health and safety plan, in compliance with applicable federal and provincial legislation, through all phases of the Project. As such, conventional workplace hazards are expected to be negligible.

10.2.4 Mitigation Measures

Several mitigations have been assumed and will be important in keeping doses ALARA:

- For external radiation exposure the most important sources are ore cuttings in drums on the wellfield and totes of filter cake in the precipitate removal area. Doses from external sources can be most effectively reduced by maximizing distances or minimizing time at close distance. In the first case of the drums on the wellfield, increasing the distance to the drum is a readily available option. For exposure to totes of filter cake in the ISR plant it was assumed that three totes will be in the area simultaneously at all times. The external dose from this source could be reduced by managing the quantity of filter cake in the work area, as well as worker proximity.
- External doses from ore cuttings at the special waste pad were assumed to be mitigated by a berm around the pad, which provides shielding. However, this area is a potentially substantial source of external dose, and work inside the berm will be minimized.
- For the drying and packaging/loading areas of the ISR plant, the equipment sources of dust will be enclosed under negative pressure. Workers will be in the room outside the enclosure, where air exchange is maintained at 6 exchanges per hour. Doses from inhalation of uranium dust will be controlled by monitoring of dust levels and managing worker time in these areas to keep doses ALARA.
- Dust inhalation is also a potentially substantial component of worker dose at the core shack. At this location, dust levels will be monitored and time in the shack will be managed to control dose from inhalation of ore dust. An administrative level of respirable dust equal to one-quarter of the ACGIH TLV of 270 microgram per cubic metre ($\mu g/m^3$) has been assumed. It may be possible to increase air exchange in the core shack, above the planned six exchanges per hour, should this be necessary. This would also reduce radon exposure in the core shack.
- Radon levels will be monitored in the precipitate removal and yellowcake precipitation areas of the ISR plant, and in the core shack, to support management of radon exposure and dose.

In general, it will be necessary to manage work sequence and schedule to avoid prolonged exposures to the identified sources, especially those identified as being important to worker dose. Doses can be most effectively reduced by reducing exposure times and maximizing distances from the source, as well as by use of protective shielding.

Furthermore, worker health is managed under the RPP, which is a worker health and safety plan specifically for radiation exposures. The RPP designates the roles and responsibilities of Denison and contractors, specifies the radiation dose limits, action levels and administrative levels, describes procedures to monitor and manage worker exposures (dust and radon monitoring, personal dose monitoring), and describes the processes for training and record-keeping. The successful implementation of the RPP, in conjunction with in-design measures described for the various project activities, is key to maintaining acceptably low doses of radiation exposure to workers during all phases of the Project.

10.2.5 Residual Effects Evaluation

10.2.5.1 Residual Effects Characterization

The residual effects evaluation describes the likely residual effects of the Project on Worker Health and Safety. Residual effects are those that remain after implementation of all mitigation measures and management plans and are the expected consequences of the Project on the Worker Health and Safety VC and the Worker Health KI.

A residual effects characterization is not required for the Worker Health and Safety VC and the associated Worker Health KI because in-design mitigation measures and the RPP are expected to effectively mitigate potential radiation exposures to acceptable levels throughout all phases of the Project.

10.2.5.2 Significance and Confidence

Because no residual effects characterization for Worker Health and Safety was required, assessment of significance and confidence is not applicable.

10.2.6 Cumulative Effects

The cumulative effects assessment considers whether residual adverse effects of the Project on the Worker Health and Safety VC will overlap spatially and/or temporally with the same kind of residual adverse effects on the VC resulting from other past, present, and reasonably foreseeable projects or activities. No residual adverse effects were identified to Worker Health and Safety; therefore, no cumulative effects are anticipated.

Additionally, the spatial boundaries of the Worker Health and Safety VC are limited to the Project Area. Considering the limited footprint of the Project Area, no existing or reasonably foreseeable projects were identified to overlap with the Project for the assessment of cumulative effects on Worker Health and Safety.

10.2.7 Monitoring and Follow-up

Monitoring of radiation exposure to workers throughout all phases of the Project is a key component of the RPP. In accordance with the RPP:

Workers who have a reasonable likelihood of exceeding an effective dose of 1 mSv/yr are classified as NEWs, and are subject to personal dose monitoring, reporting and information requirements under the *Radiation Protection Regulations* (Government of Canada 2021). Licensees are required to use a dosimetry service that is licensed by the CNSC (LDS) to measure and monitor the doses of radiation received by and committed to NEWs who have a reasonable probability of receiving one or both of:

- an effective dose greater than 5 mSv in a one-year dosimetry period; and
- an equivalent dose to the skin, or to the skin of the hands and feet, that is greater than 50 mSv in a one-year dosimetry period.

All workers are required to wear personal dosimeters, measured at regular intervals (three months). Dosimetry monitoring will document worker exposures to radiation and will demonstrate compliance with dose limits. Personal dosimeters are measuring external gamma exposure; however, personal alpha dosimetry may be implemented in areas where exposure to uranium and decay products is increased (ISR plant). A bioassay program may be implemented to monitor internal exposure of workers that will have a higher exposure to uranium and its progeny.

In addition to personal dose monitoring, area monitoring for gamma radiation, radon and/or radioactive dust in air will be performed in work areas where higher exposures are expected. This will provide information for estimating doses in these areas to facilitate safe work planning. Action levels and administrative levels for exposure will be defined, and monitoring data will be compared to these levels, to make sure that corrective action can be taken as needed to maintain worker doses ALARA.

10.2.8 Worker Health and Safety Summary

Worker Health and Safety was selected as a VC because there is the potential that workers may be directly or indirectly exposed to radiation during the Construction, Operation, and Decommissioning phases of the Project. The KI is Worker Health. Worker Health and Safety was assessed within the Project Area because worker exposures will occur only within the boundary of the Project Area during the different Project phases.

The Radiation Protection Regulations (Government of Canada 2021) under the NSCA outline the regulatory requirements with respect to control of radiation doses to both workers and members of the public. Workers exposures and doses will be monitored and controlled so the doses do not exceed radiation dose limits, and are kept ALARA. Potential radiation doses to workers as a result of Project activities were estimated in the Worker Dose Assessment (Ecometrix 2023 in Appendix 10-C). Plans for monitoring of personal doses and area exposure levels, and use of action levels to apply corrective actions as needed, are outlined in an RPP.

Potential effects to worker health during Construction and Operation are expected to be negligible given that the predicted radiation doses are less than the annual allowable effective dose of 20 mSv/yr, and radon is predicted to be within the range that is manageable under a RPP. In-design measures, and use of PPE as needed, will be in place during these phases of the Project, in accordance with the RPP. During the Decommissioning phase, in-design measures may no longer be in place; however, the RPP will continue to be in place through Decommissioning to make sure that radiation exposures remain below the annual allowable effective dose of 20 mSv/yr.

Conventional workplace hazards will be managed through a conventional health and safety plan, in compliance with applicable federal and provincial legislation, through all phases of the Project. As such, conventional workplace hazards are expected to be negligible.

No residual effects were identified for Worker Health and Safety, because in-design mitigation measures and the RPP are expected to effectively mitigate potential radiation exposures to acceptable levels throughout all phases of the Project. Worker doses will be kept ALARA.

10.2.9 References

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Appendix 10-A Environmental Risk Assessment

See file “S10_App 10-A - Environmental Risk Assessment_Wheeler River.pdf”

Appendix 10-B Engagement Database Summary – Human Health

See file “S10_App 10-B Human Health Engagement_Wheeler River.pdf”

Appendix 10-C Worker Dose Assessment

See file “S10_App 10-C Worker Dose Assessment_Wheeler River.pdf”

Denison Mines

Wheeler River Project

Final Environmental Impact Statement

November 2024

Powering
PEOPLE, PARTNERSHIPS AND PASSION.

Wheeler River Project

Final Environmental Impact Statement

Section 11 – Land and Resource Use

November 2024

Denison Mines

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Roadmap

This roadmap of the Wheeler River Project Environmental Impact Statement (EIS) has been provided to summarize the main document sections and appendices of the EIS.

Wheeler River Project Environmental Impact Statement

Executive Summary

Part I: Introduction and Context

- Section 1: Project Introduction and Overview
- Section 2: Project Description
- Section 3: Indigenous and Local Knowledge
- Section 4: Engagement
- Section 5: Approach and Methodology of the Assessment

Part II: Biophysical Environmental Assessments

- Section 6: Atmospheric and Acoustic Environment
- Section 7: Geology and Groundwater
- Section 8: Aquatic Environment
- Section 9: Terrestrial Environment

Part III: Human Environment Assessments

- Section 10: Human Health
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Abbreviations, Acronyms, and Units

Abbreviation / Acronym	Definition
ATV	All-terrain vehicle
BMP	Best management practice
CEA	Cumulative effects assessment
COI	Communities of Interest
COPC	Constituent of potential concern
Denison	Denison Mines Corp.
EA	Environmental Assessment
EIS	Environmental Impact Statement
ERA	Ecological risk assessment
ERFN	English River First Nation
FCA	Fur Conservation Areas
FFMC	Fresh Water Fish Marketing Corporation
GBMU	Game Bird Management Units
HBC	Hudson’s Bay Company
HCB	Heritage Conservation Branch
HDPE	High-density polyethylene
HQ	Hazard quotient
HRMP	Heritage Resource Management Plan
IK	Indigenous Knowledge
ILRU	Indigenous Land and Resource Use
ISR	in situ recovery
KI	Key Indicator
KML	Kineepik Métis Local #9
KPI	Key Person Interview
LK	Local Knowledge
LSA	Local Study Area
MN-S	Métis Nation-Saskatchewan
MOHI	Ministry of Highways and Infrastructure
MP	Measurable Parameter
NR1	Northern Region 1
NR3	Northern Region 3
OLRU	Other Land and Resource Use
PM	Particulate matter

Abbreviation / Acronym	Definition
Project	Wheeler River Project
RSA	Regional Study Area
SK MOE	Saskatchewan Ministry of the Environment
TK	Traditional Knowledge
TLU	Traditional land use
TRV	Toxicity reference value
TSA	Timber Supply Area
TSP	Total suspended particulate
VC	Valued Component
WMZ	Wildlife Management Zones
YNLR	Ya'thi Néné Lands and Resources Office

Units	Definition
ha	hectare
km	kilometre
km^2	square kilometre
m	metre
m^2	square metre

Glossary

Term	Definition
Constituents of potential concern	Contaminant that could be released to the environment as a result of a project and that may change one or more of the environmental components (atmospheric, aquatic, terrestrial).
Indigenous Community of Interest	A community whose traditional land or potential or established Aboriginal and/ or Treaty rights are in proximity to the Project or has existing transportation infrastructure that would be used by the Project. An Indigenous Community of Interest is more likely to experience impacts from the Project.
Indigenous community	An Indigenous community with a potential interest in the Project, including any Indigenous community identified by a Regulatory Agency as having a potential interest in the Project.
Indigenous Knowledge	Indigenous Knowledge is also known as Aboriginal Traditional Knowledge and Traditional Ecological Knowledge. Generally, Aboriginal Traditional Knowledge is considered as a body of knowledge built up by a group of people through generations of living in close contact with nature. Aboriginal Traditional Knowledge is cumulative and dynamic. It builds upon the historic experiences of a people and adapts to social, economic, environmental, spiritual and political change.
Indigenous people	Section 35 of the *Constitution Act, 1867* defines the term “Aboriginal peoples of Canada” as referring to the First Nation, Inuit and Métis peoples of Canada. The term “Indigenous” is used interchangeably with “Aboriginal”.
Key indicator	An important component or aspect of the Valued Component that is expected to be affected (changed) as a result of the Project.
Local Knowledge	Specialized knowledge developed through long-term association, interaction, and cumulative experience.
Measurable parameter	A parameter or metric associated with the Key Indicator that can be used to detect and measure Project-related changes.
Toxicity reference values	Toxicity reference value is a toxicological value associating specific health effects with a level of exposure to a chemical. Toxicity reference values are used in the risk characterization to determine Incremental Lifetime Cancer Risks for carcinogens and Hazard Quotients for non-carcinogens.
Valued Components	Valued Components are aspects of the biophysical and human environments that may be affected (adversely or positively) by the Project. The value of a component not only relates to its role in the environment, but also the value people place on it.

11 Land and Resource Use

Section 11 of the Environmental Impact Statement (EIS) for the Wheeler River Project (the Project) is focused on Land and Resource Use. Resource use is comprised of subsistence, commercial and recreational use of resources derived from the natural environment. The integrated biophysical and human environment assessment approach is illustrated in Figure 11-1. As a guide for EIS reviewers, Figure 11-2 provides a preview of the Valued Components (VCs) associated with the assessments completed in this section of the EIS.

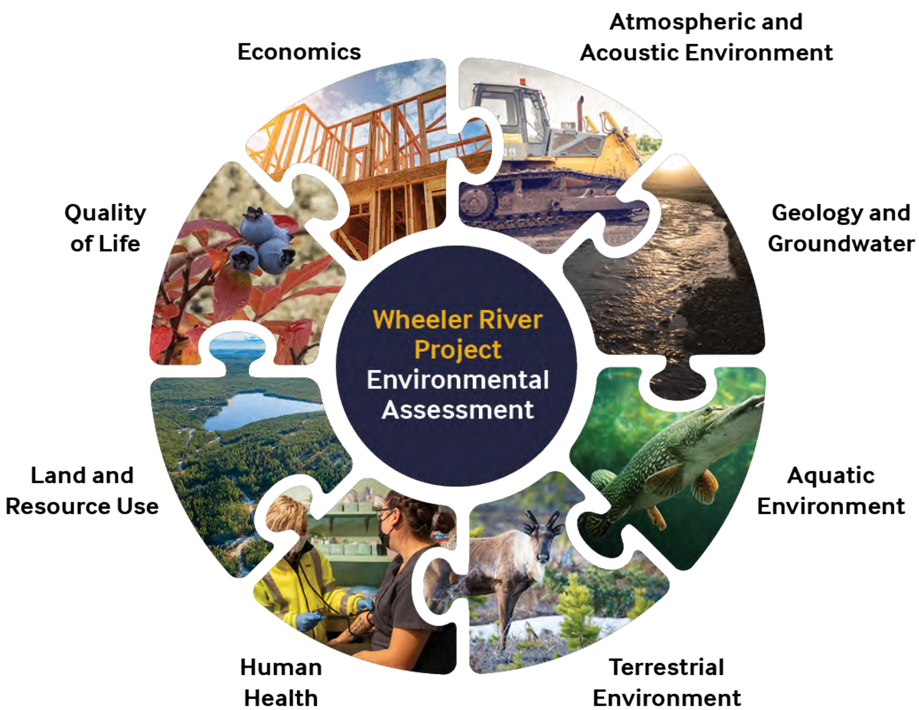

Figure 11-1: Biophysical and Human Environment Assessments for the Wheeler River Project Environmental Assessment

Figure 11-2: Land and Resource Use - Valued Components

Indigenous Land and Resource Use (ILRU) described in Section 11.1 is conducted by Indigenous people[1] and includes hunting, fishing, trapping, and gathering for food production. Gathering includes collection of natural products such as firewood, driftwood, feathers, or other products used for cultural purposes in addition to plants for dietary and medicinal purposes.

Other Land and Resource Use (OLRU) described in Section 11.2 includes commercial resource uses such as commercial fishing, commercial trapping, mining, forestry, lodges and outfitters and ecotourism in which both Indigenous and non-Indigenous people participate. Recreational resource use includes recreational fishing, recreational hunting, and cabin use by non-Indigenous people. Protected areas are also described in OLRU.

Section 11.3 describes Heritage Resources, which, for the purposes of this EIS, include physical and cultural heritage or any structure, site, or thing that is of historical, archaeological, paleontological, or architectural significance.

An overview of the Project location is provided in Figure 11-3.

[1] Section 35 of the *Constitution Act, 1867* (Government of Canada 1982) defines the term "Aboriginal peoples of Canada" as referring to the First Nation, Inuit and Métis peoples of Canada. The term "Indigenous" is used interchangeably with "Aboriginal".

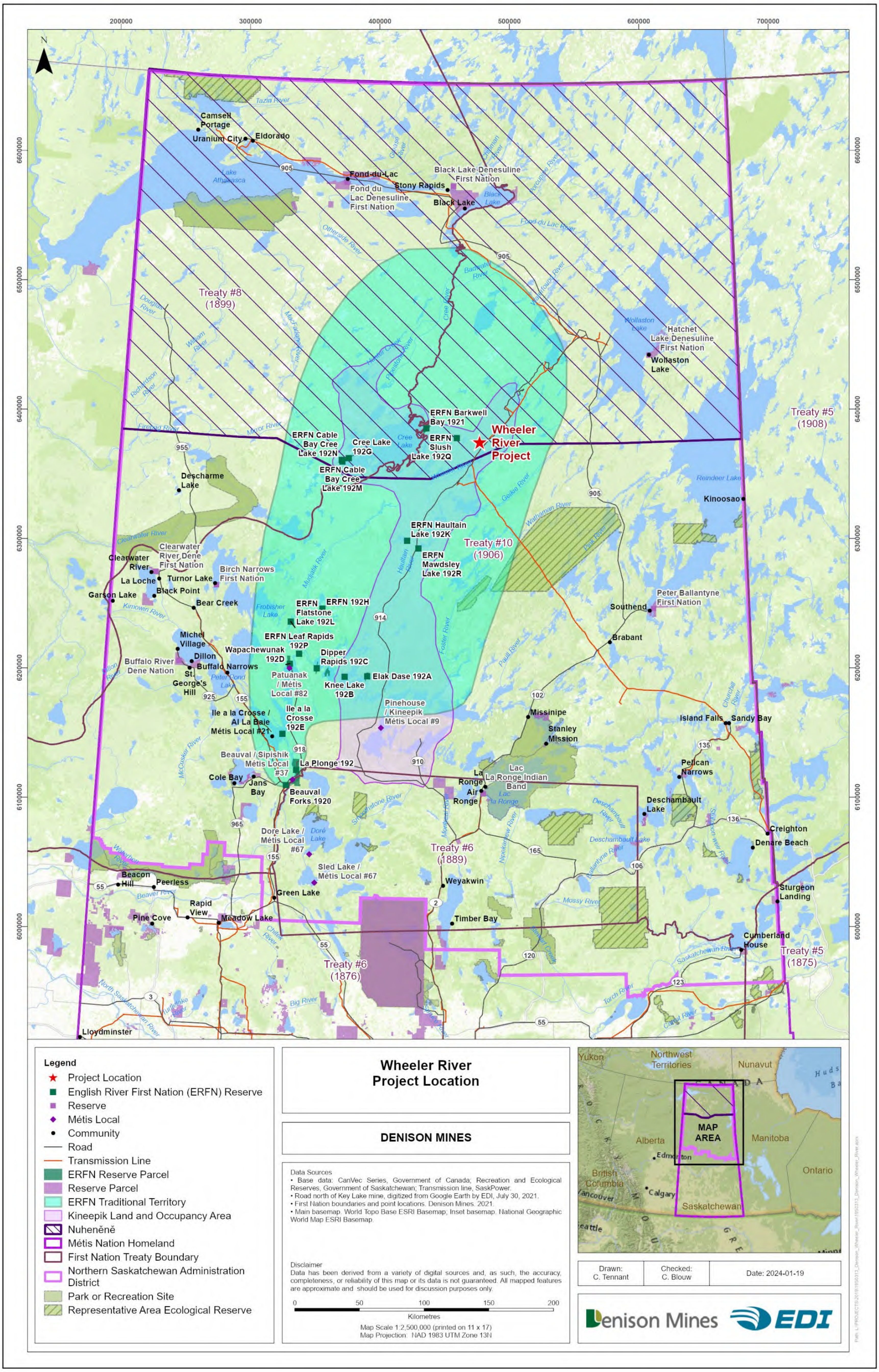

Figure 11-3: Wheeler River Project Location

11.1 Indigenous Land and Resource Use

This subsection addresses potential effects from the Project on the Indigenous Land and Resource Use VC. This section comprises the following steps as part of the assessment:

- scope of the assessment;
- summary of existing conditions;
- identification and description of potential interactions between the Project and the VC;
- identification and description of mitigation measures applicable to the VC to eliminate, reduce, or control the potential adverse Project-related effects);
- identification and characterization of predicted Project residual effects (i.e., after mitigation), including characterization of significance and assignment of the level of confidence in the predictions; and
- identification and characterization of potential cumulative effects.

Figure 11.1-1 is a graphic representation of the assessment process used in this EIS.

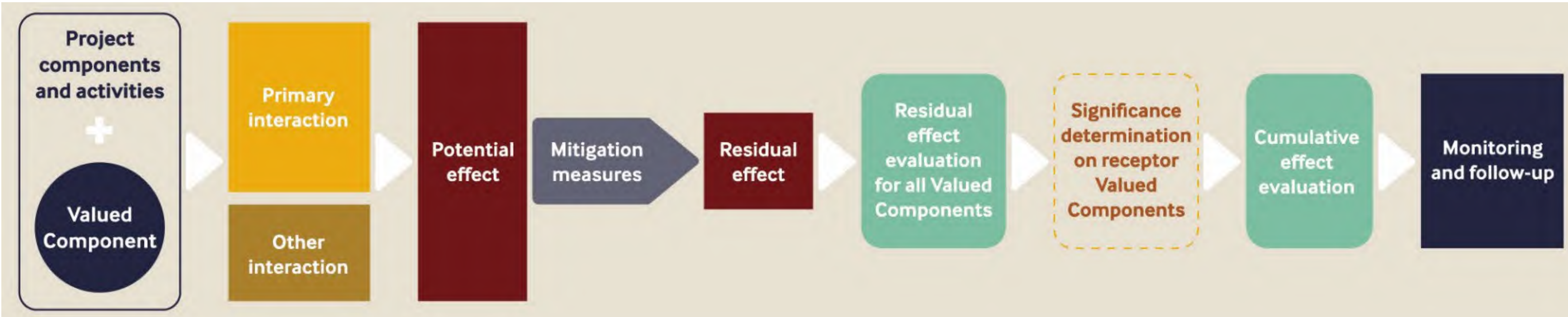

Figure 11.1-1: Environmental Assessment Process for the Wheeler River Project

Indigenous Land and Resource Use describes traditional or subsistence practices by Indigenous people and considers potential effects of the Project on these practices as per the *Technical Guidance for Assessing the Current Use of Lands and Resources for Traditional Purposes under CEAA 2012* (CEAA 2015). Subsistence practices include hunting and fishing for domestic purposes, as well as non-commercial trapping of furbearers for food or fur (although many Indigenous resource users also pursue some activities on a commercial basis, as described in Section 11.2). Gathering of natural items for ceremonial practices, herbs, roots, berries, plant medicines, food, and firewood are also subsistence practices. Changes to how resource use areas are accessed (e.g., traditional routes such as trails, waterways, landmarks, and portages) and where resource users stay on the land (e.g., cabins, campsites, ceremonial places, and events) are also considered, as they may affect ILRU success and the ability to continue important cultural practices. Sacred sites such as burial grounds, cultural landscapes, and habitation sites remain important to link the past with the present. Placenames and waterbodies discussed in this subsection are displayed on Figure 11.1-2.

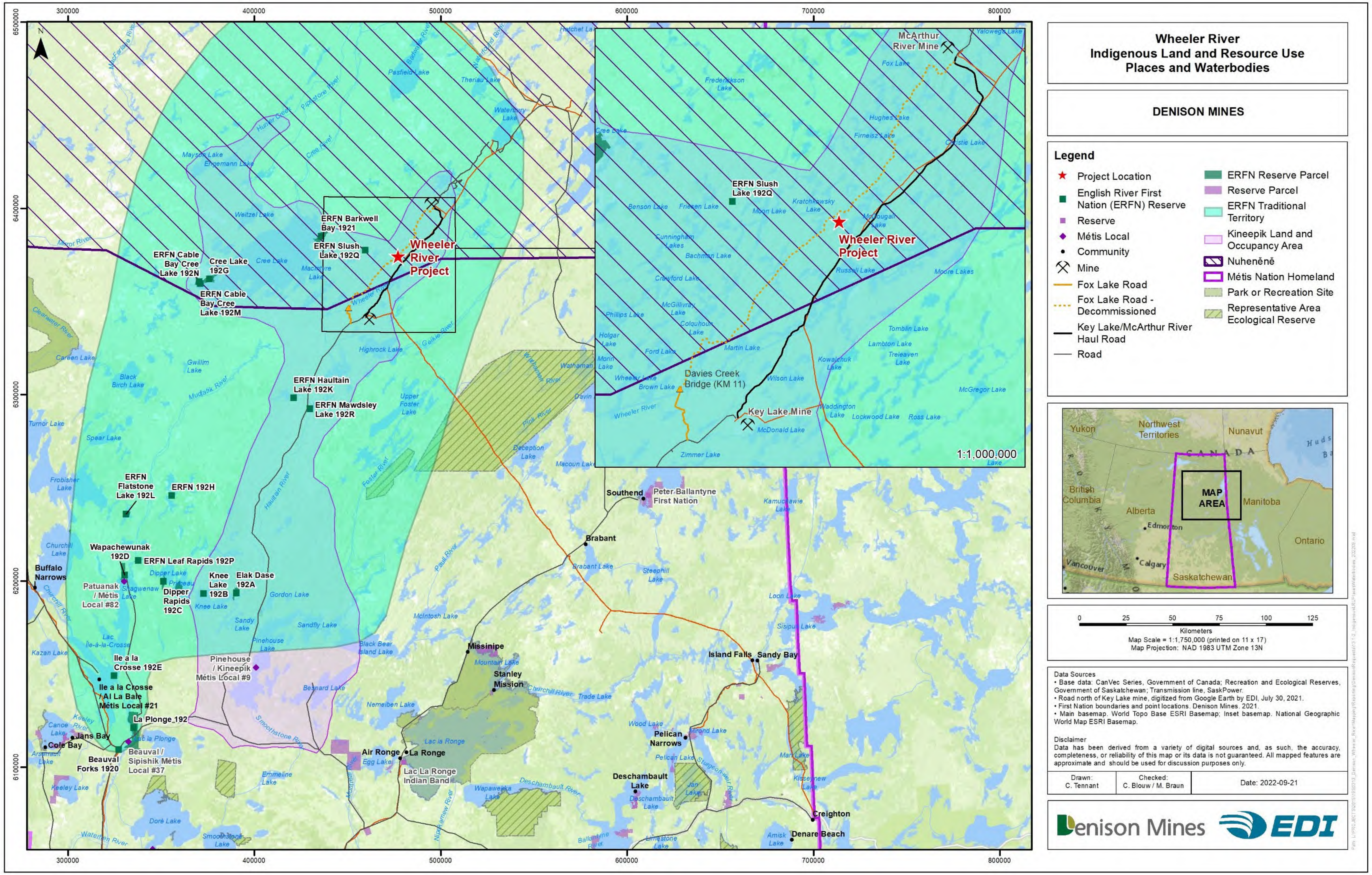

Figure 11.1-2: Indigenous Land and Resource Use Places and Waterbodies

11.1.1 Scope of the Assessment

11.1.1.1 Valued Component Selection

Valued Components are aspects of the biophysical and human environments that may be affected (adversely or positively) by the Project. The value of a component not only relates to its role in the environment, but also the value people place on it (Denison 2020). An initial VC list was developed for engagement purposes based on a scan of other Environmental Assessments (EAs) conducted in northern Saskatchewan, combined with regulatory expectations and professional experience; ILRU was among the VCs identified (Denison 2020). Additional input into VC selection was obtained through discussions with Indigenous Communities of Interest (COI), government agencies, and the public. Denison Mines Corp. (Denison) reviewed and considered this input to develop a VC list that reflects the key environmental, socio-economic, heritage, and human health components and interests to focus the detailed assessment for the EA.

To validate VC selection and as part of engagement activities, Denison sought feedback from the English River First Nation (ERFN)[2] and the Northern Village of Beauval, the Northern Village of Pinehouse Lake, and the Northern Hamlet of Patuanak (hereafter Beauval, Pinehouse, and Hamlet of Patuanak, respectively). In early 2021, Denison prepared and shared an online survey that included information about Denison and the Project, and posed validation questions about the VCs being assessed as part of the EA process. A total of 23 completed surveys were received from ERFN and 62 completed surveys were received from Beauval and Pinehouse. Denison also met with the Métis Nation-Saskatchewan (MN-S) in early 2023 to share information about the Project, including discussion on VCs considered in the assessment; no new VCs were identified as part of that discussion.

The information related to the VCs was incorporated into the assessment. For example, three ERFN members affirmed the importance of ILRU: “*I wish traditional livelihood to continue by the future generations in these areas*” (21-EN-ERFNSUR-456.40); “*Cause I’m a hunter and I always use the land*” (21-EN-ERFNSUR-456.42); and “*community concerns and requirements for the future of our children's, grandchildren's, great grandchildren's connection to the land and utilization of renewable resources by future generations*” (21-EN-ERFNSUR-456.44). In their health and socio-economic study, the ERFN and Shared Value Solutions (ERFN and SVS 2022a) described the practice of ILRU as spiritual: “*they exercise spirituality …[by] practising traditional activities such as hunting, fishing, trapping, and gathering plants for food; maintaining a close relationship with the land; maintaining a close relationship with ERFN culture and language; [and] accessing traditional medicine*”.

The Kineepik Métis Local (KML) #9 at Pinehouse authored a document to provide their unique voice and perspective on the Project for the EIS (KML 2022). The KML have indicated that they are

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[2] ERFN’s Wapachewunak Reserve 192D is also referred to a Patuanak.

responsible for all proponent and industrial activity that occur in their land and occupancy use area (KML 2022). The KML have practiced governance on these lands since time immemorial (KML 2022). While there is an overall consensus of support for the Project, two of the primary interests highlighted the need to have "*confidence in the continued success of the new mining application [in situ recovery or ISR] on [their] traditional territories*" and the potential cumulative effects to land use and land users due to the Highway 914 extension project (KML and Limnos Environmental 2022).

The Wheeler River Project: Métis Knowledge Study Report (MN-S and Two Worlds Consulting 2023) included descriptions of baseline conditions and a summary of potential Project interactions relative to the VCs identified in the EIS. Valued components of the most interest to the Métis as per the knowledge gathered in the study report included land and resource use and proposed key indicators and measurable parameters relative to potential Project changes.

The Ya'thi Néné Lands and Resources Office (YNLR) was created as a not-for-profit organization to be the single point of contact between industry, government, and the local Athabasca communities of Hatchet Lake First Nation, Black Lake First Nation, Fond du Lac First Nation, Camsell Portage, Stony Rapids, Uranium City, and Wollaston Post. Denison has been engaging with YNLR since 2019 to understand any interest or concerns about the Project that the YNLR may have. In September 2021, Denison virtually presented information about the Project, alternatives considered over the years, and the VCs selected. The YNLR in its report prepared for the Project noted the desire to protect the [Project] areas for future generations and current youth. One Athabasca Denesųłiné member noted: "*Fishing, hunting, trapping….we the Dene people live off the land*" (YNLR 2022).

The rationale for the selection of ILRU as a VC is drawn from community input, regulatory requirements, and subject matter expert advice and includes:

- ILRU is a priority for all communities.
- Pursuant to Section 5(1)(c)) of the *Canadian Environmental Assessment Act, 2012* (Government of Canada 2019), the potential to affect the ability of Indigenous people to maintain traditional land and resource use must be evaluated.
- VCs that support ILRU must also be considered including aquatics, vegetation and ecosystems, ungulates (moose), furbearers, and woodland caribou.
- Linkages that concern human health and well-being of Indigenous land and resource users are considered by including human health and safety, noise, air quality, and surface water quality; and changes in the actual or perceived level of constituents of concern in surface water, terrestrial wildlife, plants, and fish tissues.

Figure 11.1-3 is a graphic representation of the main linkages among the Indigenous Land and Resource Use VC and other VCs, illustrating the flow of assessment information into and from the Indigenous Land and Resource Use VC.

Figure 11.1-3: Integrated Assessment Approach - Key Connections between Indigenous Land and Resource Use and Other Valued Components

11.1.1.2 Key Indicators and Measurable Parameters

To provide focus and analytical rigour to the EA, the effects assessment for each VC identifies relevant Key Indicators (KIs) and associated Measurable Parameters (MPs; Table 11.1-1). These are defined as follows:

- **Key Indicator:** an important component or aspect of the VC that is expected to be affected (changed) as a result of the Project.
- **Measurable Parameter:** a parameter or metric associated with the KI that can be used to detect and measure Project-related changes.

Key indicators for ILRU use include:

- resource availability for harvesting subsistence resources (distribution and abundance of animals, plants, and wildlife for harvest and suitability of animals, plants, and wildlife for consumption);
- land/water availability to practice traditional land use (TLU); and
- perceived suitability of lands and resources therein.

Resource availability is a KI of the ability to maintain ILRU. Changes in resource availability (e.g., fish and wildlife harvested) were identified based on the results of fish and wildlife VCs such as Fish Habitat and Fish Health (Sections 8.3 and 8.5 in Section 8 Aquatic Environment); wildlife and wildlife habitat including key species of ungulates (moose), and woodland caribou (Section 9.3 in Section 9 Terrestrial Environment).

Land (and water) availability is a KI of the continued opportunity and access to lands to practice traditional activities such as hunting, fishing, trapping, and plant and berry gathering. Land availability is measured through a quantitative comparison of lands altered or lost for use due to the Project footprint, associated infrastructure, or restricted for safety purposes. Navigation and access to resources and travel safety is considered through a qualitative assessment of the interactions between land use patterns and Project infrastructure and activities.

Changes to the KI of perceived suitability of lands and resources therein is measured qualitatively because it is driven by the perceptions of resource harvesters and is based on how resource users perceive changes to the areas' suitability for land and resource use activities. Resource harvesters may experience Project-related disturbances and, depending on how these changes are perceived, it may cause some resource harvesters to avoid the Project Area. Variability exists in the sensitivity of resource harvesters to changes in traffic volumes, aesthetics (i.e., noise, dust, and a visually modified landscape), and changes in activity levels, such as the presence of the Project workforce, and potential increases of competing harvester groups in the area. Resource users may also experience changes in their perception of the quality of resources for consumption such as the palatability of fish or wildlife or have apprehensions about the safety of resources for consumption. These changes may affect the patterns of ILRU during all Project phases including Post-Decommissioning. The ERFN refer to this indicator as a "psycho-social' effect, meaning that even if people know their fears are "*perceived fears, the fear … is real and has real impacts on ERFN members' perception o*f their overall health and well-being" (ERFN and SVS 2022a). The MN-S identified citizen enjoyment while conducting land and resource use activities and/or using associated travel routes as a measurable parameter for consideration (MN-S and Two Worlds Consulting 2023).

Table 11.1-1: Key Indicators and Measurable Parameters for Indigenous Land and Resource Use

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Resource availability for harvesting subsistence resources.	Maintenance of the abundance, distribution and health of wildlife, fish, and plants used for traditional purposes. The Project has the potential to alter the relative abundance and distribution of moose, woodland caribou, waterbirds and waterfowl, and upland game birds, which are important for subsistence hunting.	Change in relative abundance and distribution of wildlife, fish, and plant species. Change in the suitability of wildlife, fish, and plants for human consumption.
Land/waters available for traditional practices	Continued opportunity and access to lands to practice traditional activities such as hunting, fishing, trapping, and plant and berry gathering. The Project has the potential to alter safe access and navigation to resource harvest areas and the availability of supporting infrastructure such as cabins and camping sites, which are important to the continuation of traditional land and resource use.	Change in lands available to conduct traditional harvesting, such as lands and waters altered/lost as a result of Project activities. Change in opportunities for traditional land use, including access, navigation, and occupation sites.
Perceived suitability of land and resources therein.	Project-related disturbances can affect traditional land and resource use aesthetics and the perceived suitability of resources and resource harvest areas.	Change in aesthetics of the land/water use experience. Change in perceived suitability of land / water for resource use. Change in quality of resources for consumption.

11.1.1.3 Spatial and Temporal Boundaries

11.1.1.3.1 Spatial Boundaries

Three spatial boundaries have been defined for the ILRU VC: the Project Area, a Local Study Area (LSA) and a Regional Study Area (RSA; Table 11.1-2, Figure 11.1-4).

Table 11.1-2: Description of Spatial Boundaries and Study Areas

Study Area	Descriptors
Project Area	The area in which all Project components/activities will be located. It is expected that all physical disturbances resulting from Construction, Operation, and reclamation activities will occur within this area or footprint.
Local Study Area (LSA)	The area established to assess the potential, largely direct effects of the Project on the environment; delineated based on the area over which direct and indirect effects are most likely to occur on VCs. Defined as the Project footprint plus the maximum combined extents of supporting VC RSAs including Aquatic, Terrestrial, Noise, and Health VCs as changes in these components can affect the Indigenous resource use environment. The area considers trapping and fishing areas, ones that involve resource user travel through and adjacent to Project activities and are inclusive of the Key Lake and McArthur River operations. The approximate physical parameters of the LSA include a maximum length of 84 km and a maximum width of 42 km. The approximate length and width provided are created by minimizing the area of the rectangle around the LSA polygon. The area of the LSA is approximately 2,620 km^2.
Regional Study Area (RSA)	The area established to assess the potential, largely indirect effects of the Project in the broader, regional context, and provides the regional context over which cumulative effects may occur. Defined as trapping blocks N-16 and N-18, and the footprint of the Key Lake Mine to capture regional land use, regional effects on aquatic and terrestrial resources, and the maximum extents of changes to noise, health in combination with other potential development. While cumulative effects are not expected in most areas of the N-16 and the N-18 trapping blocks, the spatial boundaries of the trapline are a familiar reference for local Indigenous communities and capture the broad land usage patterns of local communities. Trapping blocks are defined regions and have membership that is regulated by a local trapping association and membership is generally only open to local Indigenous community residents[1] though non-Indigenous trappers may also participate as members of the trapping association. The approximate physical parameters of the RSA include a maximum length of 338 km and a maximum width of 163 km. The approximate length and width provided are created by minimizing the area of the rectangle around the RSA polygon. The area of the RSA is 29,754 km^2.

1 The Northern Fur Conservation Block constitutes most of the forested area of northern Saskatchewan. This area was partitioned into 89 Fur Conservation Areas (FCAs or Trapping blocks) in 1946. The FCAs were established to allow recovery of the beaver population, and to function as the units of management whereby the fur harvest of a restricted number of trappers could be managed through an orderly trapline management system that would reduce conflicts and maintain forest trap-lines as commercial entities. Each FCA is composed of a group of registered/licenced trappers, from which a representative council of not more than five members is chosen. Each FCA membership and elected council is responsible for its own administration, organization, and operation. The FCA blocks have authority on issues relevant to their membership and block administration (Government of Saskatchewan 2012).

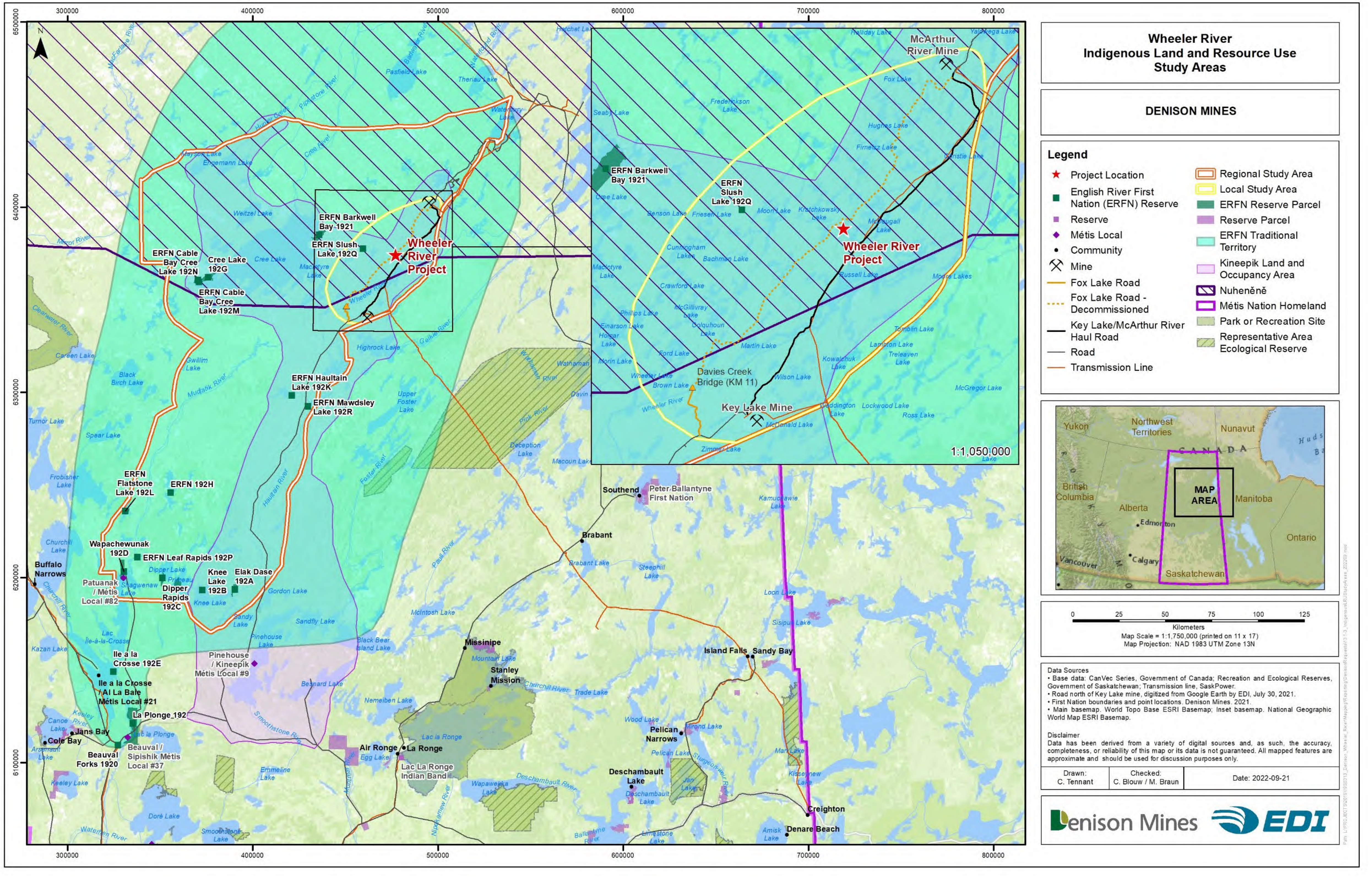


Figure 11.1-4: Indigenous Land and Resource Use Study Areas

11.1.1.3.2 Temporal Boundaries

Temporal boundaries for characterizing components of the ILRU existing environment varied. The temporal scope of the ILRU assessment will be forward looking and include the period from initial Construction to the end of Decommissioning as defined by the following Project phases:

- Construction: includes site preparation; wellfield and freeze hole drilling; processing plant construction; other service infrastructure; and electrical infrastructure. The duration of construction will be approximately two years.
- Operation: includes operation of the wellfield; operation of the processing plan and production; maintenance activities; water withdrawal from groundwater or surface water for potable use, fire suppression, and make-up water in the processing plant; water treatment; waste management; environmental monitoring; package and transport of nuclear substances; reporting to regulators; engagement; and site security. The duration of Operation will be approximately fifteen years.
- Decommissioning: mining chamber remediation; decontamination; asset removal; demolition and disposal; and reclamation. The duration of Decommissioning will be approximately five years. Section 2.3.3 outlines a conceptual decommissioning plan to support the EA for the Project. Denison's decommissioning commitment is to return the land back to the Province of Saskatchewan for unrestricted surface land use post-closure. The conceptual decommissioning plan outlines how radiological, physical, and chemical risks will be managed during Decommissioning so no unreasonable risks remain. Denison will prioritize passive versus active controls to reduce long-term risk.

11.1.2 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

At its broadest level, Indigenous Knowledge (IK) can be understood as a body of knowledge built up by a group of people through generations of living in close contact with nature (CEAA 2015). This unique and collective knowledge of Indigenous peoples may include, but is not limited to, the environmental, cultural, economic, political, and spiritual conditions of a community or region. The results of IK collection can influence the assessment by guiding the development and refinement of primary data collection, providing context for interpretation of secondary data and providing context for the baseline.

Local Knowledge (LK) is specialized knowledge developed through long-term association, interaction, and cumulative experience. It is context-specific and unique. As the information is held by an individual, it cannot be validated and vetted through processes commonly applied in the collection of IK, which is considered as community-held and shared knowledge. In this EIS, IK and LK are viewed as complementary and influential alongside western science to produce a full understanding of the potential effects of the Project, whether measurable or perceived. Both forms of information have been given full and fair consideration.

Primary sources of IK and LK were identified and, where available, direct quotes were integrated into the baseline narrative and impact assessment. These data are integrated into the existing environment (Section 11.1.3) and effects assessment (Section 11.1.4) subsections.

In some cases, IK and LK information provided in the EIS has been generalized to safeguard resources. For example, to protect the resources and interests of individual holders of information, moose harvest locations, cabins, trails, and other features are not displayed on maps. This approach respects the privacy of IK and LK held by Indigenous community members. As an alternative, harvests have been noted in a broad sense for consideration in the effects assessment.

Discrepancies within and between IK, LK, and western scientific information occur and can be a limitation to baseline descriptions and effects assessments. To address any discrepancies, disagreements between IK, LK, and/or western science, information is presented side-by-side and addressed through proposed mitigation and monitoring. These actions address uncertainty and provide an opportunity to adopt a precautionary approach to the assessment and mitigation and monitoring activities.

Denison has recorded and stored information regarding IK, LK, and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 21-EN-ERFNSUR-456.40). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment. Appendix 11-A provides a summary of unique identification numbers referenced within Section 11.1.

11.1.2.1 English River First Nation

Indigenous Knowledge (referred to as Traditional Knowledge or TK by the ERFN) was provided by ERFN for consideration in the EIS. This included several reports:

- *Wheeler River Project – Summary of Health and Socio-Economic Study Results,* which summarizes results from 16 interviews that were conducted for the health and socio-economic topics (ERFN and SVS 2022a).
- *Wheeler River Project - Summary of Traditional Knowledge Study Results,* which analyzed and presented results from 21 land use interviews that provided both IK and LK and included details on ERFN's resource harvesting locations, species harvested, travel routes, cabins and special sites (ERFN and SVS 2022b).
- *The English River First Nation Country Foods Study Final Report*, which conducted in 2016 through funding secured from the First Nations Environmental Contaminants Program to complete a country foods study. The study involved three components: a dietary study, a sampling program, and a human health risk evaluation. The overall study objectives were to

examine country food usage by ERFN community members and to assess if the country foods are safe to eat. The involvement of ERFN community members was one of the fundamental goals of the study, which relied heavily on TK to identify what and where to sample (CanNorth 2017a).

- *The English River First Nation Aboriginal Traditional Knowledge Summary Report*, which was compiled by Environment Canada on behalf of ERFN to summarize information for the purposes of recovery of the Woodland boreal caribou population. Ten individuals (mostly Elders) were selected by ERFN to complete TK interviews to understand boreal Caribou in the English River Traditional Territory (ERFN 2011).

Local Knowledge also was provided by an ERFN trapper, fisher, and resource harvester (ERFN Trapper) who resided in and conducted resource use in the Project Area. The ERFN Trapper explained the use of the area by outfitters and cabin lease holders, fish and wildlife abundance and distribution, species harvested for traditional use, and navigation and travel along waterbodies and roads. On October 29, 2019, at Denison's Project exploration camp, the resource user attended a full-day interview. Notes from this interview were finalized on January 2, 2020, with their approval and are used in most ILRU components herein. Unfortunately, prior to the filing of the EIS, the ERFN Trapper passed away. Despite his passing, ERFN considers the ERFN Trapper's use of the area as representative of current and future land users and expects that the relationship to the Project area will be continued and strengthened through generations of future use.

11.1.2.2 Kineepik Métis Local #9 at the Northern Village of Pinehouse

The KML #9 at the Northern Village of Pinehouse submit several documents to support the consideration of IK in the EIS. For example, KML at Pinehouse authored a document to provide their unique voice and perspective on the Project for the EIS titled *Kineepik Valued Ecosystem Components – KML Pre-statement for Denison EIS* (KML 2022). While there is an overall consensus of support for the Project, two of the primary interests raised the need to have "*confidence in the continued success of the new mining application [in situ recovery or ISR] on [their] traditional territories*" and the potential cumulative effects to land use and land users due to the Highway 914 extension project (KML 2022).

The KML hired Tobias and Associates to produce a Pinehouse land use and occupancy map survey in 2011 (Northern Village of Pinehouse 2011) and update it in 2018, which produced two ESRI geodatabase files containing that use: KMLUO2011 and KMLUO2018, each an important source of LK. To protect ownership and confidentiality, maps are not published. Land use is described in text instead without revealing exact locations. Methods used for survey data collection in 2018 regarding the use and occupancy map were documented in a methods report (Tobias and Associates 2018a); the research design and implementation adhered to best practices for use-and-occupancy mapping as described in the methods text "Living Proof" (Tobias 2009).

The KML also prepared a "Response to the Environment Impact Assessment For the proposed Ministry of Highways 914 Extension Project", which specified ILRU use in the Project Area and identified concerns about ILRU in combination with the Highway 914 extension project (KML and Limnos Environmental 2022).

11.1.2.3 The Métis Nation-Saskatchewan

The MN-S submitted *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) to Denison in October 2023. The Métis knowledge summarized therein included secondary literature approved for use by the MN-S and primary information collected during interviews with nine Métis citizens from Northern Region 1 (NR1) and Northern Region 3 (NR3), exclusive of information from the KML at Pinehouse who formally revoked its delegated Duty to Consult from the MN-S. The study included an introduction; a description of the Métis in Saskatchewan; the methodology for the study; Métis knowledge; Métis ways of knowing, doing, and living; and findings and recommendations relative to the Project. The spatial boundaries considered in the study were inclusive of the Northern Saskatchewan Administration District (MN-S and Two Worlds Consulting 2023). Information drawn from the study to support the effects assessment more narrowly focused on uses identified within the spatial boundaries for Indigenous Land and Resource Use (Section 11.1.1.3.1).

11.1.2.4 The Ya'thi Néné Lands and Resources Office on Behalf of Athabasca Communities

The YNLR was created as a not-for-profit organization to be the single point of contact between industry, government, and the local Athabasca communities of Hatchet Lake First Nation, Black Lake First Nation, Fond du Lac First Nation, Camsell Portage, Stony Rapids, Uranium City, and Wollaston Post. Denison has been engaging with YNLR since 2019 to understand any interest or concerns about the Project that the YNLR may have. Denison and YNLR agreed on a workplan proposal to carry out research associated with better understanding land use activities in or around the Project.

In March 2022, the YNLR transmitted its report entitled *An Exploration of Recorded Athabasca Denesųłiné Traditional Knowledge, Land Use and Occupancy Information in the Vicinity of Denison Mines Wheeler River Project* (YNLR 2022). Denison requested the inclusion of their report into the EIS. This report focused primarily on the Athabasca Denesųłiné First Nations including Hatchet Lake, Black Lake, and Fond du Lac. Indigenous Knowledge and LK within this report, as well as publicly available information, has been integrated into the EIS with focus on the Athabasca Denesųłiné communities. This report is an amalgamation of known information from YNLR and was not collected explicitly for the purposes of the Project. As such, it should be interpreted with caution. With approval from YNLR, the March 2022 report is included as an appendix to the EIS (see Section 3 Indigenous and Local Knowledge, Appendix 3-A).

11.1.2.5 Other Sources of Information and Local Knowledge

Engagement data, IK, and LK were also sourced from the Engagement Database, which is updated continuously. As identified at the beginning of Section 11.1.2, engagement, LK, and IK comments are stored in the Engagement Database for integration into the existing environment and assessment sections (see Appendix 11-A).

Local Knowledge information was also sourced from the:

- Millennium Uranium Project EIS (Cameco 2013), which was completed prior to it being put on hold on May 15, 2014, due to economic conditions (CNSC 2019);
- socio-economic baseline annex for the McArthur River Expansion Project (InterGroup 2011a);
- socio-economic baseline annex for the Eagle Point Water Management Project proposed at the exiting Rabbit Lake operation (InterGroup 2011b); and
- socio-economic environment annex VI for the Tazi Twé Hydroelectric Project EIS (Golder 2013).

Other secondary sources of information included land use studies, planning processes, other EISs, and community-based studies. For example, the Pinehouse-Dipper Land Use Study by the Saskatchewan Institute of Applied Science and Technology (SIAST 2003) provided IK and LK from resource harvesters. DPRA Canada (DPRA 2013a) prepared a community profile of ERFN at Patuanak on behalf of the Nuclear Waste Management Organization. Land and resource use conducted by the Northern Village of Pinehouse was documented by Tobias and Kay (1994). A First Nations Environmental Contaminants Program (FNECP) also documented country foods consumed by ERFN members (CanNorth 2017a).

11.1.3 Existing Environment

The Project is located in an area traditionally used by Indigenous people, which, over the last few centuries, included the Dene, Cree, and Métis of northern Saskatchewan. Places and settlements discussed in this section are shown on Figure 11.1-4. For the Indigenous people in northern Saskatchewan, ILRU has been a defining feature of their culture and identity. Natcher (2009) equates this to their social economy, which he describes as the harvest and use of wild foods and resources: "*Having endured profound social and economic change, Aboriginal peoples throughout northern Canada have maintained a lasting connection with the environment through hunting, fishing and gathering resources... Aboriginal [now Indigenous] peoples from across the north harvest, process, distribute, and consume considerable volumes of wild foods annually.*"

Section 11.1.3.1 provides an historic overview of the Dene and Métis communities of ERFN/Patuanak[3]; Pinehouse, known as Kinīpihko-sāhkahikan in Cree; and Beauval[4] or Beautiful Valley, and their use of renewable resources for subsistence purposes. This subsection also describes initial contact with the Hudson's Bay Company (HBC) and subsequent changes associated with the changing economic and social conditions as settlement into permanent communities gradually occurred. This is followed by a description of contemporary ILRU by community or community groupings in Section 11.1.3.2.

11.1.3.1 Historic Settlement and Land Use of the Dene and Métis Communities in the Project Region

11.1.3.1.1 Dene Settlement and Land Use

English River First Nation/Patuanak is a community of Denesųłiné or Dene people (historically called Chipewyan), believed to be of the Thi-lan-ottiné division of Denesųłiné (Smith 1981). The more southerly bands of the Dene occupied the Churchill River drainage system around Lac Île-à-la Crosse and as far southwest as Cold Lake and Lac la Biche, Alberta (Jarvenpa 1980). The residents of ERFN/Patuanak identified themselves as the 'kesye hot' ine' or 'poplar (aspen) house people' (Jarvenpa 1980). The Dene peoples of ERFN/Patuanak have a long history in the region and northern Saskatchewan.

Prior to the mid-1700s, the Dene were known to live off the caribou on the northern edge of the boreal forest and into the barren grounds. The abundance of caribou for food and skins, and relatively easy access to the animals, was an important factor in keeping the Dene out of the fur trade and on the margins of the boreal forest (Smith 1976). The movement of the Dene people into the boreal forest was encouraged by the HBC to gain their active participation in the fur trade (Yerbury 1976, Gillespie 1976). The HBC actively recruited and trained the Chipewyan people in the skills of trapping and skinning furs to engage them in the fur trade (Jarvenpa 1980).

As the Dene learned how to trap and produce valuable furs that could be exchanged for goods at the trading posts, they moved further into the boreal forest, where there was a greater abundance of fur-bearing animals. The move into the boreal forest was enabled by a peace agreement between the Cree and the Dene in the winter of 1715–1716 (Gillespie 1976; Smith 1976). The move was further enabled by the smallpox epidemic of 1781, which drastically reduced the Cree population in the boreal forest region of western Saskatchewan (Smith 1976; Yerbury 1976). The smallpox epidemic was followed by outbreaks of influenza, further reducing the Cree population (Yerbury 1976). A few years after the smallpox epidemic of 1781, a dominant Dene population was

[3] The Northern Hamlet of Patuanak and the ERFN Wapachewunak Reserve 192D are located adjacent to each other and 'Patuanak' is used interchangeably to refer to both settlements. Where the source data make the distinction, 'Patuanak' is used to refer to the ERFN reserve community and 'Hamlet of Patuanak' is used in reference to the adjacent municipal settlement. Generally, residents of the two communities have the same history and ancestry and are described in literature as one community.

[4] The ERFN occupies reserve lands adjacent to Beauval, known as La Plonge (IR 192).

established in the area. Fur traders estimated that nine-tenths of the Cree population had died from the epidemic (Yerbury 1976; Smith 1981).

Research shows that the Dene people who moved south along the Churchill River after the smallpox and influenza epidemics of the 1780s are the ancestors of the Dene of the ERFN and the community of Patuanak. During this time, the Dene people were mobile, moving around the area and setting up temporary seasonal camps that were constructed of either canvas or skin tents. In the summer, larger groups would gather in places along the Churchill River to renew kinship ties and to socialize. A gathering like this would last for about a month before smaller groups would disperse throughout the region (Jarvenpa and Brumbach 1988).

By late 1892, the majority of the early ERFN settlement locations occurred along the Churchill River and consisted of log cabin settlements, as was observed by J. B. Tyrrell of the Geological Survey of Canada (Jarvenpa 1980). Tyrrell describes the early settlements along the Churchill River as consisting of log dwellings of a few Dene families that were beginning to spend the summers at permanent sites by 1892. These structures were the meagre beginnings of bush communities in the ERFN territory. After spending the summers at the cabins along the Churchill River, the people would disperse *"over vast areas of the north for trapping and subsistence purposes"* (Jarvenpa 1980).

The following main settlement areas existed before the current ERFN community was established on Shagenaw Lake at the mouth of the Churchill River (Wapachewunak 192D):

- Cree Lake;
- Primeau Lake;
- Dipper Lake (previously called Pelican Lake, with settlements on the east and west shore);
- Île-à-la Crosse;
- Knee Lake;
- Foster Lake; and
- Gwillim Lake (Sandy Lake area) on the Gwillim River, a tributary of the Mudjatik River (Jarvenpa 1980).

Of these settlements, the Cree Lake location is closest to the Project Area. Families that inhabited the Cree Lake area in the early to mid-1900s have descendants living in the area seasonally or using the area at the present time. These settlements were used until the 1930s and 1940s.

Between late October and mid-April, men and older boys from these small settlements would travel throughout the surrounding area and back to deliver furs and meat from their hunting and trapping activities. On these outings, the men would travel to areas where they had hunting encampments consisting of portable hide or canvas tents and a hearth for a fire (Jarvenpa and Brumbach 1988). Trappers would move the location of their trap lines within a given geographic area as the number of animals along a creek or lake shore declined in relation to their activities. This would result in a trap line rotation, allowing areas time to recover, and for the furbearing animal populations to rebuild their populations, while another area was trapped for the next few years (Jarvenpa 1980). As a result, larger areas within a fur block were trapped by individual trappers moving their trapline from one area to another over a period of several years to match the density of fur bearing animals.

Historically, people from ERFN/Patuanak travelled throughout their traditional territory by canoe, dog sled, walking, or snowshoeing (Jarvenpa 1980). With the introduction of airplanes, power boats, snowmobiles, roads, and vehicles, the ability to travel throughout the traditional territory improved. The Mudjatik and Haultain rivers were two of the primary travel corridors for ERFN/Patuanak people from the settlements along the Churchill River to the areas south of and around Cree Lake.

In 1883, the Dene and Cree along the Churchill River[5] were concerned with the number of southerners coming to explore a route for a railway (Dodson et al. 2006). Little interest in negotiating a Treaty was returned by the Canadian government who regarded a Treaty as an avoidable expense (Dodson et al. 2006). In 1902, more impetus to Treat came because of Métis demands for scrip[6] in 1902, and the creation of the Province of Saskatchewan in 1905 (Dodson et al. 2006). The Cree and Dene wanted assurances that access to their hunting, trapping, and fishing grounds would be protected, and support would be forthcoming in lean years (Dodson et al. 2006). In August 1906, Treaty 10 was finalized with ERFN followed by other regional nations. Reserve lands now occupied were subsequently created at LaPlonge (reserve 192) and at Wapachewunak (192D) (Daum Shanks 2015).

In 1946, the forested area of northern Saskatchewan was partitioned into 89 Fur Conservation Areas (FCAs), which make up the Northern Fur Conservation Block. The government sought to *"regulate trapping by assigning specific trapping areas to individuals"* (ILO 2000). The implementation of a registered trapping system was in response, in part, to the arrival of non-Aboriginal trappers in the north, and the subsequent decline in furbearing populations. The use of the bush plane in the 1930s also opened up areas to trapping that were previously only accessed by Indigenous peoples by waterways or dog teams (InterGroup 2011a).

Jarvenpa (1980) notes that with the institution of the Northern Fur Conservation Program, each fur block or FCA "*became associated with distinct populations of trappers from specific settlements.*

[5] The ancestors of the ERFN and the Cree at Canoe Lake, now known as Birch Narrows Dene Nation and Buffalo River Dene Nation.

[6] The Métis scrip system was implemented after the 1869-70 Red River Resistance and involved either land or money scrip valued at 160 acres or $160. In 1879, amendments to the Dominion Lands Act acknowledged that the Métis had outstanding claims to their lands in the North-West Territories (including land in what is now Manitoba, Alberta and Saskatchewan).

Trappers from Patuanak, Dipper Lake, Primeau Lake and Knee Lake exploit fur within the Patuanak Fur Conservation Area (N-16) while residents at Cree Lake trap in the Cree Lake block (N-18)".

By the early 1940s, most families had relocated to the larger settlement of Patuanak and four other small settlements, including Dipper Lake, Primeau Lake, Knee Lake, and Cree Lake. The men continued to make trips into the trapping and fishing areas, traveling to and from their community in the different seasons to deliver food and furs (Jarvenpa 1976). For example, participants in the TK study, "*recalled stories of their parents and grandparents travelling these routes over the course of several weeks by foot and dog sled*" (ERFN and SVS 2022b).

Into the 1970s, this pattern continued, with Patuanak becoming a permanent residence for many of the Dene in the region. The attraction of housing provided by the government, electricity, an elementary school, stores, and other services provided strong incentives for people to make Patuanak their permanent residence. A small number of families continued to live in four smaller settlements (Jarvenpa 1976). However, when the elementary school was started in Patuanak in 1968, a large influx of people came into the community to take advantage of education for their children. The result was a sharp decline in population in the smaller settlements of Dipper Lake, Primeau Lake, Knee Lake, and Cree Lake (Jarvenpa 1980).

English River First Nation has identified lands, including Fur Block N-18 and N-16 and a wide margin around these two fur blocks, as their traditional territory. Jarvenpa's discussions with trappers and Elders in ERFN/Patuanak in the 1970s and a review of the recorded accounts of HBC men led him to identify a broad region around fur blocks N-16 and N-18 as the traditional territory that was used by ERFN/Patuanak members in the early to mid-1900s. This broader area is "*at least 50% larger than now defined by trapping blocks*" (Jarvenpa 1980). With the advent of the fur block system, ERFN trappers felt that geographical boundaries had been imposed upon their movement (Jarvenpa 1980). For example, "*seasonal movements across vast areas of territory to follow different food sources*" was common (ERFN and SVS 2022b). While the road and mechanized travel has improved access to the traditional territory, an Elder stated that she thinks the highway has scared the animals away from one of the traditional camps along Highway 914 due to the vibration from all the big trucks (InterGroup 2011a).

11.1.3.1.2 Métis Settlement and Land Use

Initially, the term 'Métis' applied to persons of mixed French and Indigenous descent, but was later used to describe persons of mixed descent from English-speaking Protestant people (i.e., mainly Scottish people) and Indigenous persons (Anderson 1985). During the fur trade era from 1763 to 1821, 86 trading posts were established in what would become Saskatchewan, with a third of those situated on the shores of the Churchill River (Anderson 1985). French-speaking voyageurs (coureurs de bois) had a large role in establishing the posts for the North West Company and by working at, and trading with, HBC trading posts (Anderson 1985). These men married Indigenous women (Préfontaine et al. 2003), learning Indigenous practices and culture and blending them with their own (Barkwell and Prefontaine 2001). As described in *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023):

> *"The unions were originally a result of French, English, and Scottish fur traders seeking marriages with the daughters of "prominent" Indigenous families, primarily of Cree Saulteaux, and Dene ancestry, to secure access to furs."*
>
> and,
>
> *"The Métis are the first distinct peoples to be born in modern history. The creation of a completely distinct peoples is almost completely unique to Canada, which is why so many still grapple with Métis identity and culture."*

After the 1821 merger of the North West Company and the HBC, many Métis used their extensive skillset to become independent labourers in roles such as trappers, traders, guides, provisioners, interpreters, and scouts to avoid indenture in the HBC fur trade monopoly. In response to the transfer of Rupert's Land to the new Dominion of Canada, the Red River Resistance (1869 to 1870) occurred in response to new government control over Métis culture and land rights (Bumsted 2006). Waves of immigration to what is now Saskatchewan occurred as the Red River Métis in Manitoba moved to maintain their traditions, culture, and independence (Anderson 1985). "*The Métis people of Saskatchewan are a distinct Nation whose communities existed prior to Saskatchewan or Manitoba's entry into confederation – and right around the time Canada itself was formed*" (MN-S and Two Worlds Consulting 2023).

The Métis Homeland is extensive and characterized by deep attachment to specific regions that emerged during the fur trade (MN-S and Two Worlds Consulting 2023). Outposts in northern Saskatchewan, such as the one at Île-à-la-Crosse, predate the founding of the Red River settlement, with two of the most important posts in Saskatchewan located in Portage La Loche (now La Loche) and Green Lake (MN-S and Two Worlds Consulting 2023).

In communities such as Beauval, fur trading posts were erected, and many became the northwestern Saskatchewan Métis communities of the present day (Raymond 2013). Beauval or 'Beautiful Valley' was established in the early 20th century as a Roman Catholic mission and a transportation centre.

The settlement at Pinehouse was initially settled by Dene families prior to the 20th century; however, a smallpox outbreak in 1901–1902 nearly decimated the Dene population, forcing many of the survivors out of the area (McNab 1992). Consequently, smaller groups of Cree and Métis families from surrounding areas began moving in creating the settlement known today (Raymond 2013).

Trapping for the Métis who settled in the communities of Pinehouse and Beauval was not only a source of income, but also a livelihood inseparable from their identity and worldview. Raymond (2013) describes the northwestern Saskatchewan Métis possessing a specific 'work ethic' based upon the concept of *wahkootowin*, which placed high value on kinship systems and reciprocity. *Wahkootowin* encompassed all aspects of northern Métis life including the economy, along with living a 'northern style of life', which involved hard work and survival skills that allowed the Métis to flourish within Saskatchewan's northern landscape.

Northwestern Saskatchewan Métis women interviewed reflected on their lives in the mid-20th century. For example, Monique Gardiner stated:

> "*There was no assistance of any kind available then. We ate wild meat, ducks, moose meat. We only had the basics like flour, sugar, salt, tea, from the store…They used logs to build houses and dirt roof or hay roof, a long time ago. It was tough times*" (Raymond 2013).

To survive, the Métis were resourceful. Georgina Morin stated, "*In the old days people worked, trapped, fished to make a living… We worked hard to survive…We were not lacking anything*" (Raymond 2013).

Métis requests for scrip from the Canadian government was initiated in 1902 and became more urgent upon the establishment of Saskatchewan in 1905 (Dodson et al. 2006). Métis scrip discussions occurred simultaneously with Treaty 10 negotiations in 1906. Scripped families heard from the Commissioner himself that the village's space, and how the Métis families had lived there, was theirs to keep and continue (Daum Shanks 2015). Descriptions on scrip payments vary, with some saying a one-time scrip payment of $240 was offered to those who elected to take scrip (Daum Shanks 2015), while others say the value of scrip varied by factors, such as age, gender, and family size (MN-S and Two Worlds Consulting 2023). Some Métis were reported to have become treaty Indians and vice versa at the time (Daum Shanks 2015). As described in *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023):

> *"The policy was further complicated by land speculation, fraudulence, and administrative complications leading to many Métis losing their land or selling it at significantly lower value. These processes together rendered Métis population without a land-base, into 'squatters', or the 'Road Allowance people' (Augustus 2005)".*

As game laws and fishing restrictions were put in place by the Government of Canada and Province of Saskatchewan, Métis citizens faced challenges in their continued ability to harvest to support their families. As explained in *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023):

> *"Imposed harvesting regulations began with the establishment of Treaties. Treaties promised hunting and fishing continuity for First Nations… First Nation Treaty rights had the effect of creating a division among existing kinship relations between First Nations and Métis, since Métis were not granted the same rights to land and resources, effectively blocking Métis from areas where they had practiced harvesting and trapping (Raymond,*

2013). Fundamentally, Métis have not been provided a similar recognition of rights. The distinction of First Nations rights from Métis was described during a 1992 community hall in Île-à-la-Crosse:

> *In northern Saskatchewan, and particularly in our community, the Indian and Métis people have lived together. We have hunted, fished, and trapped together. We didn't define each other of that's an Indian and that's a Métis until the federal government came and decided to put a number on some of our people and said, "You are treaty now," and the ones that are not treaty are now Métis. We cannot hunt with our treaty brothers and sisters as Métis people or else we will get charged if we hunt with them (Royal Commission on Aboriginal Peoples 1992).*

Progressively, landmark cases affirmed the constitutional rights of the Métis to engage in activities like hunting and trapping."

Each of the settlements in the study area have a different history.

Hamlet of Patuanak

The Hamlet of Patuanak is a settlement located beside the Wapachewunak Reserve. The Patuanak settlement was started by the fur trade industry and the church prior to Treaty 10 in 1906 (SERM 2000). Patuanak became a hamlet in 1984, following the passing of the *Northern Municipalities Act 1983 (repealed)* (Government of Saskatchewan 2010; SERM 2000).

Pinehouse

The settlement at Pinehouse Lake was initially settled by Dene families prior to the twentieth century and was known as Snake Lake. A smallpox outbreak in 1901–1902 nearly decimated the Dene population, forcing many of the survivors out of the area (McNab 1992). Consequently, smaller groups of Cree and Métis families from surrounding areas began moving in, creating the settlement that is there today (Raymond 2013).

Beauval

The first settlers arrived in the area near current-day Beauval around 1907 to a place they called 'Mesakamyak' (to land onto), south of the current community (SERM 2000). Formerly known as 'La Plonge Village', Beauval or 'Beautiful Valley' was established in the early 20th century as a Roman Catholic mission and a transportation centre. In 1910, Alexander Laliberte opened a fur trading store to serve the local trappers, which became an outpost (Cameco 2021).

11.1.3.2 Contemporary Indigenous Land and Resource Use in the Region

This subsection is organized by Indigenous community for each of the ILRU topics and uses considered in the assessment, which include:

- **Hunting:** Topics included are the cultural importance of hunting; harvested big game, small game, and bird species; and seasonality where that information has been provided.
- **Trapping:** Trapping has traditionally been an important activity for Indigenous communities. The species trapped can be used for sustenance, utility (e.g., pelts), spiritual, and medicinal purposes. (Trapping for commercial purposes is covered in Section 11.2.3.2).
- **Fishing**: Fishing has traditionally been an important activity for Indigenous communities for providing food. (Fishing for commercial or recreational purposes is covered in Section 11.2.3.3).
- **Plant Gathering:** Indigenous communities gather plants for food, medicine, and ceremonies.
- **Sacred and Cultural Sites:** Examples of sites with tangible culture include traplines, kills sites, cabins, and Indigenous communities. Additional sites can have ceremonial or spiritual purposes.
- **Navigation, Access, and Occupation:** Travel routes and access are important to understanding an Indigenous community's spiritual and cultural relationship with the broader landscape and the practical aspect of uninhibited access to resource harvest locations. Seasonality is provided as is known. Together, travel, access, and habitation / occupation sites such as cabins and campsites help create a sense of place or cultural landscape because they underscore their relationship with the land, which supports their worldview and cultural transmission. Protection of traditional use cabins were specifically mentioned by a participant in Spring 2022 engagement activities (22-EN-SUR-652.53).

The timeframe considered is 1950 and forward, or 'in living memory', meaning within or during a time that is remembered by people still alive as recommended in Technical Guidance for Assessing the Current Use of Lands and Resources for Traditional Purposes under the *Canadian Environmental Assessment Act 2012* (CEAA 2015). Future ILRU is also included and relates to forward looking community goals and aspirations for land and resource use as shared by communities.

11.1.3.2.1 English River First Nation/Patunuak

Background

The land, water, and air are highly valued by ERFN and its members as a source of sustenance, spiritual growth, and linkages between the past and present (DPRA 2013a). In ERFN led studies, participants describe their connection to the land:

> "*it's like our plate; it gives us everything. The land gives us the food that we need, it gives us the clothing that we need, it gives us the heartbeat that we need. The trees in the*

> *area also provide us with shelter and also provide us with medicines in the area. So that's really critical to us. The waters are also very important to us; without the waters, we're not alive, and that's one of the things. The forestry itself, it creates life, because the medicines we get from them is really important to us, the traditional medicines", and… my relation to the land is based on respect. I know that we're not the only ones on this earth, that was taught to us by our parents and our grandparents, and so because of that those kind of values kind of stick to your mind for the rest of your life*". (ERFN and SVS 2022b).

The ancestral Lands or traditional territory of the ERFN is called "Nuhtsiye-kwi Benéne", which refers to the lands that ERFN calls home (ERFN and SVS 2022b). The ERFN's Nuhtsiye-kwi Benéne, includes:

> "*Maintaining, if not improving, environmental quality within ERFN's traditional territory, to support current and future traditional uses (including hunting, trapping, fishing, wild rice production, collection of berries and plants, recreation, spiritual practices) … [and] controlling issuance of Provincial permits for exploration and 'recreational' leases on Crown land*" (DPRA 2013a p. 61).

As part of the health and socio-economic study conducted in 2021, interviewees reported a growing desire for community members to re-engage and reconnect to these traditional activities, noting that this passion should be further supported by the band and by Denison (ERFN and SVS 2022a).

General patterns of ILRU were verified for accuracy with the ERFN Trapper during an interview in October 2019.

Hunting

Numerous species are hunted and consumed by ERFN/Patuanak residents (CanNorth 2017). Moose, snowshoe hare, and woodland caribou contributed the most to their diet; a full list of hunted species is provided in Table 11.1-3 (CanNorth 2017). Waterbird and waterfowl were recorded to be the least consumed country food type (CanNorth 2017). ERFN and SVS (2022b) did not describe waterbird and waterfowl harvests in their study area.

Table 11.1-3: Species Harvested by English River First Nation

Large Mammals	Small Mammals	Birds
Moose	Snowshoe Hare	Canada Goose
Barren ground caribou		Canvasback Duck
Black bear		Mallard Duck
White-tailed / Mule deer		Ptarmigan
Woodland caribou		Ruffed Grouse
Elk		Spruce Grouse
		Common Teal
		Wood Duck
		Bird eggs

Source: CanNorth 2017

Hunting occurs throughout Nuhtsiye-kwi Benéne. Big game hunting sites were documented in areas proximal to ERFN/Pataunak, along with areas around Cree Lake, and areas along the Key-Lake McArthur River haul road (ERFN and SVS 2022b). A member of the ERFN Nuhtsiye-kwi Benéne Committee (Ancestral Lands Committee), noted that moose is a mainstay for the community (21-EN-ERFN-473.12) and another member noted that moose is what "*we have in our freezer*" (21-EN-ERFN-473.18). Based on 2010 and 2011 interviews with ERFN/Pataunak residents conducted as part of the Millennium EIS, Highway 914 and adjacent trails are used for hunting moose (InterGroup 2011a). Brown Lake was also noted specifically as a moose hunting area (21-EN-ERFN-473.17).

Three moose hunting locations documented in the ILRU LSA were used more than 10 years ago (ERFN and SVS 2022b). Two moose hunting areas were documented along the Key Lake – McArthur River haul road within the last 10 years (ERFN and SVS 2022b). The ERFN Trapper provided some observations on species' population and distribution trends and noted that moose are less dense in the LSA, preferring habitat north of the Project (19-LK-ERFNTrap-134.172). Other ERFN members have noted concerns about food sources for moose, along with concerns about contamination (ERFN and SVS 2022b).

Caribou have been the most frequently sighted big game between Russell and McDougall lakes (19-LK-ERFNTrap-134.174). Two woodland caribou hunting areas were documented along the Key Lake – McArthur River haul road within the last 10 years (ERFN and SVS 2022b). Overall, the ERFN Trapper reported that similar numbers of caribou are present in the Project Area compared to past years, but fewer moose (19-LK-ERFNTrap-134.177). Elders interviewed for the ERFN *Aboriginal Traditional Knowledge Study Summary Report* (ERFN 2011) have identified that woodland caribou may be losing their calving areas due to forest fires and may be moving elsewhere to have their calves. Other threats to woodland caribou include industry (like mining), exploration, and tourists in the summer (ERFN 2011). Specific concerns about disturbances to lichen, as a food source for caribou, were identified – either resulting from industrial activities or from the presence of more people (ERFN and SVS 2022). Elders have expressed concerns that future generations will not see an abundance of wildlife like there used to be and have mentioned that TK is important to the protection of woodland caribou (ERFN 2011).

Trapping

Trapping areas were documented throughout Nuhtsiye-kwi Benéne (ERFN and SVS 2022b). Many northern trappers supplement their family's diets with meat from harvested furbearers, which, when smoked, can be delicacies. Edible furbearers include beaver and muskrat. The tradition of hunting is often passed down when children are taught to shoot small game before the age of 10 (SERM 2000). Education of future generations through youth camps and experiences on the land are valued by ERFN as opportunities to share knowledge and traditions.

Like commercial trapping described in Section 11.2.3.2, subsistence trapping is conducted concurrently with commercial trapping or other traditional activities generally from November to April. The ERFN Trapper of the area consumed small lynx, muskrat, and beaver from his trapline, but there "*are fewer around than in the past*" (19-LK-ERFNTrap-134.66). One additional harvester noted they have harvested wolf and beaver for personal use over the last 20 years at locations between Pinehouse and the McArthur River Mine (ERFN and SVS 2022b).

A description of commercial trapping is in Section 11.2.3.2.

Fishing

Fishing occurs throughout Nuhtsiye-kwi Benéne (ERFN and SVS 2022b). Species harvested include Walleye and Whitefish, which are the first and fourth most consumed country food (CanNorth 2017). Other fish species harvested in lower quantities include Northern Pike, Sucker, Sauger, Lake Trout, Cisco (tullibee), Burbot, and Yellow Perch, among others (CanNorth 2017).

The ERFN Trapper reported fishing for personal and commercial use in Russell Lake, Moore Lakes, Kratchkowsky Lake, and Moon Lake. Their preferred fish for consumption included Northern Pike, Whitefish, and Trout (19-LK-ERFNTrap-134.138). Additional fishing locations were documented, including Russell Lake for Whitefish, the Wheeler River bridge for Walleye, and other local waterbodies within the last 10 years for Whitefish, Northern Pike, and Lake Trout close to the Project (ERFN and SVS 2022b). The ERFN Trapper stated that more cabins in the area "*has affected me because there are more boats on the lakes. More boats on the lakes leads to more overfishing, anglers also cut access trails to lakes*" (19-LK-ERFNTrap-134.25).

Gathering

Berry picking and medicinal plant harvests were documented close to the community (SIAST 2003). CanNorth (2017) reported the use of berries including blueberry, wild raspberry, bog cranberry, and wild strawberry. Wild rice, wild mint and Labrador tea, rat root (*Acorus americanus*), mushrooms, carrot and others were also recorded (CanNorth 2017). CanNorth (2017) did not record harvest locations. The ERFN also spoke of an important plant called 'medicine stick' found on the north and south shores of Cree Lake (17-EN-ERFN-104.2).

Personal harvesting areas occur throughout Nuhtsiye-kwi Benéne, and were identified proximal to ERFN/Patuank, Cree Lake, and in areas along Highway 914, including areas north of Mawdsley Lake to areas past the McArthur River operation. Four berry collection locations were documented by four individuals in the LSA (ERFN and SVS 2022b). Berries collected included blueberries, cranberries, and raspberries over the last 20 years (ERFN and SVS 2022b). The ERFN Trapper stated "*I might eat some berries while I am walking around but I don't gather berries. I don't drink Labrador Tea*" (19-LK-ERFNTrap-134.124). Concerns about any spills or accidents relative to personal berry harvesting were identified, along with how mining traffic might affect access to berry picking areas or affect the quality of blueberries (ERFN and SVS 2022b).

Occupancy, Cultural Sites, and Navigation

"The places where the people of ERFN have settled, moved, and occupied the land over time is a key in understanding their rights to the land" (ERFN and SVS 2022b). Participants in ERFN's Wheeler River TK study, documented 61 cultural sites across Nuhtsiye-kwi Benéne. These cultural sites included birth sites, burial sites, historic family village sites, historically important sites, gathering places, recreation areas, and other sites of cultural importance (ERFN and SVS 2022b).

In a 2018 workshop with Denison, former ERFN Chief McIntyre spoke of the origins of local place names and the presence of important cultural sites in the Project Area:

> "*Since 1906, the area where you're working has been Treaty 10 land…[and] those lands were the primary area of ERFN and contain burial sites and birth sites of ERFN members. The Dene name of the Wheeler River, Russell Lake and Cree Lake all come from the Denésuliné of English River. The Elders have always expressed that it's a primary area of ERFN. One of our late Elders was born north of there in 1922. Our traditional gathering place is there*" (18-EN-ERFN-5.1)."

Sites located close the Key Lake gate include a historical family village site and birth site. An overnight location is present on an unnamed lake just east of the Project and adjacent to the Key Lake – McArthur River haul road (ERFN and SVS 2022b).

Numerous cabins and canoe routes are documented throughout the ERFN traditional territory (SIAST 2003). Cabins are concentrated along the Churchill River system and scattered throughout trapping blocks N-16 and N-18 as are canoe routes. One route extends from the community to north of Cree Lake. Camping sites were documented at Knee Lake and on the Haultain River (SIAST 2003). A series of trails also access large portions of ERFNs traditional territory (SIAST 2003). ERFN occupancy (cultural sites and overnight sites), show concentrations of use at Cree Lake, the

Haultain River, Mawdsley and Costigan Lakes, Russell Lake, Wheeler River, as well as the Patuank and Churchill River area (ERFN and SVS 2022b).

The ERFN maintains a cultural camp at Kilometre 160 of Highway 914 where the highway crosses the Haultain River. The St. Louis School holds a camp for students each September at this location while the community moose hunt is underway (Cameco 2013). Many families gather in the area and set up a main camp along the highway near the Haultain River. Other families set up camps in proximity to the main camp at locations to which they have historic land and resource use ties. The camp provides opportunities for Elders to interact with youth in land-based activities such as berry picking, fishing, target practice, moose hunting, nature walks, and other activities (Cameco 2013). Additional culture camps were reported to occur in the first week of July (families), the second week of July (Elders), and in winter (DPRA 2013a). Former ERFN Chief McIntyre expressed the importance of the cultural camp: "*For many years I've invited (the media) to come to our gathering on the Key Lake road, to showcase and impress on the world that we're still using those areas*" (18-EN-ERFN-5.3).

Access beyond the Key Lake gate is restricted, although some resource users and members of ERFN are provided access to the Key Lake – McArthur River haul road if they are on the Ministry of Environment list, or have received a gate access pass. Some resource users are reported to use the decommissioned Fox Lake road to bypass the gate (19-LK-ERFNTrap-134.225; ERFN and SVS 2022b). The Fox Lake Road was approved for decommissioning in February 2014 and, after engagement with ERFN and Pinehouse, ERFN wrote a letter expressing interest and later in 2016, received responsibility for the bridge over Davis Creek (Denison 2022). The ERFN members now drive the decommissioned Fox Lake road in trucks to the Davis Creek bridge. Members will transfer to quads or snowmobiles (depending on the season and conditions) once the road becomes impassable by vehicle. The bridge over Davis Creek provides access to more territory as the next large creek crossing is at Moon Creek (Denison 2022). No access routes or culture/historical trails were identified as intersecting with the Project site (ERFN and SVS 2022b).

The ERFN Trapper had been splitting his time between a primary residence on the Wheeler River (junction of Moon Creek and Wheeler River on Three Island Lake) and another cabin at the southwest end of Russell Lake. A third cabin is located on Phillips Lake and was used to stage resource use activities further away (InterGroup 2011a, KPI Program). The ERFN Trapper was also noted to have siblings who use the cabins (17-EN-ERFN-104.4).

11.1.3.2.2 Kineepik Local #9 (Pinehouse)

Background

The Northern Village of Pinehouse is situated on the southwest shoreline of Pinehouse Lake. The integrity of the natural environment is highly valued by Pinehouse residents, as it is a source of sustenance, spiritual growth, and linkages between the past and the present (DPRA 2013b).

Pinehouse's vision statement reflects this: "*Pinehouse is a holistic, healthy, self-sustaining community. We will continue to work in unity to reclaim our community through positive values and Indigenous identity"* (Northern Village of Pinehouse 2011). The Pinehouse visioning and strategic planning exercises provide insights into the values, goals, and objectives of the community including key issues related to the natural environment:

- maintaining, if not improving, environmental quality in Pinehouse and the surrounding area, to support current and future traditional use (including hunting, trapping, fishing, wild rice harvesting, collection of berries and plants, recreation, and spiritual practices) and community uses (e.g., recreation); and
- protecting the integrity of the natural environment, particularly areas of value for community use (DPRA 2013b).

The people of Pinehouse rely heavily on subsistence food sources obtained from hunting, trapping, fishing, and gathering and, based on a study conducted from 1983 to 1984, Pinehouse residents derived one-third of their annual income in-kind from the natural environment (Tobias and Kay 1994). The lakes and rivers in the area are used extensively by residents to fish (commercially, and for subsistence), trap (in fur block N-11), and hunt (SIAST 2003).

Currently, the high cost of hunting, fishing, and related activities is an ongoing challenge, limiting the participation of some residents (DPRA 2013b). Overall, practice of these traditional and/or 'income-in-kind' activities are still prevalent today as a vital part of the Pinehouse economy and survival of its residents (DPRA 2013b). The Northern Village of Pinehouse (2011) reported that their traditional lands are about 15,000 km^2 in area and extend 250 km north of Cree Lake, west of Knee Lake, east to Russell Lake and south to Emmeline Lake located between Beauval and La Ronge (Northern Village of Pinehouse 2011).

<u>Hunting</u>

Big game hunting areas are documented west of the community around the headwaters of Sandy Lake, north of the community along the Haultain River system that is parallel to Highway 914, and east of the community, in the headwaters of Sandfly Lake (SIAST 2003). Hunting occurs year-round (SERM 2000). Bird hunting was recorded in numerous locations around Pinehouse Lake and the shorelines of Sandfly Lake (SIAST 2003).

Highway 914 and adjacent trails are used for opportunistic hunting for moose. The 2011 and 2018 land use and occupancy results portray dense caribou and moose harvests along Highway 914 south of the Key Lake Mine. Scattered harvests are noted around Cree and Russell lakes, but in very low concentrations. Bear hunting is not documented north of the Key Lake Mine, but is common in areas around the community. Deer harvests are not recorded north of the Key Lake Mine (Tobias and Associates 2018b).

A great variety of waterbirds, waterfowl, and upland game bird species are harvested by Pinehouse residents in a geographic pattern similar to big game hunting; for example, harvest sites are the most dense in areas near the community, concentrated along the Highway 914 corridor south of Key Lake, and scattered around Cree and Russell lakes in very low concentrations (Tobias and Associates 2018b).

Species hunted are listed in Table 11.1-4**.**

Table 11.1-4: Species Hunted by Pinehouse Residents

Large Mammals	Small Mammals	Birds (waterbirds, waterfowl, and upland birds)	
Black bear	Snowshoe Hare	American Coot	Merganser species
Moose	Porcupine	American Wigeon	Northern Pintail
White-tailed deer		Black Scooter	Northern Shoveler
Woodland caribou		Blue-winged Teal	Ptarmigan
		Bufflehead	Red-breasted Merganser
		Canada Goose	Red-necked Grebe
		Canvasback	Ring-necked Duck
		Common Goldeye	Scaup species
		Common Loon	Scooter species
		Common Merganser	Snow Goose
		Grebe species	Surf Scooter
		Green-winged Teal	Teal species
		Grouse	Tundra Swan
		Mallard	White-winged Scooter

Source: Tobias and Kay 1994, Tobias and Associates 2018b.

Trapping

Trapping was most common around the shores of Pinehouse Lake and on the Churchill River system between Sandy and Sandfly lakes and Gordon Lake in the north. These harvest areas are within the area and consistent with Tobias and Kays' findings that trapping occurred within the N-11 trapping block. Tobias and Kay (1994) listed three edible species derived from trapping: lynx, beaver, and muskrat, which, together, contributed to a small portion of the subsistence diet at approximately 4%.

Additional fur data points provided by the Tobias and Associates studies included beaver and muskrat harvests on the shores of Cree Lake and Weitzel Lake northwest of Cree Lake (Tobias and Associates 2018b). A description of commercial trapping is in Section 11.2.3.2.

Fishing

The lakes and rivers in the Pinehouse area are fished extensively by residents (commercially and for subsistence) (DPRA 2013b). Fishing also has been documented on the waterbodies around the Key Lake Mine and the Wheeler River west of the Key Lake – McArthur River haul road bridge using primarily rod and reel fishing (Tobias and Associates 2018b). The concentration of fishing effort in the Wheeler River and Key Lake Mine areas are low in comparison to areas around the Pinehouse community (Tobias and Associates 2018b). Species fished for food are listed in Table 11.1-5.

A description of commercial fishing is provided in Section 11.2.3.3.1.

Table 11.1-5: Species Fished by Pinehouse Residents for Food

Food Fish	Bycatch
Lake Whitefish	Cisco
Northern Pike	Burbot
Perch	
Lake Trout	
Walleye	
White Sucker	

Source: Tobias and Kay 1994, Northern Village of Pinehouse 2011, Tobias and Associates 2018b.

Gathering

Products gathered by Pinehouse residents include berries, fuelwood, construction logs (Tobias and Kay 1994), mushrooms, moss, blueberries, medicinal plants, and decorative floral products (SIAST 2003). The land use and occupancy studies in 2011 and 2018 identified the collection of moss, bird eggs, specialty plants, and other unspecified plants listed in Table 11.1-6.

Berry gathering is documented around the Key Lake Mine and to the south adjacent to Highway 914. Several medicinal plant harvest sites are also adjacent to Highway 914 south of the Key Lake Mine. Firewood and specialty wood collection sites are sparse on Russell Lake. Bird egg gathering is very common around the lakes and waterbodies near the community, but is not recorded north of Key Lake (Tobias and Associates 2018b). The vast majority of gathering occurs closer to the community and on the N-11 trapping block.

Table 11.1-6: Species Gathered by Pinehouse Residents

Gathered Products	
Berries	Moss
Bird eggs	Mushrooms
Construction logs	Other plants
Firewood	Specialty wood
Medicinal wood	

Source: Tobias and Kay 1994, SIAST 3003, Northern Village of Pinehouse 2011, Tobias and Associates 2018b.

Occupancy, Sacred and Cultural Sites, and Access and Navigation

Land use and occupancy studies recorded birth, death, and burial sites, meeting sites, heritage cabins, settlements, and legend or spirit sites. None were recorded north of the Key Lake Mine (Tobias and Associates 2018b). One heritage cabin was identified on the opposite (east) side of Highway 914 near the south end of the decommissioned Fox Lake road (Tobias and Associates 2018b). The area around cabins is considered sacred to Pinehouse residents. The Northern Village of Pinehouse (2011) explained that "*Children are taught how to harvest a moose, how to smoke fish or snare a rabbit at these cabins*" and "*being on the land and water is peaceful and spiritual*".

The Northern Village of Pinehouse (2011) reported that "*all the lakes are accessible by trails, roads and canoe routes. There are traditional bush cabins dotted all over them*". Gordon Lake was reported to be a community gathering place for Pinehouse residents (Cameco 2013). Family camps were also reported further north along Highway 914 although the use of those camps had only been prevalent since the 2000s (Cameco 2013). The community also hosts week-long cultural camps in summer and winter for local Elders, youth, and families. Each year there are two Elder camps at Gordon Lake, one in the early summer and another in the fall, as well as several youth camps at Muskeg Lake. Elder camps are as large as 60 individuals, with youth camps ranging from 20 to 60 participants (InterGroup 2011a).

Overnight sites consist of temporary shelters of tents, shack-tents, and lean-tos based on the interviews conducted by Tobias and Associates (2018b). These sites are dense along Highway 914 and on adjacent waterbodies south of the Key Lake Mine. Other overnight sites are located at the Key Lake Mine, possibly associated with employment there. Russell lake and the Wheeler River on the west side the Key Lake – McArthur River haul road also has camping locations identified, as do the shores of Cree Lake. No sites were identified near the proposed Project site (Tobias and Associates 2018b).

11.1.3.2.3 Métis Nation – Saskatchewan

Background

"*Land and resource use forms an integral part of Métis ways of knowing, doing and living*" (MN-S and Two Worlds Consulting 2023). The Métis in NR1 and NR3 follow a seasonal cycle of land and resource use and have developed an intricate understanding of where resources are available at different times of the year. "Historically, these activities reflected a reliance on the natural environment to sustain both family and the Métis economy" (MN-S and Two Worlds Consulting 2023). *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) identified three land and resource use areas of interest, including areas described as:

- the Project area representing uses and Métis Knowledge around the Wheeler River site, including Wollaston Lake, McArthur River, Key Lake, and South of Key Lake;
- the Churchill River Watershed representing uses and Métis Knowledge southwest of Cree Lake, near Beauval, Pinehouse, and Patuanak (land use concentrated in NR3); and
- Cree Lake representing uses and Métis Knowledge west of Highway 914 and south of Lake Athabasca.

The traditional and commercial harvests of Métis people are deeply intertwined, with activities pursued for both trade and familial sustenance. Activities such as fishing, trapping, and food gathering are foundational to the traditional economy (MN-S and Two Worlds Consulting 2023).

The concept of kiyowekin, or the practice of visiting, facilitates a connection between people and the land and "this relationship-based understanding underpin(s) how Métis gathered, shared, cared for relatives, saw the land as a relative, and enacted decision-making across communities" (Flaminio, Gaudet, and Dorion 2020; MN-S and Two Worlds Consulting 2023). As described by one participant in the study report (MN-S and Two Worlds Consulting 2023):

> "*My Uncle, he's a pretty quiet man, but he's the kind of guy that could come across and talk about lands and resources but he doesn't have time. He loves his land… you know, that's beautiful to see – our culture."*

The Wheeler River Project: Métis Knowledge Study Report (MN-S and Two Worlds Consulting 2023), in describing harvesting activities, noted the importance of multi-generations spending time on the land together and its contribution to knowledge transfer and reinforcement of Métis values. The study report also described the key factors affecting Métis land and resource use over time, including:

- imposed government programs and policies, such as the establishment of the Treaties; the game laws and fishing restrictions created by the federal and provincial governments; and the creation of the Primrose Lake Air Weapons Range;
- changes to wildlife behaviour, particularly changes to woodland caribou behaviour as a result of habitat loss, climate change, and other environmental changes; and
- development activities, including various on-going uranium operations; access roads and highways; creation of campgrounds and recreation areas; presences of lodges, outfitters, and tourism; hydroelectric and transmission facilities; and abandoned mines.

Residents of Beauval conduct hunting, trapping, fishing, and gathering. A network of cabins, campsites, trails, and waterways support that use (SIAST 2003). Land use patterns are focussed on Lac la Plonge, Doré Lake, and along the Highway 155 corridor southwest of the community (SIAST 2003).

Hunting

Métis hunting occurs throughout the homeland and in NR1 and NR3. Areas for hunting were identified along Highway 914 north and south of the Key Lake Mine, along the Fox Lake Road, and west to the areas surrounding Cree Lake (MN-S and Two Worlds Consulting 2023). The species harvested by Métis citizens in NR1 and NR3 are identified in Table 11.1-7, although not all species are present proximal to the Project.

Table 11.1-7: Species Hunted by MN-S NR1 and NR3 Citizens

Large Mammals	Small Mammals	Birds (waterbirds, waterfowl, and upland birds)	
Black bear	Rabbit	Ptarmigan	Ruffed grouse (“chicken”)
Woodland caribou		Black duck	Swan
Barren-ground caribou		Mallard duck	
Moose		Other ducks and waterfowl	
White-tailed deer		Geese	

Source: MN-S and Two Worlds Consulting 2023

To harvest game, Métis use guns or snares, although the hunting method depends on the time of year and location. Large mammals are typically field dressed while further skinning, curing, and boiling of game meat may occur in other locations. Hunting trips may be short (e.g., a day) or extending over days or a season. Participants in *The Wheeler River Project: Métis Knowledge Study Report* noted overlap with cultural camps, such as those located near Patuanak or Kilometer 160 of the Key Lake Road (MN-S and Two Worlds Consulting 2023).

The Fox Lake Road was identified as an important route for accessing hunting grounds and connecting different areas of use, with *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) observing, “We hunt moose… Fox Lake Road. We did hunting and fishing up there. My grandpa and them used to do a whole bunch of commercial fishing in all the lakes here.”

For residents of Beauval, big game hunting was recorded along Highway 155 (southwest of the community) and along Highway 165 (west of the community) and on the shorelines of Lac la Plonge and Doré Lake based on 24 interviews conducted by SIAST (2003). Bird hunting focussed on local waterbodies and rivers. Trapping was recorded exclusively within trapping block N-12. Fishing was recorded at Lac la Plonge and Doré Lake (SIAST 2003).

Although preference for species varies among individuals, moose and caribou are collectively considered an important cultural food source. Other small game such as ducks, geese, rabbit, and chickens also support the traditional diet. Moose are harvested north and south of the Key Lake Mine and along the Fox Lake Road. Rabbit and chicken were recorded as harvested south of the Key Lake Mine. The Project site was identified as an area that overlaps with a caribou hunting area, and caribou have also been hunted between the Key Lake Mine and Cree Lake. Hunting and reciprocity are closely tied, and harvesters often share game with others in the community and among family members (MN-S and Two Worlds Consulting 2023).

Trapping

The Métis played a central role in the fur trade, and as such, trapping is understood as integral to Métis culture, family life, and relationship to the land. Historically, trapping was undertaken for food, clothing, and other household purposes, in addition to being an important source for trade. Historically trapped species included beaver, muskrat, weasel, fox, lynx, marten, otter, fisher, and raccoon, with the felt of beaver pelts sought after in the 17th and 18th centuries (MN-S and Two Worlds Consulting 2023). Species currently trapped by citizens in MN-S NR1 and NR3 are presented in Table 11.1-8. “Today, trapping continues less for income and more so for consumption” (MN-S and Two Worlds Consulting 2023), as also reflected in observations such as:

> *“Beaver and muskrat harvested in the spring and summer are eaten in the winter. Rabbits are caught by snares, skinned, and added to stews… (An) advisor recalled that their family relied on trapping to supplement food during times of scarcity:*
>
> > *And my dad was there, so he’d actually do, we had no food, so sometimes he’d set rabbits and snares, so he did a little bit trapping here.”*

Table 11.1-8: Species Trapped by MN-S NR1 and NR3 Citizens

Trapped Species*			
Beaver	Fox	Mink	Squirrels
Coyote	Lynx	Otter	Wolf
Fisher	Marten	Rabbit	Weasels
			Wolverine

Source: MN-S and Two Worlds Consulting 2023.

*Note: *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) does not specify which species are trapped for traditional or commercial purposes. It is assumed all species are traditionally trapped. Commercial trapping is discussed in greater detail in Section 11.2.3.2.

“*Trapping requires large expanses of land and is contingent on the annual cycles of animal abundance and availability. To prevent the depletion of resources, trapping areas were rotated by the tappers”* (Golder Associates 2022; MN-S and Two Worlds Consulting). Areas of importance for trapping were identified in *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023), including areas proximal to Highway 914 (both east and west of the highway) and south of the Key Lake Mine. Métis trapping also occurs near Costigan Lake.

“Trapping activities are also informed by the level of effort to trap different species. For example, wolf is more challenging to trap than smaller mammals such as mink. In addition to surrounding environmental conditions, access to trapping areas and established traplines remain important to Métis land and resource use. Métis have cabins near and along their traplines which supports their ability to practice trapping activities during all seasons (MN-S and Two Worlds Consulting 2023).”

Fishing

Subsistence fishing supports the traditional Métis diet, with the species harvested by NR1 and NR3 citizens identified in Table 11.1-9. Fishing methods vary by harvester, location, and time of year. For example, fish harvested in the summer are more likely to spoil during warmer temperatures, so are either consumed relatively soon after catching in the summer, or in some instances dried or smoked in the summertime to allow storage over the winter. During the winter, fish are more likely to be caught using nets (MN-S and Two Worlds Consulting 2023).

Table 11.1-9: Species Fished by MN-S NR1 and NR3 Citizens

Species Fished	
Cisco	Mullet
Jackfish	Trout
Pickerel	Whitefish
Mariah (burbot)	Walleye

Source: MN-S and Two Worlds Consulting 2023

Métis fishing cabins were identified on Cree Lake, Highrock Lake, Russell Lake, and Haultain Lake. Other fishing areas were identified proximal to the Key Lake and Cigar Lake operations (MN-S and Two Worlds Consulting 2023). The Fox Lake Road was an important road for accessing some fishing areas. An advisor in *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) shared that his grandfather used to fish on Russell and Close lakes before the mining development affected access to the area:

"Well, they used to fish…They used to fish in Russell and the mine's kind of took that out. My grandpa. Big trout in there…They didn't want them in there anymore. And they only let certain people through the gate now, like they don't even let regular people through the gate."

Gathering

Métis gatherings occur throughout NR1 and NR3 depending on the availability and accessibility of the species listed in Table 11.1-10. Berries are typically harvested in the summer and fall and are often prepared and stored for year-round use (e.g., canned or made into a quick jam). Other plants such a Labrador tea, rat root, and chaga are harvested in the spring and fall. Wild rice is harvested in the fall. Many plants have medicinal properties (MN-S and Two Worlds Consulting 2023).

Table 11.1-10: Species Gathered by MN-S NR1 and NR3 Citizens

Species Gathered		
Berries and fruit	**Plants**	**Eggs**
Blueberry	Rat root	Gull eggs
Saskatoon Berry	Firewood	Duck eggs
Chokecherry	Mint leaves and other herbs	
Cranberry	Chaga	
Raspberry	Wild rice	
Strawberry	Firewood	
Pin cherry	Labrador tea	

Source: MN-S and Two Worlds Consulting 2023

Gathering activities are often conducted by family and friends and often occur proximal to roadways, although certain plants located on islands require boat access. Berries are harvested along Highway 914 north and south of the Key Lake Mine and along the Fox Lake Road. Chaga is harvested off birch and other hardwood trees and is known to be found along the Fox Lake Road and the north shore of Cree Lake. (MN-S and Two Worlds Consulting 2023).

In the past, almost all Beauval families understood the power of plants to better their lives (University of Saskatchewan 2000). Plant knowledge keepers hold 'iyiniw Maskikiy' or 'Indian Medicine', which gives special attention to the medicinal properties of plants (University of Saskatchewan 2000). Natural products harvested include tree buds and black poplar pods, fresh willow tips, bear berry plants, red willow bark, rose hip, tamarack bark, Labrador tea, sphagnum moss, birch sap, spruce gum, and wild mint leaves. Berries harvested include cranberries, chokecherries, and blueberries, which are also used for medicinal purposes and overall health (University of Saskatchewan 2000).

The Wheeler River Project: Métis Knowledge Study Report (MN-S and Two Worlds Consulting 2023) highlighted the importance of Métis women in harvesting activities. Concepts such as kiyowekin (visiting responsibilities) and wahkotowin (kinship roles and responsibilities) hold importance to women, demonstrating "an intricate understanding of the seasons, ecosystems, and the optimal time for gathering specific plants or berries."

Occupancy, Cultural Sites, and Navigation

> *"Métis utilize cabins, traditional campsites, and travel routes across the Homeland. These activities are distinct from contemporary notions of camping and outdoor activities as they are inherently for land-based and cultural activities, including hunting, gathering, trapping, and fishing. Historically, Métis were understood as a "highly mobile population" and the notions of mobility and kinship are integral parts of Métis culture (McNab and Arlen 1992;* MN-S and Two Worlds Consulting 2023)."

The Wheeler River Project: Métis Knowledge Study Report (MN-S and Two Worlds Consulting 2023) noted that in the past, dog teams, snowshoes, and planes were common methods of travel. Today, skidoos, quads, ATVs, and other motorized vehicles (including planes) are more typically used. It may take several hours travelling over land to arrive at cabins, camps, and hunting and harvesting grounds.

The Métis use Highway 914 north and south of the Key Lake Mine and the Fox Lake Road to access resource harvesting areas. There are Métis cabins and camps located east of Upper Foster Lake, at Kilometer 160 west of Highway 914 near the Haultain River, on Russell Lake, and other locations near Highway 914 and the Fox Lake Road (MN-S and Two Worlds Consulting 2023).

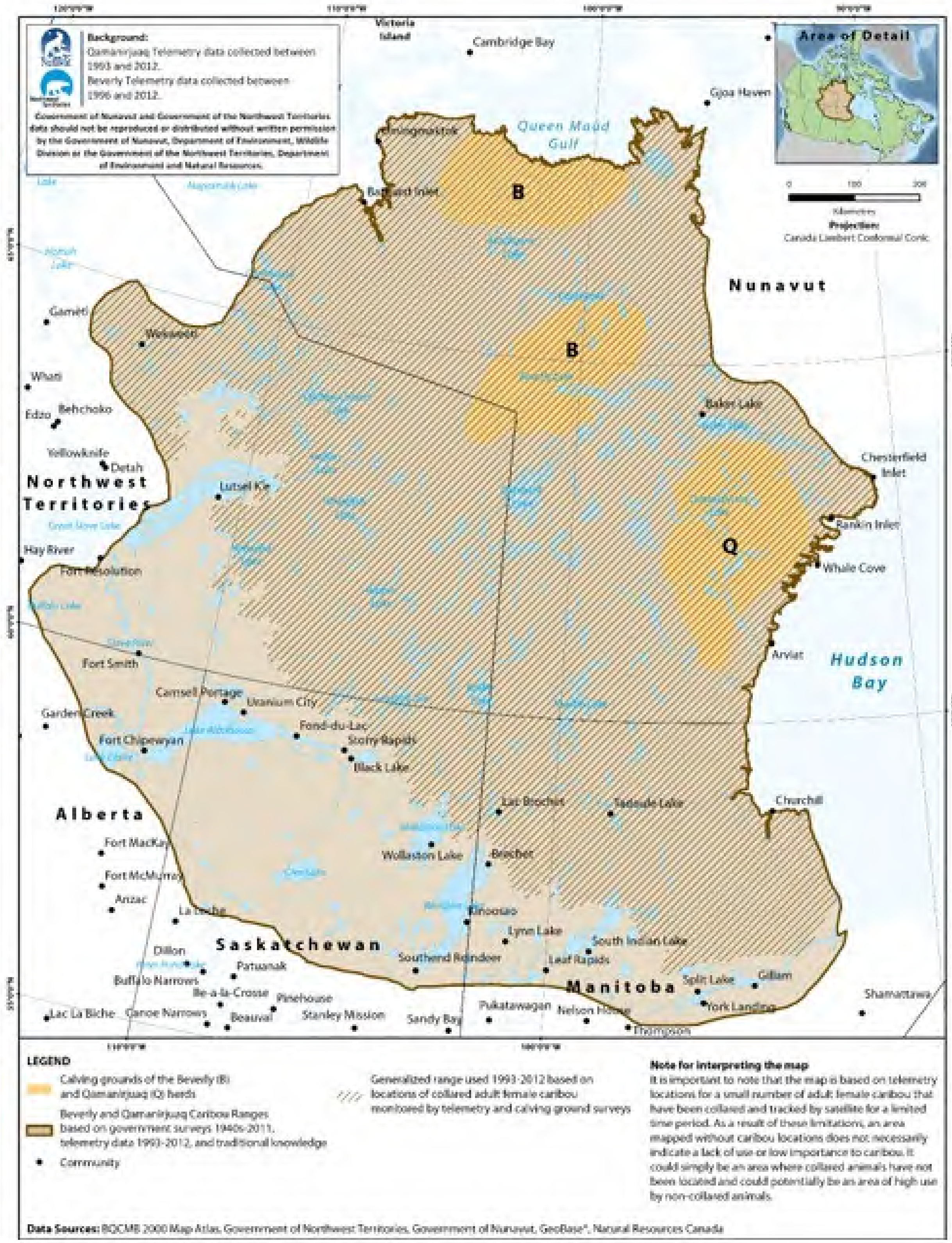
For residents of Beavual, family camping, historic, ceremonial, and burial sites are located on the shores of Lac la Plonge, on an island in Doré Lake, and in one location south of the community. Land-based and canoe routes link the resource harvesting locations, including Lac la Plonge, Dore Lake, the Beaver River, and other waterbodies local to the community. Cabins are scattered around the landscape to support resource harvesting activities (SIAST 2003).

11.1.3.2.4 Athabasca Denesųłiné Communities

Background

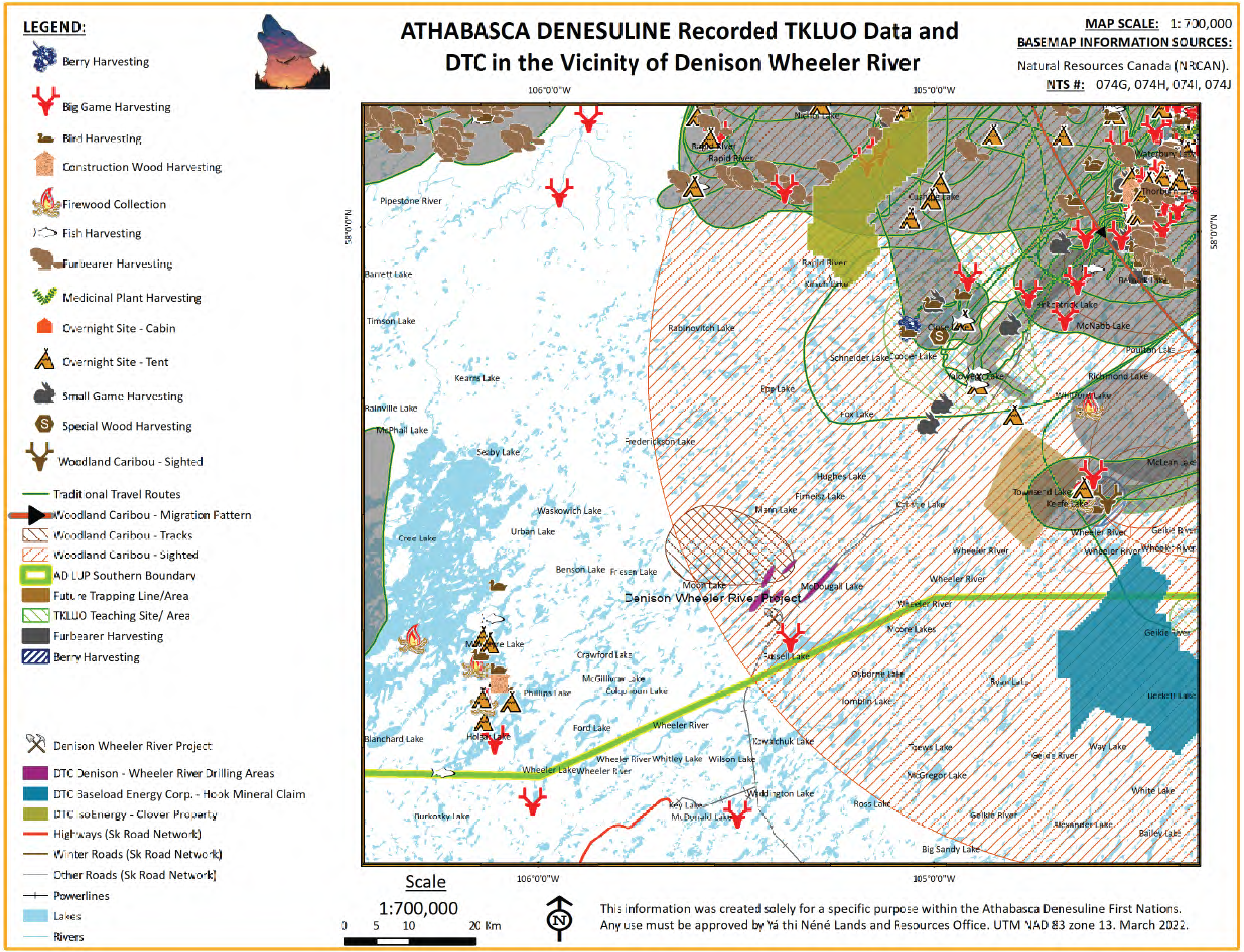
The YNLR (2022) state that Athabasca Denesųłiné "*culture, history and way of life are interwoven with the movements and health of the Beverly, Ahiak, Bathurst and Qamanirjuaq barren-ground caribou herds*". A map produced by the Beverly-Qamanirjuaq Caribou Management Board (BQCMB 2000), shows the range of the barren-ground caribou (Figure 11.1-5; YNLR 2022).

The Project is in the Nuhenéné, the traditional territory of the Athabasca Denesųłiné, on land within Treaty 10. Hatchet Lake First Nation is a signatory to Treaty 10. Fond du Lac First Nation and Black Lake First Nation are both signatories to Treaty 8. The Athabasca Denesųłiné shared multiple maps of their patterns of land use in their *An Exploration of Recorded Athabasca Denesųłiné Traditional Knowledge, Land Use and Occupancy Information in the Vicinity of Denison Mines Wheeler River Project* (YNLR 2022). Figure 11.1-6 provides a summary of uses in proximity to the Project. The YNLR (2022) note "*the land is also used for therapeutic purposes, youth gatherings, fish camps, and general camping. Accessible areas were utilized year-round for hunting, trapping and fishing with activities such as berry picking occurring in the summer*."



Source: BQCMB 2000, telemetry data updated in 2012. Note: map is based on telemetry locations for a small number of collared adult female caribou.

Figure 11.1-5: Extent of the Beverly Qamanirjuaq Caribou Range



Source: YNLR 2022

Figure 11.1-6: Athabasca Denesuline Recorded Traditional Knowledge, Land Use and Occupancy in the Vicinity of the Wheeler River Project

Hunting, Trapping, Fishing, and Gathering

Since the 1970s, over 500 Denesųłiné have participated in TK/oral history/land use and occupancy studies that recorded their lives, history and ILRU (YNLR 2022). The studies have been specific to other projects and initiatives (and therefore limited in geographic scope), but still offer information on general patterns of travel, important cultural sites, and hunting, trapping, fishing, and gathering locations have been documented (YNLR 2022). The YNLR note that these are likely only to be a sample of the collective knowledge and land use of the Athabasca Denesųłiné and are not specific to the Wheeler River site (YNLR 2022; see also Figure 6 in Appendix 3-A of Section 3).

The text herein provides a summary from secondary literature sources followed by relevant and available information extracted from the Athabasca Denesųłiné TK and land use and occupancy database. These data were used to generate the features displayed in Figures 7 and 8 of the YNLR report focussing on ILRU proximal and in relation to the Project Area (YNLR 2022), with Figure 8 of that report provided as Figure 11.1-6 in this section. A description of that ILRU is located at the end of this subsection.

Barren-ground caribou is the most important resource for the people of the Athabasca region and residents continue to harvest caribou for domestic purposes, although residents also harvest moose, black bear, and waterfowl. Modern times have reduced dependency on the caribou herds for survival, but the animal remains an important part of the culture and lifestyle of the people in the Athabasca region. The high cost of transporting food and other goods to the remote communities means that caribou meat, along with other wild foods, remains an important source of country food (BQCMB 2021).

Residents of the Fond du Lac and Black Lake areas follow the Beverly herd, while residents of Hatchet Lake/Wollaston Lake tend to follow the Qamanirjuaq herd (Meyer 1981). Due to unpredictable patterns of caribou migration, residents of the Athabasca region must sometimes travel into the Northwest Territories and Nunavut to hunt; however, some years the herds travel as far south as Wollaston Lake (InterGroup 2011b). The Beverly and Qamanirjuaq herds do not typically travel far enough south to include the area of most uranium mining operations within their territories (InterGroup 2011b).

Traditional food studies via the Community Based Environmental Monitoring Program occurred with the Black Lake Denesųłiné First Nation and Stony Rapids in 2018 and the Fond du Lac Denesųłiné First Nation in 2019. Results from both studies indicated that all barren-ground caribou harvesting sites were in the Northwest Territories (Canada North Environmental Services 2018; Canada North Environmental Services 2019). All respondents in both the 2018 and 2019 studies reported consuming barren-ground caribou, and the identified harvesting locations indicated that any barren-ground caribou consumed was harvested in areas north of the communities of Black Lake and Fond du Lac Denesųłiné First Nations, into the southern reaches of the Northwest Territories. The communities of Black Lake, Fond du Lac and Hatchet Lake reported to the Beverly and Qamanirjuaq Caribou Management Board that barren-ground caribou herds were not observed within Saskatchewan during the winter of 2020/2021 and that hunters had to travel significant distances (into the Northwest Territories) by snowmobiles to access caribou (BQCMB 2021).

Fishing for domestic use occurs throughout the year for various species. Lake Whitefish is a preferred fish species because it is easily smoked (InterGroup 2011b). Other food species used include Lake Trout, Walleye, Northern Pike, Arctic Grayling, and suckers. Fish have been a vital part of traditional life in the Athabasca region and continues to be prepared for consumption based on local, social, and cultural practices (Marles et al. 2000; InterGroup 2011b).

Traditional uses of forest plant species are numerous. Wood continues to be collected as an important heating fuel for homes throughout the region. Trees and plants also have cultural significance, including medicinal, ceremonial, and spiritual uses (InterGroup 2011b). Good berry picking spots are actively used around Athabasca Denesųłiné communities and on traplines (InterGroup 2011b). Berry-picking is also done opportunistically while out on the land. In addition to plant gathering, residents of Black Lake report gathering duck eggs in spring (InterGroup 2011b).

Additional sources, including the Community Based Environmental Monitoring Program (2018; 2019) and the socio-economic baseline assessment for the Tazi Twé Hydroelectric Project EIS (Golder 2013), recorded harvests of fish, moose, berries, snowshoe hare and spruce grouse in locations close to communities and distant from the Project.

A careful review of the local map of recorded Athabasca Denesųłiné land use information in the vicinity of the Project (YNLR 2022) illustrated one harvest site of large game on the shore of Russell Lake, and one big harvest site proximal to Key Lake in the LSA. The timeframe of these harvests is not known, though the use was recorded over the last 20 years. No other harvests are recorded in the LSA including harvests of small game, woodland caribou, fish, berries, or wood. Woodland caribou were sighted by Athabasca Denesųłiné members in the LSA and tracks have also been observed but no harvests were documented (YNLR 2022).

Overall, limited contemporary ILRU has occurred in the LSA, except for a single big game harvest reported on Russell Lake.

Occupancy, Sacred and Cultural Sites, Access and Navigation

Important sites were recorded on the YNLR (2020) local map of recorded Athabasca Denesųłiné land use information in the vicinity of the Project including overnight (tent) sites near Holgar and McIntyre lakes located within the LSA and east of Cree Lake.

A network of traditional travel routes is documented in the LSA. As part of engagement activities undertaken by Denison with the YNLR and the First Nation Chiefs, travel by a Hatchet Lake First Nation Elder from Hatchet Lake to the area near Russell Lake and the Highrock River was described as an area the nation has connections to (19-EN-HLFN-78.2). Also, the area towards Cree Lake and the Gieke River are areas where the Dene travelled (19-EN-HLFN-78.2).

Current sites, such as cabins, were not documented in the LSA. Camping sites and navigation were documented based on historic use of the LSA by the Hatchet Lake First Nation.

11.1.4 Assessment of Project-related Effects

11.1.4.1 Potential Interactions Between the Project and Valued Component/Key Indicators

The Project will require the Construction, Operation, and Decommissioning of several components (as described in Section 2 Project Description). Potential interactions between these Project components and activities and the OLRU VC and its associated KIs are summarized by Project phase and activity in Table 11.1-11.

Potential interactions in Table 11.1-11 are ranked as:

- **Primary Interaction** (✓): Project activity is expected to interact with the VC/KI which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- **Other Interaction** (✓): Project activity is expected to interact with the VC / KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- **No Interaction**: Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

Table 11.1-11: Potential Project Interactions for Indigenous Land and Resource Use

Project Phase/Activity	Indigenous Land and Resource Use		
	Resource availability for harvesting subsistence resources	Land/waters available for traditional practices	Perceived suitability of lands and resources therein
Construction Activities			
Development of access roads and air strip	✓	✓	✓
Site preparation and earthworks; clearing, leveling and grading of the Project Area	✓	✓	✓
Power generation – generators	✓	✓	
Installation of main substation and distribution of power around site	✓	✓	
Wellfield and freeze hole drilling; ground freezing	✓	✓	
Ground freezing	✓	✓	
Batch plant operation (concrete); crusher at borrow area	✓	✓	
Development of surface infrastructure (camp, operations centre, plants, ponds, pads, and support facilities)	✓	✓	

Project Phase/Activity	Indigenous Land and Resource Use		
	Resource availability for harvesting subsistence resources	Land/waters available for traditional practices	Perceived suitability of lands and resources therein
Waste management (composting, domestic and industrial landfill operation, recycling)	✓	✓	✓
Water management (including treatment and site runoff)	✓	✓	✓
Groundwater supply		✓	✓
Surface water withdrawal	✓	✓	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	✓	✓	
On-site and off-site operation of vehicles and transport of materials	✓	✓	
Air transportation for workers	✓	✓	
Regulatory site inspections			
Engagement – site visit from Interested Parties			
Employment and expenditures			
Operation Activities			
Operation of the ISR wellfield	✓	✓	
Wellfield and freeze wall drilling	✓	✓	
Operation and expansion of freeze wall		✓	
Batch plant operation (grout and cement); crusher in borrow area	✓	✓	
Expansion of pond and pads	✓	✓	
Operation of the processing plant and production of uranium concentrate	✓	✓	✓
Water withdrawal from groundwater or surface water body	✓	✓	✓
Management of surface water (including seepage and site run-off)	✓	✓	✓
Water treatment, both domestic and industrial	✓	✓	✓
Water release to surface water body	✓	✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	✓	✓	✓
Hazardous waste management (temporary storage, handling, and off-site transportation)	✓	✓	✓
Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates	✓	✓	✓

Project Phase/Activity	Indigenous Land and Resource Use		
	Resource availability for harvesting subsistence resources	Land/waters available for traditional practices	Perceived suitability of lands and resources therein
On-site and off-site operation of vehicles and transport of materials	✓	✓	✓
Power supply – primarily power from the grid, also generators and back-up generators	✓	✓	
Package and transport of nuclear substances	✓	✓	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	✓	✓	
Air transportation for workers	✓	✓	
Progressive decommissioning and reclamation	✓	✓	
Regulatory site inspections			
Engagement – site visit from Interested Parties			
Employment and Expenditures			
Decommissioning Activities			
Site water management, treatment, and release	✓	✓	✓
Mining horizon remediation and thawing of freeze wall		✓	
Process water treatment and release	✓	✓	
Closure of ISR and freeze wells and related infrastructure		✓	
Decontamination of surface facilities and injection, recovery, and monitoring wells	✓	✓	
Asset removal (including site power transmission lines and electrical infrastructure)	✓	✓	
Demolition and disposal of non-salvageable surface infrastructure and materials	✓	✓	✓
Remediation of contaminated areas (wellfield, pads, ponds, domestic water treatment location, and process plant area)	✓	✓	✓
Generators	✓	✓	✓
Waste management (composting and landfill operation)	✓	✓	✓
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)	✓	✓	✓

Project Phase/Activity	Indigenous Land and Resource Use		
	Resource availability for harvesting subsistence resources	Land/waters available for traditional practices	Perceived suitability of lands and resources therein
On-site and off-site operation of vehicles and transport of materials	✓	✓	✓
Reclamation of disturbed areas	✓	✓	✓
Regulatory site inspections			
Engagement – site visit from Interest Parties			
Employment and Expenditures			
Post-Decommissioning Activities			
Environmental monitoring	✓	✓	
Regulatory site inspections			
Engagement - Site visit from Interested Parties			

Not all activities are expected to interact with the resource availability of the species resource users depend on. For example, ground freezing (after site clearing has been completed), groundwater supply and release, and operation of the freeze wall were deemed to have no interaction and were not carried forward in the effects assessment as they are not expected to result in detectable changes in the MPs associated with ILRU.

Land available to conduct ILRU pertains primarily to the Project site and laydown areas (the Project Area) within which, all other Project infrastructure and activities will be situated. Indigenous land use will be restricted in the Project Area for safety reasons. Because other activities, except off-site transportation, are contained within the Project Area they are not carried forward into the effects assessment as they are encompassed within the Project Area.

Perceived suitability of lands and resources therein pertains to project activities relating to noise, air quality, water and waste management, changes in the relationship to land and changes in competition for resources during Construction and Operation and in Operation, the treatment of waste rock and radioactive plant precipitates and the packaging and transport of nuclear substances and their potential effect on human health. In Decommissioning, Project activities pertaining most to the perceived suitability of lands and resources include removal of hazardous and nuclear substances, remediation of contaminated sites, reclamation of disturbed sites, and the treatment of hazardous waste that will meet regulatory requirements. Final closure will rely on long-term monitoring to demonstrate successful final rehabilitation.

It is recognized that some interactions are the primary contributors to potential adverse effects on VCs and KIs. While all interactions are considered in the effects assessment, the primary contributors (i.e., the grey shaded cells in Table 11.1-11) will be the focus of the effects assessment for ILRU.

11.1.4.2 Potential Project-related Effects

Based on the timing and nature of the interactions identified in Table 11.1-11, the following pathway of effects have the potential to occur during the lifetime of the Project:

- changes to resource availability:
  - terrestrial resource availability;
  - aquatic resource availability; and
  - health of the resources.
- lands/waters available for traditional practices:
  - availability/accessibility of land; and
  - availability/accessibility of waterways.
- changes to the perceived suitability of land and resources therein:
  - aesthetic experience;
  - perceived suitability of resources for safe use; and
  - quality of resources for consumption.

The pathway analysis identifies potential Project-related effects on ILRU, identifies mitigation measures for these potential Project-related effects, and determines whether any of the potential Project-related effects can be sufficiently mitigated such that they are not expected to cause a residual adverse effect. Mitigation measures for each potential effect are summarized in Section 11.1.5.

11.1.4.3 Resource Availability for Harvesting Subsistence Resources

11.1.4.3.1 Terrestrial Resource Availability

Development of access roads and air strip and clearing, level and grading of the project site laydown and associated infrastructure may alter terrestrial habitat and the distribution and abundance of terrestrial wildlife important for hunting and gathering for food. Potential effects are predicted to begin in Construction, continue through Operation, and cease when reclamation activities have been completed in the Decommissioning phase when Project components are removed, and activities cease.

Terrestrial species important to Indigenous hunting include moose and woodland caribou. Other species, such as waterfowl and snowshoe hare, were identified among traditional food sources, but do not comprise the same volume of consumption (CanNorth 2017). Though other large terrestrial mammals are harvested, such as elk and white-tailed deer, these species are not found in sufficient abundance in the LSA to be assessed as part the Project. Indigenous Knowledge holders also stated barren-ground caribou have not used the Project region for decades. "*Barren ground caribou were last seen in the north Cree Lake area around 1983".* The ERFN Trapper indicated "*that they no longer come as far south because of the large fires that have burned across the north…. these fires may have created a barrier in search of food*" (19-LK-ERFNTrap-134.158). The ERFN Elders interviewed in 2011 also noted that woodland caribou may be losing their calving areas due to forest fires and may be moving elsewhere to have their calves. Other potential threats to woodland caribou include industry (like mining), exploration, and tourists in the summer (ERFN 2011). Elders have concern that future generations will not see an abundance of wildlife like there used to be and have mentioned that TK is important to the protection of woodland caribou (ERFN 2011). This assessment, therefore, focuses on potential effects to the abundance and distribution of moose and woodland caribou.

Moose: Known harvest points for moose in the LSA include:

- two moose by the ERFN in the last 10 years (ERFN and SVS 2022b);
- one moose northeast of the Project and five around Russell Lake by the KML and Pinehouse (Tobias and Associates 2018b); and
- one unspecified big game harvest by the Athabasca Denesųłiné on the shores of Russell Lake in an unspecified timeframe (YNLR 2022).

Moose are a valued species for the ERFN and KML and represent an important food source. For the ERFN, moose meat, organs, and other parts account for 72% of the mammal portions consumed in a year (CanNorth 2017). The ERFN has expressed concern that the abundance of moose has decreased since the 1980s with the construction of Highway 914 and more people using the area (ERFN and SVS 2022b).

The potential effect of alteration and/or loss of habitat on moose is based on vegetation removal and/or ground disturbance due to Construction of Project components and infrastructure and edge effects. Clearing of vegetation within the Project footprint during Construction will result in a loss of potential moose habitat (Section 9.3.4.2 in Section 9). The alteration of moose habitat is typically associated with sensory disturbances that may include anthropogenic noises, vehicle traffic, aircraft traffic, and increased predator access (Section 9.3.4.2 in Section 9).

Noise from Project Construction, Operation, and Decommissioning activities, including the camp, may contribute to alteration of potential moose habitat through displacing moose from using habitats around these features. Habitat alteration through sensory disturbance effects (such as noise, dust deposition, and artificial light) is expected to result in reduced habitat quality and effectiveness near Project components and adjacent to regional roadways. Direct habitat loss has been mitigated by reducing the size of the Project Area to the extent practicable during Project design.

Vehicle collisions are the most likely source of direct mortality for moose. Effective mitigation measures (e.g., breaks in snowbanks; speed limits; and exclusion fencing around contaminated waste pads and ponds) will be implemented to reduce moose mortality.

After mitigation, residual effects to moose are characterized as adverse and of low magnitude, meaning the overall abundance and distribution of moose for traditional harvesting should not be affected.

Woodland Caribou: Known harvest points for woodland caribou in the LSA include:

- two woodland caribou harvested by the ERFN in the last 10 years (ERFN and SVS 2022b);
- five woodland caribou around or north of Russell Lake by the KML and Northern Village of Pinehouse (Tobias and Associates 2018b)
- one unspecified big game harvest by the Athabasca Denesųłiné on the shores of Russell Lake in an unspecified timeframe (YNLR 2022).

The Wheeler River Project: Métis Knowledge Study Report (MN-S and Two Worlds Consulting 2023) also notes that the Project site overlaps with a known caribou hunting area, although the precise location of harvest is not disclosed.

Project activities and infrastructure may affect woodland caribou populations. Populations can be affected by the amount of habitat that may be altered or lost relative to its availability in the (Section 9.3.1 in Section 9) and by woodland caribou mortalities directly or indirectly attributable to the Project. Woodland caribou are an important cultural and subsistence species for Indigenous peoples. English River First Nation Elders have noted that forest fires are a contributing factor to caribou calving success and that future generations will probably not see the same abundance as a result (ERFN 2011). Métis citizens have observed woodland caribou migrating further north and intermingling with barren-ground caribou populations, and noted that wildfires have affected caribou migration patterns (MN-S and Two Worlds Consulting 2023).

The potential effect of alteration and/or loss of habitat on woodland caribou is based on vegetation removal and/or ground disturbance due to construction of Project components and infrastructure and edge effects. Habitat alteration through sensory disturbance effects (such as noise, dust deposition, and artificial light) will result in reduced habitat effectiveness near Project components and infrastructure reaching and along roadways in the ILRU LSA. The effect of habitat alteration and/or loss on woodland caribou is expected to be minimal during Post-Decommissioning, as regeneration of vegetation is expected to continue within reclaimed areas.

After mitigation, the residual effects of alteration and/or loss of available woodland caribou habitat is not expected to result in a change that will alter caribou habitat integrity to a point where populations cannot be sustained. As such, traditional harvest of woodland caribou is unlikely to be affected by the Project.

Gathering Plants for Food or Subsistence Purposes:

Plants harvested/collected for cultural use such as berries (19-LK-ERFNTrap-134.124, 20-LK-LEASESUR-267.40, YNLR 2022, CanNorth 2017; ERFN and SVS 2022b) are common within the various vegetation communities and ecosystems within the Vegetation RSA (Section 11.1.4.3.1). For example, a local land user shared that he eats blueberries while out walking but does not actively harvest blueberries or drink Labrador tea (19-LK-ERFNTrap-134.124). Another individual identified plant collecting as an important component of their land-based activities (20-LK-LEASESUR-267.40). For ERFN, berries are recognized as an important food source, with blueberries the most common berry type, followed by raspberry, Saskatoon berry, bog cranberry, and wild strawberry (CanNorth 2017; ERFN and SVS 2022). Other vegetation used by the ERFN include wild rice, wild mint, Labrador tea, wild roots, mushrooms, and carrot (CanNorth 2017).

Harvesting for personal use, including berries, is documented along Highway 914 and in areas proximal to the highway between Key Lake and McArthur River (ERFN and SVS 2022; MN-S and Two Worlds Consulting 2023). Gathering of berries, firewood, medicines, and other earth materials were not specifically identified as being gathered in the proximity of the Project Footprint, but rather large areas are identified. Nuhtsiye-Kwi-Benéne identified four specific berry collection locations, documented by individuals in the ILRU LSA (ERFN and SVS 2022b). Berries collected included blueberries, cranberries, and raspberries over the last 20 years over large swaths of land including the Project area (ERFN and SVS 2022b). The ERFN trapper collected berries opportunistically but did not collect any other plant / earth materials (19-LK-ERFNTrap-134.124). *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) identified berry and plant harvesting areas along Highway 914 and the Fox Lake Road. The closest gathering locations used by Pinehouse residents are located around Russell Lake where firewood and specialty woods are collected and likely associated with tent sites and camping (Tobias and Associates 2018b).

Changes to plant communities are expected primarily through surface land clearing, levelling, and grading during Construction, continuing through Operation until Decommissioning. Site preparation and construction activities during Construction will involve vegetation clearing and ground disturbance for all Project components. Some of the areas to be cleared have already been disturbed and/or cleared as a result of past exploration activities, which is expected to reduce new disturbances. Loss of vegetation is anticipated to occur during Construction but will continue during the remaining Project phases and until disturbed habitat is revegetated. Dust deposition along roadways may also affect plant communities.

The assessment of effects to vegetation predicts that the Project is not expected to result in a change to the vegetation abundance KI that will alter its integrity within the Vegetation RSA to the point where it is not sustainable or unavailable to contribute to ecological functions. This means that while potential exists for some loss of traditionally harvested species, the overall abundance to resource users will remain largely unchanged. Given the vast areas identified as being used for personal gathering purposes through the LSA, combined with limited change in vegetation in proximity to the Project, traditional harvest of plants for subsistence purposes is expected to continue in the LSA and RSA.

Summary of Effects

Harvest of terrestrial resources for food in the Project Area was conducted primarily by the ERFN Trapper, which included hunting and trapping for food and opportunistic harvest of berries in the ILRU LSA (Fur Block N-18). Despite his passing, the ERFN considers the Trapper's use of the area as representative of current and future land users and expects that the relationship to the Project area will be continued and strengthened through generations of future use. Métis citizens from NR1 and NR3 also identified harvest areas along Highway 914 and the Fox Lake Road (MN-S and Two Worlds Consulting 2023).

Big game hunting is sparse and infrequent in the ILRU LSA. Indigenous harvests of terrestrial species are primarily conducted south of the Key Lake gate and/or closer to communities, although some harvest has been recorded on Russell Lake and in areas proximal to Highway 914 and the Fox Lake Road north of Key Lake. Though adverse, Project effects on moose and woodland caribou are expected to be of low magnitude and reversible. Effects to vegetation are not anticipated to alter harvesting activities in the LSA or RSA.

Effects on resource availability of terrestrial wildlife and plant species are, therefore, not expected to affect subsistence hunting and gathering because adverse effects are anticipated to be of low magnitude and reversible.

Given the limited effects on resource availability in combination with very limited subsistence hunting and gathering, this pathway was not brought forward for a residual effects assessment.

11.1.4.3.2 Aquatic Resource Availability

Altered aquatic habitat and water management, including treatment and surface water withdrawal, have the potential to affect the availability of fish for food. Potential effects are predicted to begin in Construction, continue through Operation, and cease when reclamation activities have been completed in the Decommissioning phase when Project components are removed, and activities cease. Although the ERFN Trapper passed away, his use is considered as representative of future use by the ERFN, which is expected to be strengthened over time through continued use. As such, this assessment considered that future harvesters may resume activities in the ILRU LSA and focused on those species that are not only pursued for commercial purposes but are also consumed as part of the traditional diet or used for traditional purposes – namely muskrat and beaver (CanNorth 2017). Therefore, this assessment focused on both eaten aquatic furbearers and food fish.

Aquatic furbearer species important to subsistence (i.e., trapping) harvests are muskrat, beaver, and, less importantly, mink. Aquatic species important to subsistence fishing include Walleye, Northern Pike, Lake Trout, Lake Whitefish, and Arctic Grayling.

Aquatic Furbearers (Beaver and Muskrat): The potential effect of alteration and/or loss of habitat on aquatic furbearers is based on the removal of important features (e.g., dens or lodges), and/or changes to water bodies due to construction of Project components and infrastructure (Section 9.3.4.2 in Section 9). Muskrats prefer marshy and open water habitats; any changes to these areas will reduce available habitat.

Noise from Project Construction, Operation, and Decommissioning activities, including the camp, access roads, and the airstrip, may affect aquatic furbearer habitat availability around these features. Habitat alteration through sensory disturbance effects (such as noise, dust deposition, and artificial light) will result in reduced habitat quality and effectiveness near Project components and infrastructure reaching beyond the Project Area into the Wildlife LSA. The overall effect of habitat alteration and/or loss on furbearers is expected to be minimal during Post-Decommissioning as regeneration of vegetation is expected to continue within reclaimed areas. After mitigation, the residual effects to aquatic furbearers are characterized as adverse and low magnitude because of minimal muskrat habitat alteration and local to the Project site and a 500 m buffer around the Project site (Section 9.3.6 in Section 9). Effects are predicted to be long-term but reversible because the alteration of available furbearer habitat is expected to be reversed as sensory disturbances diminish with the end of Project Operation activities and subsequent Decommissioning of Project components.

The availability of relevant species throughout the LSA and RSA is not expected to result in changes to the harvested populations. As such, use of aquatic furbearers for traditional purposes is not expected to be altered.

Walleye, Northern Pike, Lake Trout, Lake Whitefish, and Arctic Grayling: Food fishing was reported by ERFN and SVS (2002b) near the Project site within the last 10 years and at lakes throughout the ILRU LSA. ERFN and SVS (2022b) indicated that harvest included Whitefish, Northern Pike, and Lake Trout in the smaller lakes and creeks southwest of the Project. Walleye, Sucker, Sauger, Burbot, and Yellow Perch were among the other species harvested in Nuhtisye-kwi Benéne (ERFN and SVS 2022b). *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 20203) also reported fishing on Russell Lake and at other locations proximal to Highway 914 and the Fox Lake Road.

Negligible aquatic habitat loss is predicted in LA-5 (also known as Whitefish Lake) due to the installation of a discharge pipeline and diffuser configuration. The total area of the lake substrate that would be overprinted by the pipeline is expected to be approximately 135 m^2, which will constitute less than 0.05% of the lake’s surface area (Section 8.3.6 in Section 8). No other alteration, disruption, or destruction of aquatic habitat in the aquatic environment LSA

(Section 8.3.6 in Section 8) is expected. Project-induced changes to the abundance and distribution of fish is, therefore, not expected. The effect, if any, is expected to undetectable to fishers and is, therefore, not carried forward for residual effects assessment.

11.1.4.3.3 Health and Abundance of Resources

Contaminated waste management, storage, and disposal of process waste rock and radioactive plant precipitates, and package and transport of nuclear substances, spills or accidents may affect fish and wildlife abundance and distribution, thus reducing or displacing opportunities to conduct ILRU. Potential effects are predicted to begin in Construction, continue through Operation, and cease when reclamation activities have been completed in Decommissioning when Project components are removed, and activities cease. Concerns about the health of moose and their food, caribou and their food, furbearers, fish, and vegetation such as blueberries have been raised by ERFN (ERFN and SVS 2022b). These concerns are related to changes in abundance of important species. Concerns about displacement have also been raised. For example, "… *the impact of mining on the natural habitat and the displacement of the animals that currently inhabit the proposed site*" (21-EN-SUR-446.69). The risks to terrestrial wildlife for possible major accidents and malfunctions are discussed in Section 14 Accidents and Malfunctions and summarized herein.

An ecological risk assessment (ERA) was conducted to consider both radiological and toxicological risks to ecological receptors such as terrestrial and aquatic invertebrates, terrestrial and aquatic vegetation, fish, and terrestrial and aquatic mammals and birds, several of which are important to subsistence harvesters. A summary of results is presented in subsequent text, and comprehensive results are presented in Section 10 Human Health.

For radiological constituents of potential concern (COPCs), predicted radiation doses on ecological receptors were compared to benchmarks set by the Canadian Standards Association (CSA 2012) to yield a hazard quotient (HQ). If the HQ is less than or equal to one (1), this suggests low risk to the ecological receptor because exposure estimates do not exceed levels known to cause adverse effects. If the HQ is greater than one, adverse effects may be possible, and further assessment would be warranted. Results for the radiological assessment indicated no predicted exceedances of the radiation dose benchmark for the ecological receptors. This includes receptors residing and feeding in and around Whitefish Lake, McGowan Lake, and Russell Lake including species used for traditional purposes such as blueberries, Labrador tea, northern Pike, White Sucker, woodland caribou, snowshoe hare, moose, muskrat, Canada Goose, Lesser Scaup, Mallard and Common Loon.

For non-radiological COPCs, chronic dose-based toxicity reference values (TRVs) for birds and mammals were based on endpoints (i.e., growth and reproduction) considered relevant for assessing the persistence of wildlife populations. Results indicated no expected exceedances of the TRVs (HQ<1) for terrestrial and riparian receptors for all non-radiological COPCs during all phases of the Project, including for invertebrates, vegetation, mammals, and birds. This includes receptors residing and feeding in and around Whitefish Lake, McGowan Lake, and Russell Lake including species used for traditional purposes, as described previously.

All species have the potential to be impacted by accidents and malfunctions. These events primarily refer to unintentional release of radioactivity, fuel, and hazardous chemicals into the environment (Section 14). In comparison with the aquatic environment, terrestrial release of hazardous materials is easier to manage due to less mobility of the released materials with the soil and potentially groundwater. The accidents and malfunctions report (Section 14) contains assessments of the probability of occurrence (i.e., likelihood), predictions of the potential effects (i.e., severity), and the overall risk of seven types of accidents and malfunction. Conclusions indicated a terrestrial release of radioactivity and chemicals due to a vehicle accident would be unlikely, of minor severity, and low risk (Section 14). Additional accident and malfunction scenarios were considered for the aquatic environment included release of fuel and hazardous compounds into surface water (unlikely, moderate severity, low overall risk); radioactivity into surface water (highly unlikely, moderate severity, low overall risk); and the loss of freeze capacity or freeze wall affecting groundwater (highly unlikely, moderate severity, and moderate overall risk) (Section 14). Overall, the risk level is as low as reasonably possible.

Given that there are no predicted radiological and non-radionuclide COPC exceedances that would affect the growth, reproduction and survival of terrestrial and aquatic ecological receptors, potential effects on subsistence harvests use are unlikely because the MP of change in relative abundance and distribution of fish and wildlife species is unlikely. Therefore, the potential for radionuclide and non-radionuclide COPCs affecting wildlife and fish abundance and distribution is expected to be negligible and this pathway is not carried forward for a residual effects assessment.

11.1.4.4 Lands/Waters Available for Traditional Practices

11.1.4.4.1 Availability/Accessibility of Land

Development of access roads and air strip, and clearing, level and grading of the Project site laydown area may alter or displace opportunities to conduct ILRU. The Project Area is the area within which the Project and all components/activities are located (i.e., the area of maximum physical disturbance) (Section 2). Within the Project Area, restrictions to land available to conduct ILRU are expected to begin in Construction, continue through Operation and end when reclamation of disturbed areas is completed in Decommissioning. Controlling access to the property will be accomplished by the construction of both a north and south security gate (Section 2.4.5 in Section 2). While some progressive reclamation may occur during Operation, the Project Area consisting of 169.6 ha, will remain restricted to ILRU harvesters for safety purposes until Decommissioning is completed.

To minimize land that is disturbed by the Project, the Project Area has been reduced to the extent practicable and much of the proposed Project footprint has been developed within previously disturbed areas, including roads currently used for exploration activities (Section 2.4.5 in Section 2).

Indigenous Land and Resource Use has been documented by the ERFN, KML, MN-S, and Athabasca Denesųłiné. The ERFN has described the importance of the land as "The land gives us the food that we need, it gives us the clothing that we need, it gives us the heartbeat that we need" (ERFN and SVS 2022b). Harvesting was conducted by the ERFN Trapper and included hunting, trapping, and fishing (see Sections 11.2.3.2 and 11.2.3.3.1, respectively, for commercial trapping and fishing) within the ILRU LSA within the past 10 years. Other documented ERFN harvest in the ILRU LSA included berries (blueberries, cranberries, raspberries), furbearers (beaver, wolf, bear), and ungulates (moose and woodland caribou) (ERFN and SVS 2022b). Some harvest has also been documented by the KML (moose, woodland caribou, waterfowl) and Athabasca Denesųłiné (large game) near Russell Lake. At present, access to areas north of the Key Lake gate remains restricted to a small number of lease holders and members of select Indigenous communities, although access to areas north of the gate often occurs via the Fox Lake Road. Access restrictions relative to the Project Area are unlikely to affect any resource use beyond the 169.6 ha taken up by the Project.

With respect to the resumption traditional uses concurrent to trapping by one or more licensed trappers, licenced Fur blocks N-18 and N-16 (to the south) have been amalgamated under a co-management regime between the province and ERFN (19-EN-ERFN-137.1). The N-18/N-16 Fur Block Chairperson and membership may select member(s) to resume trapping in areas formerly trapped by the ERFN Trapper (Government of Saskatchewan 2012). The ERFN anticipates continued use of the area through the generations. The lands available for trapping will be reduced by 169.6 ha (1.70 km^2) due to limiting access to the Project site for safety reasons. The land that will become unavailable amounts to 1.69 km^2 of N-18's 17,694 km^2 area or less than 1/10,000 of its total area. This reduction in land available for trapping for traditional purposes, combined with the availability of suitable lands in the ILRU LSA, does not support carrying forward this pathway for residual effects assessment. Should a future need arise due to a loss of commercial trapping income, a mitigation option is discussed in Section 11.1.5.

11.1.4.4.2 Availability/Accessibility of Water

Water withdrawal and discharge from groundwater or surface water body may affect water levels, and thus affect water and ice-based navigation by resource users or affect the safety thereof. Commonly used travel routes over water/ice were not identified relative to areas likely to be affect by Project activities. The Project will source fresh water from a shallow groundwater well but may draw from both a groundwater source and a surface water source (a water withdrawal). Water withdrawal and discharge rates were modeled to understand Project-related changes in the water levels of local waterbodies known as LA-1, LA-5 (also known as Whitefish Lake), and LA-6

(NewFields Canada Mining & Environment 2021). The Project will operate a discharge line for treated water (i.e., a water discharge) that will be located in a suitable area of the lake bottom to minimize disruption of fish habitat. Potential effects are predicted to begin in Construction, continue through Operation while camp facilities are still in operation, and decline in Decommissioning as infrastructure is removed.

The following changes were predicted: the maximum change in water level in LA-1 is predicted to be a drop in water levels by 0.0037 m for withdrawal and an increase in water levels by 0.0032 m for discharge. In LA-5, the maximum withdrawal is expected to drop lake levels by 0.0041 m and under discharge conditions, the lake level will increase by 0.0032 m. Changes to water levels for LA-6 are expected to be negligible (NewFields Canada Mining & Environment 2021).

The predicted sub-centimetre change in water levels under both intake and discharge scenarios are not expected to be detectible to resource users or affect travel on LA-1, LA-5 and are not expected to occur on LA-6 and other waterbodies in the region in any season. Other potential barriers to navigation include the installation of new bridges. The construction of the access road involves the installation of two stream crossings (Section 2.3.1.8 in Section 2). Therefore, water and ice-based navigation by resource users is predicted to remain unchanged and this pathway will not be carried forward for residual effects assessment.

11.1.4.5 Perceived Suitability of Land and Resources Therein

11.1.4.5.1 Aesthetic Experience

Changes to the perceived suitability of land may occur due to Project-related disturbances to resource harvesters such as traffic, noise, air quality, changes to the relationship to land, and changes in competition for resources. Potential effects are predicted to begin in Construction, continue through Operation, and cease when reclamation activities have been completed in Decommissioning when Project components are removed, and activities cease. While the Project Area will be restricted to resource users for safety reasons, disturbances in areas very local to the Project Area and along roadways such as local access roads and the Key Lake to McArthur River haul road where Project traffic is operating. Disturbances assessed under this pathway include increases in traffic; noise; changes to air quality, and changes to the relationship with the land. These disturbances are likely to be most detectable during Construction when construction activities are at their peak and decline somewhat in Operation due to acclimatization to the Project, except for traffic, which will increase during Operation.

Traffic

English River First Nation (ERFN and SVS 2022b) have reflected that existing "*traffic along the Key Lake highway has undoubtedly had effects on the Ancestral Lands and the people of English River who occupy those lands*" and that the "*ERFN has been feeling the impact of increased traffic since the 1970s*". Similarly, the KML #9 have expressed concerns with respect to increases in traffic associated with Project activities including increased risk of heavy haul vehicle incidents with land users (KML 2022). Land users north of the Key Lake gatehouse would expect to see an increase in traffic of 23% during Construction to 30% during Operation (Denison 2022). However, from a total volume basis this amounts to an additional 14 trucks a day during Construction and 18 trucks a day during Operation (or less than one truck per hour if operating on a 24-hour basis). Decommissioning traffic volumes are expected to be similar to traffic volumes during Operation. Several proven mitigation options are planned to reduce the risk of increased traffic (see a full list in Section 12.3.5 in Section 12 Quality of Life).

Noise

The main sources of noise will be local to the Project Area and conservatively, within 10 km from the outer boundaries of the Project Area (Independent Environmental Consultants 2022a). Noise generated during Construction is related to air and ground transport of people and goods, the operation of a concrete batch plant and crusher, operation of power generators, drilling of holes for the freeze wall and wellfield, and construction of the freeze plant. Noise during Operation will operate similar to Construction except the generator sets will only be used under emergency conditions and operation of the ISR plant and shipping of yellowcake will begin. The Noise assessment predicted no exceedances of either the federal or provincial sound level criteria. Incremental increases in noise from baseline were predicted for one seasonal cabin owner at McGowan Lake during Construction at +5.1 dBA in daytime (a moderate impact) and +4.6 dBA during the night (a low impact). Noise during Operation was predicted to be +3.4 dBA during daytime and +2.7 dBA at night (a low and marginal impact respectively). Mitigation and monitoring measures for these effects are well established and effective and are described in greater detail in Section 11.2.5.

Should noise monitoring results exceed predictions or if Indigenous land users have future concerns about noise levels, Denison remains open to meeting the land users to work on noise mitigation strategies to reduce noise effects as needed.

Air Quality

The main sources of dust and air emissions will be local to the Project Area and, conservatively, the Air Quality LSA is defined as a bounding box offset by 20 km from the centre of the Project Area (Independent Environmental Consultants 2022b). Air quality has been identified as a concern for stakeholders (21-EN-SUR-446.76). The assessment of air quality was modelled from meteorological data collected in 2016 to understand potential dispersion patterns of COPCs such as total suspended particulate (TSP) and two sizes of particulate matter (PM; $PM_{2.5}$ and PM_{10}), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and carbon monoxide (CO).

Fugitive dust can come from unpaved roads, wind erosion (e.g., at borrow sites, the waste pads, or landfill site), and through material handling. Dust is measured by the amount of TSP and PM in the atmosphere. During Construction and Operation, the maximum predicted 24-hour concentrations of TSP and PM_{10} are above the Project criteria along a small section of the northwest Property Boundary and at locations outside of the site around the haul road, with the overall maximum occurring next to the haul road. During Decommissioning, fugitive dust is reduced though still in exceedance of project criteria at off-property areas along the haul road. One of the largest contributors to the exceedances is unpaved road dust.

Combustion of diesel, gasoline, or propane fuel results in emissions of gaseous COPCs including NOx, SO_2 and CO. Modelling results predicted no exceedances of the Project criteria for CO or SO_2 during Construction, Operation or Decommissioning. During Construction, NO_2 concentrations of 224% of the Project criteria northwest of the property boundary were predicted and during Operation and Decommissioning, short-term NO_2 exceedances are predicted at the site near the northwest property boundary only during emergency use of the generators (i.e., when power is not available from the grid). Nitrogen dioxide concentrations are highest near the centre of the Project Area, where the diesel generators will be located, indicating that the largest contributor to NO_2 concentrations during all Project phases is expected to be on-site power generation.

Predicted concentrations of metals and radon are all below their applicable Project criteria throughout the Air Quality LSA and during all Project phases. Mitigation for these effects are well established and effective, and are described in Section 11.2.5.

Summary of Effects

In summary, sources of air pollution such as SO_2, CO, and radon gas will not surpass criteria in any Project phase. Total suspended particulate, PM, and NO_2 criteria are expected to be exceeded at a location northwest and within 250 m of the property boundary during Construction and Operation (assuming for NO_2 that the generator sets will be used in Operation). Criteria for TSP and PM caused by fugitive road dust are also anticipated to be exceeded during Construction, Operation, and, to a lesser extent, during Decommissioning within 300 m of either side of the haul road and in the Air Quality LSA.

Given that no specific ILRU has been identified within 400 m of the Property boundary (where TSP, PM and NO_2 criteria are predicted to be exceeded), the effects of this assessment focuses on the portion of the haul road where TSP and PM may be exceeded. This portion of the roadway (within 20 km of the Project) may be used in future for Indigenous land and resource users who may experience some disturbance from road dust.

To control road dust during summer (May to October), water and/or chemical dust suppressant will be applied to all site roads (Section 6.1.5 in Section 6). In the winter months (November to April), natural mitigation from snow/ice can help control unpaved road). Additionally, vehicle speeds at the Project site are limited to 40 km/h along the site haul roads, which will also limit the amount of road dust generated (Section 6.1.5 in Section 6). The roads are also maintained during the summer months using a grader, which is a lesser source of PM along the roads.

The limited number of resource users on the road that travel on unpaved roadways and accompanying dust would be a routine occurrence for drivers in this area, combined with proven mitigation measures, suggests that effects on resource users will be negligible.

Relationship to the Land

The Indigenous COI have expressed their deep connections and relationship to the lands and waters, which may be affected by the presence of the Project, as it has by other anthropogenic sources.

The ERFN have described this connection as:

> *"The connection to the land, like the Elders have mentioned and I have mentioned, it's like our plate; it gives us everything. The land gives us the food that we need, it gives us the clothing that we need, it gives us the heartbeat that we need. The trees in the area also provide us with shelter and also provide us with medicines in the area. So that's really critical to us. The waters are also very important to us; without the waters, we're not alive, and that's one of the things. The forestry itself, it creates life, because the medicines we get from them is really important to us, the traditional medicines"* (ERFN and SVS 2022b).

The Wheeler River Project: Métis Knowledge Study Report (MN-S and Two Worlds Consulting 2023) reported:

> *"Métis understand the environment as sacred relationships linking such things as language, learning, people and social structures, traditions, land (including all parts of Eart and atmosphere), spirituality, self development, harmonious interactions, Indigenous Knowledge, health, imagination, economic conditions, balances approaches to life, political systems, and values (Métis National Council n.d.)."*

The Wheeler River Project: Métis Knowledge Study Report (MN-S and Two Worlds Consulting 2023) notes that the level of enjoyment while spending time on the land is an important factor to consider.

Many participants in ERFN studies have spoken about how Nuhtsiye-kwi Benéne have been subject to decades of uranium mining and other development, with statements such as:

> *"The whole area is sensitive now, with all the things that are going on. It's disturbing the environment; the environment has been disrupted. So, the animals, the birds, and the fish are all affected, especially where there's mining activity. Because of that, animals tend to move away. So, they're not around because of all the activities that are going on"* (ERFN and SVS 2022b).

Kineepik Métis Local #9 have also noted how the Project and other similar activities have the potential to affect their ability to express their culture and associated rights on the land, with reflections such as

> *"The substantial and growing projects and mineral exploration activity severely limits our ability to practice continued and use for the region north of Haultain River…With the significant and growing numbers of projects we do not know how we can continue to practice this method of food gathering in a safe method*" (KML 2022).

and

> *"We have issues on cumulative impacts from historical legacy exploration and mining practices. Not specific to Denison, Cameco or Orano our land users have often found remnants of past poor exploration practices that are now affecting our continued land use"* (KML 2022).

The Wheeler River Project: Métis Knowledge Study Report (MN-S and Two Worlds Consulting 2023) notes that Métis Elders are now more reluctant to harvest proximal to uranium mines.

The presence of the Project may be sufficient to prevent some resource users from pursuing traditional activities in proximity to the Project footprint as the relationship to the land is further altered by the presence of industrial activities. This is likely to vary by individual; however, experience from other uranium operations in northern Saskatchewan has demonstrated that effective relationships between industry and Indigenous users can be fostered, and that the presence of Industry does not prohibit continued uses so long as the safety and security of the site can be maintained.

Increases in Competition for Resources

The presence of the Project workforce will increase the numbers of people in the ILRU LSA by an estimated 300 during Construction and 180 during Operation and Decommissioning (Section 13.3 in Section 13 Economics). Potential exists for Indigenous users to observe an increasing number of people in the area associated with workforce personnel.

Workforce members will be transported to site by a fly-in/fly-out rotation or by a Denison shuttle and will, therefore, eliminate fishing on local lakes during commute to the site and during time off work. Denison site vehicles will not be available for recreational purposes. While at the Project site and off duty, workers may opt to fish local waterbodies. To protect sustainable use of resources, only catch and release of fish will be encouraged, and fish storage or cooking facilities will not be provided. Transportation to fishing areas via trucks or boats will not be permitted. To prevent land users from entering the Project Area, Denison will control access to the property with both a north and south security gate.

Given these mitigations, increased competition for resources will be limited due to a lack of transportation to fishing locations beyond walking distance and prohibition of firearms/hunting. Given that fishing on LA-5 has not been documented, and the effect is expected to be of low magnitude, changes in fish abundance or distribution are not expected to be detectable to Indigenous land users.

Summary of Effects

Potential Project disturbances considered under this pathway included increases in traffic, noise, air quality, perceived changes to the relationship with the land and increases in competition for resources. These disturbances will be most detectible in locations proximal to the Project site. Effects have the most potential to affect any Indigenous land and resource users who may hunt, fish, and/or gather in the general proximity of the Project.

Access restrictions at the Key Lake gate, combined with locations of Indigenous community cultural camps, result in most Indigenous land and resource use occurring to areas further south. The changes to the experience of resource use will be limited to a small number of individuals. Given proven mitigation is to be applied to traffic disturbances, noise, air quality, and increased competition for resources, the effects are expected to be minimal. As outlined in Denison's Indigenous Peoples Policy, Denison is committed to respecting Indigenous knowledge and values regarding environmental stewardship and Indigenous peoples' connection to the land, and to minimize potential effects, wherever possible. Denison is committed to maintaining positive relations with all Indigenous COI and will be open to discussions on any issues or concerns that arise. As such, this pathway is not carried forward for residual effects assessment.

11.1.4.5.2 Perceived Suitability/Safe Use of Resources

Lands and resources may be affected by hazardous and contaminated waste management, groundwater supply and surface water withdrawal, and the package and transport of nuclear substances, which in turn, affect perceptions of the suitability of lands to conduct land use. Potential effects are predicted to begin in Operation and cease when reclamation activities have been completed in Decommissioning when Project components are removed, and activities cease.

Concerns were raised regarding the ISR mining method, which is a common method of mining uranium globally but is new to Canada, and, therefore, a method that resource users have little experience with. Response to this technique has been mixed. For example, a representative of the Northern Village of Beauval commented: "*When will it be tested? When will it be proven? Safety would be one of the biggest concerns in either method*" (18-EN-VB-4.54). Community members have also commented that the ISR has "*minimal environmental effects (no tailings, small volumes of waste rock, [and] how minimal the surface disturbance is"* (19-EN-YNLR-84.1). Residents of Kineepik Métis Local #9 commented that the ISR mining method has no history for either success or failures in the region (KML 2022). Community members provided that they would need extensive consultation to understand the potential effects of the new mining method and the development of a new mill at the Project site, including how ISR and freeze walls work and how this has occurred in other regions (KML 2022). Community members provided that they require confidence that when an incidence occurs with these new mining methods there are plans in place to recover solutions that could affect groundwater quality (KML 2022).

Section 2.10 and associated Appendix 2-C in Section 2 describes the extensive review of mining methods that led to the decision to adopt the ISR mining method. Historical work evaluated 32 mining methods to extract uranium from the deposit. Methods were evaluated through an increasingly rigorous process and considered factors such as: safety, environment, production rates, capital costs, operating costs, schedule, operational flexibility, and risk. In addition, specific workshops were held in local Indigenous and non-Indigenous communities to capture community input into the selection of a preferred mining method. After several years of study, the ISR mining approach was selected as the best overall option.

As part of engagement activities, several questions were asked about the integrity of the freeze wall and the potential to lose containment of the mining solution and/or uranium. The Accidents and Malfunctions Technical Supporting Document (Section 14) noted that thawing of the freeze wall is not immediate and the wall is, therefore, resistant to temporary loss of power as it take a minimum of one year for the freeze wall to thaw. This freeze and thaw time frame is very large compared with the time required to repair and establish the freeze capacity. Interruption of the freeze capacity due to mechanical failure of the freeze plant is perceived to be a major concern, but the risk is low that such an event would result in the migration of mining fluids beyond containment (Section 14). The preliminary remediation plan is to monitor the groundwater until it meets an acceptable limit and then allow the freeze wall to thaw.

Community perceptions of health risks relative to the consumption of resources harvested from the land are also important to consider (Elias et al. 1997). By acknowledging different perceptions of risk, a constructive and respectful way of understanding and addressing health concerns can be developed (Elias et al. 1997). The ERFN described this perception of risk as follows: "*While it is acknowledged that these are perceived fears, the fear they inflict is real and has real impacts on ERFN members' perception of their overall health and well-being, resulting in negative psycho-social impacts*" (ERFN and SVS 2022a). Reductions in harvests may occur based on fear or uncertainty about the ongoing quality of country foods. For example, "*People stopped picking berries in this area when Key Lake mine was established because of concerns about health impacts*" (ERFN and SVS 2022b). Additional expressions of these concerns included uncertainty about the quality of water for drinking (though drinking surface water is not recommended), "*if you discharge water out of Whitefish Lake, I'd like to see you drink out of McGowan Lake [located downstream]*" (19-LK-ERFNTrap-134.252).

A human health risk assessment was conducted to consider both radiological and toxicological risks to humans, including Indigenous resource harvesters who consume high proportion of traditional foods. A summary of results is presented in subsequent text and comprehensive results are presented in Section 10.

For radiological COPCs, radiation doses on human receptors are compared to benchmarks set. The public dose limit for radiation protection is 1 mSv/a, as described in the Radiation Protection Regulations under the *Nuclear Safety and Control Act* (Government of Canada 2017). A dose constraint of 0.3 mSv/a is also used, as recommended by Health Canada (Health Canada 2011). The dose constraint represents a dose, lower than the public dose limit that makes sure the combined dose from multiple sources does not result in exceedance of the public dose limit. Results indicated no predicted exceedances of the public dose limit of 1 mSv/a or the dose constraint of 0.3 mSv/a for any of the human receptors, even for a resource harvester who derives the majority of his/her food from the Project Area. Therefore, it is unlikely that there would be significant adverse effects on human receptors as a result of radionuclide releases from the Project.

For non-radiological COPCs, a TRV is used to assess risk. A TRV is a toxicological value, associating specific health effects with a level of exposure to a chemical. Toxicity reference values are used in the risk characterization to determine Incremental Lifetime Cancer Risks for carcinogens and HQs for non-carcinogens. No exceedances of the TRVs (HQ<0.2) are predicted for human receptors regarding non-radiological non-carcinogens (cadmium, copper, chromium, cobalt, molybdenum, uranium, vanadium, and zinc) during all phases of the Project, with the exception of selenium from the fish (Northern Pike and White Sucker). The value for the Project HQ was 0.93 for an ERFN fisher/trapper at Russell Lake. The traditional foods diet for the fisher/trapper is conservative as it assumes that all of his annual consumption (183 kg of fish per year) would be obtained from Russell Lake, meaning the exceedance in selenium from fish could potentially occur if fish were only sourced from the one location.

Accidents and malfunctions primarily refer to unintentional release of radioactivity, fuel, and hazardous chemicals into the environment (Section 14). In comparison with the aquatic environment, terrestrial release of hazardous materials is easier to manage due to less mobility of the released materials with the soil and potentially groundwater. The accidents and malfunctions report (Section 14) contains assessments of the probability of occurrence (i.e., likelihood), predictions of the potential effects (i.e., severity), and the overall risk of seven types of accidents and malfunction. Conclusions indicated a terrestrial release of radioactivity and chemicals due to a vehicle accident would be unlikely, of minor severity and low risk (Section 14). Additional accident and malfunction scenarios considered for the aquatic environment included release of fuel and hazardous compounds into surface water (unlikely, moderate severity, low overall risk); radioactivity into surface water (highly unlikely, moderate severity, low overall risk); and the loss of freeze capacity or freeze wall affecting groundwater (highly unlikely, moderate severity, and of moderate overall risk) (Section 14). Overall, the risk level is predicted to be as low as reasonably possible.

Although the human health risk assessment predicted no radiological exceedances, and that only one COPC exceedance could potentially arise (selenium) in the unlikely circumstance that fish were only consumed from Russell Lake, perceptions surround the quality of the resource may still result in a change in behaviour and alter ILRU activity. Therefore, this pathway is being carried forward for residual effects assessment.

11.1.5 Mitigation Measures

Mitigation in this EIS is defined as the elimination, reduction, or control of potential adverse effects of the Project on the environment throughout all Project phases. Project-specific mitigation measures include Project design; implementation of best management practices (BMPs); development of management plans; implementation of emergency response programs; and provision of training, education, and awareness.

11.1.5.1 Resource Availability

Mitigation measures that protect woodland caribou and their habitat are described in Section 9.3.5 in Section 9. Also, the Government of Saskatchewan is currently compiling a BMP document intended to guide proponents when developing their approaches to avoid or minimize adverse effects of project activities on woodland caribou and woodland caribou habitat. Once available, Denison will consider all applicable measures provided in the BMPs in their mitigation planning and implementation. Additional mitigation specific to ILRU is not proposed at this time. Mitigation measures that protect moose and moose habitat are described in Section 9.3.5 in Section 9.

No additional mitigation or follow-up measures are proposed for ILRU. Denison continues to work with Indigenous Communities of Interest and has committed to collaborating with the English River First Nation and Kineepik Métis Local on a monitoring regime, suited to each of their interests and needs.

11.1.5.2 Availability of Lands/Waters

To minimize land that is disturbed by the Project, the Project Area has been reduced to the extent practicable and much of the proposed Project footprint has been developed within previously disturbed areas, including roads currently used for exploration activities (Section 2.4.5 in Section 2). Further, the Project Area (169.6 ha or 1.696 km^2) makes up less than 0.1% of the LSA (approximately 2,620 km^2). No further mitigation or follow-up measures are proposed for ILRU with respect to the availability of lands/waters. As outlined in Denison's Indigenous Peoples Policy, Denison is committed to respecting Indigenous knowledge and values regarding environmental stewardship and Indigenous peoples' connection to the land, and to minimize potential effects, wherever possible.

11.1.5.3 Perceived Suitability of Lands and Resources Therein

Mitigation measures for the perceived suitability of lands and resources therein KI are required to reduce the potential effects of traffic, noise, dust dispersion, air emissions, and the potential for COPCs to enter the environment. The ISR mining method is new to Canada and, despite the exercise of due diligence, trust will also need to be built with those who have little experience with this mining method.

Traffic

Several mitigation options are planned to reduce the risk of increased traffic as follows (see a full list in Section 12.3.5 in Section 12):

- Air transportation will be used to transport most workers between the Project site and communities at designated pick-up and drop-off points.
- Advanced driver training will be provided on the transport of nuclear substances.
- An Emergency Response Plan will be developed in case there is a spill during the transportation of dangerous goods or hazardous products.
- All materials transported by truck will be compliant with any weight restrictions or permits, spring road restrictions, or geometric constraints set out by the Saskatchewan Ministry of Highways and Infrastructure (MOHI).
- Denison will maintain roads within the Project site and the main access road to the site.
- Require Denison truck traffic to slow down to 40 km/hr for a minimum of 2.5 km on either side of the culture camp(s), which are understood to occur in September and October (but may be adjusted at the communities' direction).

Noise

Noise mitigation includes the following strategies:

- The use of high-quality, low sound emission equipment and regular maintenance will reduce noise associated with Project activities (Section 2).
- High-noise activities will be located further away from human receptor(s), such as a local leaseholder (Section 4.4.3.2 in Section 4 Engagement).
- Noise-generating equipment will be situated behind on-site obstructions (Section 6.2.5 in Section 6);
- Monitoring will take place, including collecting sound level measurements from these sources (e.g., in the vicinity of the wellfield, the concrete batch plant, and along the access road from Highway 914) once they are operating and determine whether its actual impact is lower than that which was modelled (Section 6.2.5 in Section 6).

Air Quality

Air quality on site also has the potential to affect resource users. Effects are expected to be localized primarily to the Project site and also along unpaved road corridors such as Project access roads and the Key Lake to McArthur River haul road.

To control road dust during summer (May to October), water and/or chemical dust suppressant will be applied to all site roads (Section 6.1.5 in Section 6). In the winter months (November to April), natural mitigation from snow/ice can help control unpaved road). Additionally, vehicle speeds at the Project site are limited to 40 km/h along the site haul roads, which will also limit the amount of road dust generated (Section 6.1.5 in Section 6). The roads are also maintained during the summer months using a grader, which is a lesser source of PM along the roads.

Air emissions will be reduced by:

- directing processing plant exhaust from drying and packaging areas through a stack prior to release outside of the building;
- designing the stack height based on results of air dispersion modelling to be an appropriate height for optimal dispersion; and
- employing battery-powered light vehicles where practical to reduce air emissions and noise levels and improve energy efficiency (Section 2).

In addition to the mitigation measures identified, other strategies to avoid or reduce the likelihood of TSP and PM exceedances include:

- limiting material handling activities during dry conditions and high winds;
- limiting vehicle and equipment speeds on unpaved roadways/surfaces;
- optimizing the number of vehicle and equipment movements and minimize travel distances, where possible;
- maintaining unpaved roads via grading or other maintenance practices to reduce the amount of fine particles available for dispersion; and
- collecting dust measurements during Project phases to determine whether the actual effect of Project activities is lower than what was modelled (Section 6.1.8 in Section 6).

Waste Management

Denison has designed numerous mitigation features to prevent release of any harmful substances into the environment that may affect people’s perception of the suitability of lands and resources (see also Section 2). Denison will minimize potential release of radiological and non-radiological waste by implementing the following:

- A wash bay will be made available to clean items, equipment, and vehicles that may have been in contact with potentially contaminated materials. Contaminated water from the wash bay will be collected in a sump tank and routed to the water treatment plant for treatment and discharge.

- Bulk storage tanks for processing chemicals will sit inside appropriately designed and sized concrete secondary containment basins, physically separated from the containment basins for other chemical systems.
- Surface pipelines will be designed to have secondary containment or catchment and have leak detection systems in place at key locations.
- Contaminated wastes (e.g., mineralized drill cuttings, solid impurities removed from mining solution, dewatered reject solids) will be properly contained on a double lined waste pad with leak detection capabilities and an associated monitoring program.
- Radiological clearance scanning will be conducted as required for any items, equipment, and vehicles leaving the Project Area.
- A freeze wall will be established around the uranium deposit to reduce groundwater disturbance.
- Mining solution and process water will be reused throughout the mining process, reducing water use requirements to the extent feasible and reducing the volume of treated effluent requiring discharge. Make-up water will be preferentially sourced from site runoff where possible.
- Double-walled high-density polyethylene (HDPE) or equivalent piping will be used in the wellfields and will be freeze protected and secured to minimize pipe movement.
- The ISR wellfield and processing plant will be designed to re-use most of the solutions inside each circuit; any excess water will be released to a surface water body once acceptable water quality is achieved. All effluent released to surface water will meet federal and provincial regulatory discharge limits.
- All contaminated areas, such as waste ponds and pads, will be fenced to avoid contact with workers and wildlife. Fences will be monitored and maintained.
- Ponds will maintain a minimum freeboard of at least 1.0 m.
- Having two ponds allows for increased operational flexibility, as one pond can be undergoing monitoring while the other pond is releasing water to Whitefish Lake (LA-5). All effluent released to surface water will meet federal and provincial regulatory discharge limits.

The ISR Mining Method

The ISR mining method may influence perceived suitability of lands and resource therein. Many stakeholders have noted their support for ISR technology, stating that ISR has “*minimal environmental effects (no tailings, small volumes of waste rock, [and] how minimal the surface disturbance was*” (19-EN-YNLR-84.1).

Others remain unsure about the ISR mining method. As a new technology in Canada (but not in other parts of the world), additional engagement, education, and outreach will be conducted by Denison to promote two-way communication throughout the life of the Project. By committing to this approach, Denison affirms their Indigenous Peoples Policy is advanced through collaboration with Indigenous peoples and communities to build long-lasting, respectful, trusting, and mutually beneficial relationships (Denison 2021). Pinehouse, for example, is looking for support from Denison "*in order to explain the ISR method to community at large given that it is new. He [Mayor of the Northern Village of Pinehouse Lake] expects there will be a lot of questions about it*" (19-EN-VPL/ML9-135.4).

Human Health

Denison will implement an Environmental Monitoring Program consistent with Canadian Standards Association for nuclear facilities and mines. Monitoring will focus on providing data to verify the predictions made by the ERA, to refine the models used in the ERA, and to reduce the uncertainty in the predictions made by the ERA (Section 10). The Environmental Monitoring Program will include collection of surface water, sediment, and soil samples as well as fish tissue samples, benthic invertebrate tissue samples, and country foods such as blueberries. Monitoring locations would be focused in the area of Whitefish Lake, McGowan Lake, and Russell Lake (Section 10). Monitoring the resources, in turn, will inform predictions about any changes to human health.

Community / Company Relationships

The KML propose that working cooperatively with Denison is a path towards reconciliation (KML 2022). For each concern brought forward by KML, KML proposed that each concern will be reviewed by Denison for the best possible solution and that effects on land and resources be either nil or minimal (KML 2022). This approach is consistent with Denison's Indigenous Peoples Policy (Denison 2021).

As outlined in this Indigenous Peoples Policy, Denison recognizes the critical necessity of advancing reconciliation with Indigenous peoples in Canada and the important role of Canadian business in the reconciliation process. Denison is committed to providing Indigenous people and businesses with sustainable economic opportunities and benefits and sharing the economic benefits of Denison's business activities. Denison is currently working with the Indigenous COI to make sure the Project outcomes include the development of mutually beneficial relationships and minimized Project effects, and is focussed in the following areas: engagement, empowerment, environment, employment, and education.

11.1.6 Residual Effects Evaluation

11.1.6.1 Residual Effects Characterization

General definitions of the residual effects characteristics are provided in Table 5.8-1 in Section 5 Approach and Methodology of the Assessment. Residual effects characteristics specific to ILRU are defined in Table 11.1-12.

Table 11.1-12: Indigenous Land and Resource Use – Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive	**Adverse** – Negative effect or effect is not desirable. **Positive** – Beneficial effect or effect is desirable.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions	**Low** – Minimal amount of change detectable by subsistence resource harvesters. **Moderate** – Moderate amount of change detectable by subsistence resource harvesters. **High** – High amount of change detectable by subsistence resource harvesters.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the ILRU LSA. **Regional** – Effect extends beyond the ILRU LSA into the ILRU RSA. **Beyond Regional** – Effect extends beyond ILRU RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions. **Partially Reversible** – A residual effect that partially diminishes to baseline conditions. **Irreversible** – A residual effect that will not diminish to baseline conditions.
Context	The extent to which the VC or KI has been affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its ability to recover from that effect (i.e., resilience).	**Low** – VC/KI has high resilience to stress and is able to accommodate change. **Moderate** – VC/KI has moderate resilience to stress and is able to accommodate some change. **High** – VC/KI has weak resilience to stress and is unable to accommodate change.

Residual Effect Characteristic	Definition	Rating
Likelihood	Likelihood that the residual effect will occur including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability the residual effect will occur. **Unlikely** – A low probability the residual effect will occur.

The characterization of residual effects is based on the review of the existing environment (Section 11.1.3), the assessment of Project-related effects and proposed mitigation measures, IK, KPIs, and professional judgment. All residual effects (independent of their significance rating) are carried forward to the cumulative effects assessment (CEA). In terms of confidence:

- A low level is assigned when the VC/KI and/or the Project interaction is not well understood, and/or the mitigation measures have not been proven effective.
- A moderate level is assigned where the VC/KI is understood and/or the mitigation measures have been proven effective elsewhere.
- A high level is assigned when the VC/KI and Project interactions are well understood, and the mitigation measures have been proven effective.

Table 11.1-13 provides a summary of the KIs that were or were not carried through to the residual effects assessment, along with a summary of mitigations. Table 11.1-11 provides the potential Project interactions (primary interactions and secondary interactions) for Indigenous Land and Resource Use.

Table 11.1-13: Summary of Key Indicators Considered in the Residual Effects Assessment

Key Indicator	Measurable Parameter	Consideration for Residual Effects Assessment	Mitigations (Section 11.1.5)
Resource availability for harvesting subsistence resources	Terrestrial resource availability	With mitigation there are limited effects on resource availability and the abundance and distribution of important species for subsistence use is not expected to be affected. This is considered in combination with harvesting practices generally focused more intensively on areas beyond the LSA.	Terrestrial species importance for harvesting, including caribou and moose. Mitigation measures that protect woodland caribou and their habitat are described in Section 9.3.5 in Section 9. In addition, the Government of Saskatchewan is currently compiling a BMP document intended to guide proponents when developing their approaches to avoid or minimize adverse effects of project activities on woodland caribou and woodland caribou habitat. Once available, Denison will consider all applicable measures provided in the BMP document in their mitigation planning and implementation. Additional mitigation specific to ILRU is not proposed at this time.

Key Indicator	Measurable Parameter	Consideration for Residual Effects Assessment	Mitigations (Section 11.1.5)
	Aquatic resource availability	Project-induced change to abundance and distribution of fish is not expected. The effect, if any, is expected to be undetectable to fishers.	Mitigations for the aquatic environment are described in Section 8, including for fish and fish habitat (Section 8.3.5).
	Health and abundance of resources	There are no predicted radiological and non-radionuclide COPC exceedances that would affect the growth, reproduction, and survival of terrestrial and aquatic ecological receptors. Potential effects on subsistence harvests use are unlikely because the risk to health and abundance of resources is low. The potential for radionuclide and non-radionuclide COPCs affecting wildlife and fish abundance and distribution is expected to be negligible.	Mitigations for the aquatic environment are described in Section 8, including for fish and fish habitat (Section 8.3.5). Mitigation measures that protect the terrestrial environment are described in Section 9.3.5 in Section 9. Mitigations measures for human health are described in Section 10.1.5 in Section 10.
Land/waters available for traditional practices	Availability/ accessibility of land	The Project Area (169.9 ha or 1.696 km^2) makes up less than 0.1% of the LSA (approximately 2,620 km^2). The reduction in land available for traditional purposes, combined with the availability of suitable lands in the ILRU LSA, does not support carrying this pathway forward into the residual effects assessment.	To minimize land that is disturbed by the Project, the Project Area has been reduced to the extent practicable and much of the proposed Project footprint has been developed within previously disturbed areas, including roads currently used for exploration activities. No further mitigation or follow-up measures are proposed for ILRU with respect to the availability of lands. As outlined in Denison's Indigenous Peoples Policy, Denison is committed to respecting Indigenous knowledge and values regarding environmental stewardship and Indigenous peoples' connection to the land, and to minimizing potential effects, where possible.
	Availability/ accessibility of water	Water and ice-based navigation by resource users is predicted to remain unchanged and this pathway will not be carried forward into the residual effects assessment.	No further mitigation or follow-up measures are proposed for ILRU with respect to the availability of waters. As outlined in Denison's Indigenous Peoples Policy, Denison is committed to respecting Indigenous knowledge and values regarding environmental stewardship and Indigenous peoples' connection to the land, and to minimizing potential effects, where possible.
Perceived suitability of land and resources therein	Aesthetic experience	Potential Project disturbances considered under this pathway include increases in traffic, noise, and air quality, perceived changes to the relationship with the land, and increases in competition for resources. These disturbances will be most detectible in locations proximal to the Project site. Effects have the most potential to affect any Indigenous land and resource users who may hunt, fish, and/or gather in the general proximity of the Project. Access restrictions at the Key Lake gate, combined with locations of Indigenous community	For further information related to mitigation measures for traffic, noise, air quality, waste management, the ISR Mining Method, human health, and community/company relationships, see Section 11.1.5.

Key Indicator	Measurable Parameter	Consideration for Residual Effects Assessment	Mitigations (Section 11.1.5)
		cultural camps, result in most Indigenous land and resource use occurring in areas further south. The changes to the experience of resource use will be limited to a small number of individuals. Given proven mitigation is to be applied to traffic disturbances, noise, air quality, and increased competition for resources, the effects are expected to be minimal. As outlined in Denison's Indigenous Peoples Policy, Denison is committed to respecting Indigenous knowledge and values regarding environmental stewardship and Indigenous peoples' connection to the land, and to minimizing potential effects, wherever possible. Denison is committed to maintaining positive relations with all Indigenous COI and will be open to discussions on any issues or concerns that arise. As such, this pathway is not carried forward into the residual effects assessment.	
	Perceived suitability/ safe use of resources	Although the human health risk assessment predicted no radiological exceedances, and that only one COPC exceedance could potentially arise (selenium) in the unlikely circumstance that fish were only consumed from Russell Lake, perceptions surrounding the quality of the resource may still result in a change in behaviour and alter ILRU activity. Therefore, this pathway is being carried forward into the residual effects assessment.	For further information related to mitigation measures for traffic, noise, air quality, waste management, the ISR Mining Method, human health, and community/company relationships, see Section 11.1.5. The KML proposed that working cooperatively with Denison is a path towards reconciliation (KML 2022). For each concern brought forward by the KML, the KML proposed that each concern will be reviewed by Denison for the best possible solution and that effects on land and resources be either nil or minimal (KML 2022). This approach is consistent with Denison's Indigenous Peoples Policy (Denison 2021). Denison is currently working with the Indigenous COI to make sure the Project outcomes include the development of mutually beneficial relationships and minimize Project effects. The Project outcomes will be focussed in the following areas: engagement, empowerment, environment, employment, and education.

11.1.6.2 ummary of Project-related Residual Adverse Effects on Indigenous Land and Resource Use

Despite the mitigation tools to be implemented, it should be noted that how potential effects are perceived can be highly variable among resource users and dependent on proximity to the effect. For example, Project-related effects such as noise and dust can cause avoidance of the area by some resource harvesters while others may be undeterred. Variable in sensitivities among individuals may affect how one person perceives an effect compared to another (e.g., magnitude may be high for some and negligible for others). The magnitude of perceived effects tends to decline with increasing distance from the Project and Project activities, such as traffic.

11.1.6.3 Perceived Suitability of Lands and Resources Therein

After the implementation of Project mitigation measures, residual effects on ILRU are expected to be adverse, of low magnitude during all Project phases, be located primarily in the ILRU LSA, and be medium-term in duration. Effects to ILRU are expected to be continuous in frequency, low in context, and fully reversible following Decommissioning.

A summary of residual environmental effects on perceived suitability of lands and resources therein is provided in Table 11.1-14.

Table 11.1-14: Indigenous Land and Resource Use – Summary of the Characteristics Ratings for Residual Effect 1

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Perception of suitability of lands and resources may result in avoidance of areas and selection of alternate areas to carry out land use activities.
Magnitude	Low	Presently few resource users practice land use in Project affected areas and only a sub-set may perceive lands to be unsuitable. The presence of other uranium operations in the region have demonstrate that ILRU persists in the presence of industry.
Geographic Extent	Local	Effects are expected to be contained within the ILRU LSA including land in close proximity (up to 400 m) around the Project Area, and up to 300 m on either side of local access roads and the Key Lake – McArthur River haul road.
Duration	Medium-term	Project Construction to Post-Decommissioning is 38 years. Effects on resource users will be most detectable during Construction and Operation and declining throughout Decommissioning.
Frequency	Frequent	Project disturbances are expected to occur many times on the regular basis throughout the life of the Project.
Reversibility	Fully Reversible	Project-related disturbances are expected to cease once Project infrastructure is removed, the site is remediated, and activity returns to baseline levels.
Context	Low	Resource users are able to adapt and change to new conditions and exhibit resiliency to changing conditions.
Likelihood	Likely	The Project will likely have some effect on ILRU.

11.1.6.4 Significance and Confidence

All changes to KIs for ILRU are expected to be negligible, except for the perceived suitability of lands and resources KI. While it is difficult to predict individual perceptions on the suitability of land proximal to the project for ILRU, resource users may experience disturbances from traffic, noise, air quality changes, changes related to the relationship to the land, and increased competition for resources. Resource users may also be concerned about personal exposure to contamination of surface and groundwater, soils, and sources of waste. Some perceptions may be strong enough to cause some individuals to avoid practicing ILRU in areas proximal to the Project. Overall, the adverse effects are expected to be low in magnitude, limited in geographic extents, and reversible, and the conclusion relative to changes to ILRU is **not significant**.

The overall confidence in the determination is moderate. The range of certainty is based on the previous experience with the uranium industry in northern Saskatchewan, the prior experience of Indigenous COI with the industry, knowledge of other uranium mining operations, evidence gathered from processes such as the Community Vitality Monitoring Partnership and based on other relevant project experiences in Canada and beyond. The mitigation strategies that have been proposed have been successful in similar contexts such as management of noise, traffic, dust, and competition for resources. Confidence cannot be considered as high, as the Indigenous COIs lack certainty about ISR mining technique, and further engagement and education is warranted to familiarize the communities with the process.

11.1.7 Cumulative Effects

Projects considered in the cumulative effects assessment (Section 5.9 in Section 5; see also Table 11.1-15) were systematically examined for temporal and spatial overlap. Temporal overlap occurs when the project is a reasonably foreseeable development meaning that the Project is a future certainty or is reasonably foreseeable[7] and this development will take place within the planning horizon and expected life cycle of the Project (i.e., within 38 years; IAA 2018). Existing projects were not considered as part of the CEA because they were captured and assessed within baseline conditions. Spatial overlap was considered within the ILRU RSA where Project interactions may occur. Projects that met both criteria were carried forward for CEA.

Table 11.1-15: Projects and Activities Considered for the Cumulative Effects Assessment

Project Description	Project Type	Temporal Overlap	Spatial Overlap (within the ILRU RSA)	Carry Forward for Cumulative Effects Assessment
Cameco Cigar Lake Mine	Existing Mine	Existing	Yes	Considered as part of existing environment
Cameco Key Lake Operation	Existing Mill[1]	Existing	Yes	Considered as part of existing environment
Cameco McArthur River Operation	Existing Mine[2]	Existing	Yes	Considered as part of existing environment
Cameco Millennium Mine	Potential Future Mine[3]	Project on pause with no certainty on start date	Yes	No

[7] The physical activity is expected to proceed, e.g., the proponent has publicly disclosed its intention to seek the necessary EA or other authorizations to proceed.

Project Description	Project Type	Temporal Overlap	Spatial Overlap (within the ILRU RSA)	Carry Forward for Cumulative Effects Assessment
Wheeler River (Gryphon) Project	Potential Future Mine[4]	Project not currently being pursued by Denison	Yes	No
Various campgrounds / recreation sites	Campground/Recreation Site	Existing	No	Considered as part of existing environment
Cree Lake Winter Road	Completed Road	Existing	Yes	Considered as part of existing environment
Fox Lake Winter Road	Completed Road	Existing	Yes	Considered as part of existing environment
Key Lake Road	Completed Road	Existing	Yes	Considered as part of existing environment
MacFarlane Lake Winter Road	Completed Road	Existing	Yes	Considered as part of existing environment
Thin Creek Bridge	Completed Road	Existing	Yes	Considered as part of existing environment
Waterbury Lake Local Access Road	Completed Road	Existing	Yes	Considered as part of existing environment
Highway 914 All Weather Road	Future Road (Proposed)	Yes	Yes	Yes
Various lodges and outfitters	Outfitter and lodging	Existing	Yes/No	Considered as part of the existing environment
Various Ecological Reserves	Ecological Reserve (provincially designated protected area)	Existing	No	Considered as part of the existing environment
Various Indigenous Lands	Indigenous Land / Treaty	Existing	Yes/No	Considered as part of the existing environment

1, 2 Both the Cameco McArthur River Mine and the Key Lake Mill were moved from active operations to care and maintenance in January 2018 because of sustained low uranium prices (Cameco 2018). The McArthur River mine was in safe state of care and maintenance until early 2022. On February 9, 2022, Cameco announced plans for the McArthur River and Key Lake operations gradual return to production (Cameco 2022).

3, 4 The proponent has not publicly disclosed its intention to seek the necessary EA or other authorizations to proceed.

Many of the projects listed in Table 11.1-15 are considered as part of the existing environment and are thus already considered in the context of the residual effects assessment. Other projects lack spatial or temporal overlap with the ILRU RSA and thus are not carried through the CEA. The only project carried forward for CEA is the Highway 914 extension project. The effects from this Project were overlayed with residual effects from the suitability of lands and resources therein KI. Resource availability for harvesting subsistence resources and land availability to practice TLU KIs were not carried forward for a residual effects assessment and, therefore, are not subject to CEA.

Highway 914 Extension Project

The Highway 914 extension project EIS was filed on September 3, 2022 (Stantec 2021). The project is described as follows by Stantec (2021):

> *"Saskatchewan Ministry of Highways (MOH or the Ministry) is proposing a highway extension project consisting of the construction of 50.7 kilometres (km) of all-weather highway that will extend the existing Highway 914 starting near the McArthur River mine site to an existing road near the Cigar Lake mine site… The purpose [of] the Project is to create an alternate travel route for residents of Saskatchewan's northernmost communities. Several communities have one road option to access the southern areas of the province (Provincial Highway 905). Development of the Project would provide a secondary route for vehicles travelling to and from the north".*

The first four years of the Highway 914 Extension project construction will consist of the construction of the roadway between the McArthur River and Cigar Lake mines. This portion of the roadway has no spatial overlap with the ILRU RSA and, therefore, no cumulative effects. Assuming that both projects will start their construction phases in the same year, there would be no overlapping cumulative effects during the construction phases of both projects. Both projects would become active during their operation phases when spatial overlap would occur because industrial, public, and recreational traffic will flow freely along the length of the road between the Key Lake Mill and the Cigar Lake Mine. Public access on the roadway will eliminate the need to check in at the access gate at the Key Lake Mill.

Highway 914 is presently gated at the Key Lake Mill at the southern extent of the ILRU LSA, which restricts access to areas north of the Key Lake Mill and along the Key Lake to McArthur River haul road. It was predicted by the ERFN Trapper that "*If the gate at Key Lake is removed or the road is redesigned to go around Key Lake allowing unimpeded access to the north, there would be lots of concerns about the increase in the number of people coming north into this area*" (19-LK-ERFNTrap-134.224). Increased access to the area was identified as a concern by the KML #9 particularly with respect to hunting, fishing for food as an "*increase human traffic will affect our ability to practic*e" subsistence harvesting (KML and Limnos Environmental 2022). The KML have requested additional information from the province on safety processes to protect community members from increased traffic on the 914 extension and the KML considers the current road condition unsuitable to support increased traffic (KML 2022). The timing of overlap would begin during Project Operation and continue until Post-Decommissioning is complete when temporal overlap ceases.

Improved access to ILRU RSA via the Highway 914 extension and a bypass of the Key Lake gate is expected to affect the suitability of lands and resources therein due to increased traffic, noise, dust and increases in competition for resources. As noted, the magnitude of these effects is relative to individual resource user perspectives, ranging from no effect to a perception that the area has become completely unsuitable for land use.

Although offering an alternative route south, the Highway 914 extension will not considerably shorten travel to the south by Athabasca Denesųłiné communities to southern population centres, and decisions on which route to take would remain influenced by the final destination of any travelers. It is possible that the previous route south via Highway 905 will remain the preferred route for through traffic. It is also possible that travel down Highway 914 may be pursued for destinations on the west side of Saskatchewan, or to explore parts of the province that were otherwise difficult to reach by road (but that nonetheless constituted parts of some individuals' familial territories). Indigenous land use from Athabascan Denesųłiné communities may increase along Highway 914 as people would have access to an area that would otherwise require extensive distances to reach by vehicle.

The absence of the Key Lake gate and the removal of the process of providing identification will provide recreational users and local Indigenous communities with greater access to the ILRU LSA, which is not currently used intensively. The ERFN, the Hamlet of Patuanak, and Pinehouse will be the mostly likely users to access these areas due to their established traditional activities in areas proximal to the Project; however, the distances from the communities to the area may still act as a barrier.

A summary of the CEA is presented in Table 11.1-16. Overall, the potential cumulative effect is characterized as being adverse and of moderate magnitude due to the potential for increased competition for resources, though not high because existing ILRU land users will benefit from better access as well. Cumulative effects are expected to be confined to the ILRU RSA around the Project Area and adjacent to roadways, medium-term (approximately 35 years with assumptions about when the projects will overlap), and continuous from Operation to the end of Decommissioning. Residual effects will be fully reversible by Post-Decommissioning, context is low due to ILRU resource users being resilient and adaptive to new and changing conditions, and the effects are likely. Cumulative effects are predicted to be **not significant**. Confidence is moderate because it relies on individual perceptions of suitability, which can be variable.

Table 11.1-16: Summary of Cumulative Effects for Indigenous Land and Resource Use

Cumulative Effects	Project Phases	Cumulative Effects Characterisation[1]								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Perception of reduced suitability of land and resources therein	Operation – Post-Decommissioning	M	RSA	MT	CF	FR	L	L	NS	M

[1] Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)

Frequency:	Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility:	Fully reversible (FR), Partially reversible (PR), Irreversible (IR)
Context:	Low (L), Moderate (M), High (H)
Likelihood:	Unlikely (U), Likely (L)
Significance:	Not-Significant (NS), Significant (S)
Level of Confidence:	High (H), Moderate (M), Low (L)

Climate Change Considerations

The Project must also be considered in the context of climate change. The sensitivities of the Project to severe weather (e.g., extreme temperatures and excessive precipitation) and forest fires have been examined as they have the potential to adversely affect the Project. Events including flooding, tornadoes, and forest fires, which are likely to become more frequent and/or more severe under climate change have been considered in the Accidents and Malfunctions report (Section 14). The Project will be designed, constructed, operated, and maintained relative to applicable regulations, codes, and standards. Detailed plans and procedures would be developed for the Project that are site specific including:

- process monitoring and operational procedures;
- mine development and control procedures;
- radiation protection plan;
- spill and emergency response plan;
- traffic and transportation plan;
- security procedures;
- travel management plan;
- environmental monitoring procedures;
- personnel training procedures;
- regular and preventive inspection and testing procedures; and
- surface water and flood management procedures.

Based on a consideration of the mitigation strategies to be applied, past experience, and application of BMPs, effects of a changing climate on the Project are expected to be **not significant**.

11.1.8 Monitoring and Follow-up

For the purposes of this EIS, monitoring and follow-up are defined as follows:

- Monitoring programs are designed to meet regulatory requirements (e.g., permit or license conditions), and / or to demonstrate compliance with environmental commitments made in the EIS.

- Follow-up programs are those that are proposed to address any uncertainties identified during the EA process (e.g., to verify predictions made during the EA; determine the effectiveness of proposed and implemented mitigation measures) and to determine if and when to implement adaptive management measures.

Monitoring and follow-up activities relative to the VCs that support ILRU are detailed in their respective sections of the report. No monitoring or follow-up activities specific to the ILRU VC are proposed at this time. As outlined in Denison's Indigenous Peoples Policy, Denison is committed to respecting Indigenous knowledge and values regarding environmental stewardship and Indigenous peoples' connection to the land, and to minimize potential effects, wherever possible.

11.1.9 Indigenous Land and Resource Use Summary

The proposed Project is located in an area traditionally used by Indigenous people, which, over the last few centuries, included the Dene, Cree, and Métis of northern Saskatchewan. The Project is known to overlap with the traditional territories of ERFN, the Kineepik Métis Local #9, and the Athabasca Denesųłiné communities; however, much of each groups uses occur in areas more proximal to their home communities. Access restrictions north of the Key Lake gate mean that use is restricted to lease holders (e.g., cabin owners) and select Indigenous communities. The closest areas of intensive community use relate to ERFN's cultural camp (km 160) and Kineepik Métis Local #9/Northern Village of Pinehouse's cultural camp at Gordon Lake, both of which are located south of the Key Lake gate along Highway 914. Indigenous Land and Resource Use activities that tend to occur in the ILRU LSA include hunting (including moose and woodland caribou), the gathering of plants for food or subsistence purposes, trapping of aquatic furbearers (including beaver and muskrat), and fishing (including Walleye, Northern Pike, Lake Trout, Lake Whitefish, and Arctic Grayling). Proximal to the Project, many of the most recent uses were by an ERFN Trapper who passed away prior to the filing of the EIS. These uses are considered as representative of future land use by the ERFN, although all three Indigenous groups have documented uses on Russell Lake south of the Project Area.

The various phases of the Project have the potential to induce different effects on ILRU and its KIs: resource availability for harvesting subsistence resources (terrestrial and aquatic resource availability and health of resources), land and waters available for traditional practices, and perceived suitability of land and resources (aesthetic experience, perceived suitability of resources for safe use, and quality of resources of consumption). The KIs of resource availability, land and waters available for traditional practices, and perceived suitability of land and resources for aesthetics were not carried forward to residual effects assessment and can be eliminated, reduced, or controlled through mitigation measures.

Although the human health risk assessment concluded that there are no radiological exceedances, and that COPC exceedance could arise (selenium) in the unlikely circumstance that fish were only consumed from Russell Lake, perceptions surrounding the quality of the resource may still result in a change in behaviour and alter ILRU activity. As a result, the perceived suitability of lands and resources for safe use was carried through to the residual effects assessment.

Mitigation measures for ILRU KIs include Project design, implementation of BMPs, development of management plans, implementation of emergency response programs, minimizing land that is disturbed by the Project and reducing the Project footprint to the extent practicable, provision of training, education, and awareness, and mitigations to reduce risks associated to increased traffic, noise, air quality, the potential for COPCs to enter the environment, waste management, the ISR mining method, and human health.

With the implementation of Project mitigation measures, overall, residual effects on ILRU perceived suitability of lands and resources for safe use are expected to be adverse, low magnitude during all Project phases, located primarily in the LSA, and medium-term in duration. Effects are expected to be continuous in frequency, low in context, and fully reversible following decommissioning. While it is difficult to predict individual perceptions on the suitability of land proximal to the Project for ILRU, resource users may experience disturbances from traffic, noise, air quality changes, changes related to the relationship to the land, and increased competition for resources. Resource users may also be concerned about personal exposure to contamination of surface water and groundwater, soils, and sources of waste. Some perceptions may be strong enough to cause them to avoid practicing in areas proximal to the Project. Overall, given limited use of the ILRU LSA, adverse effects that are low in magnitude, the limited geographic extents of effects, and the reversibility of effects, the conclusion relative to changes to ILRU is **not significant**.

The overall confidence in the determination is moderate. This is based on the previous experience with the uranium industry in northern Saskatchewan, the Indigenous COI's prior experience with the industry, knowledge of other uranium mining operations, evidence gathered from processes such as the Community Vitality Monitoring Partnership, and based on other relevant project experiences in Canada and beyond. The mitigation strategies that have proposed have been successful in similar contexts, such as management of noise, traffic, dust, and competition for resources. A slightly lower degree of certainty is applied to perceptions of the safety of the ISR mining method because, while regionally residents have long-standing experience with uranium mining, the ISR method is new in their experience and additional engagement will be required to inform citizens on how the operations work and the degree to which environmental health is protected. The only project carried through to the CEA relative to land and resource use was the Highway 914 extension project, which could result in potential changes to resource abundance and distribution and access considerations. Overall, the CEA concluded that the cumulative effects could potentially be adverse, of moderate magnitude, and within the ILRU RSA, with most effects occurring around the Project Area and adjacent to roadways. These effects are anticipated to be medium-term, and continuous from Operation to the end of Decommissioning. Residual effects are expected to be fully reversible by Post-Decommissioning, the context is low due to ILRU resource users being resilient and adaptive to new and changing conditions, and the effects are likely. Cumulative effects are predicted to be **not significant**. Confidence is moderate as it relies on individual perceptions of suitability, which can be variable.

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11.2 Other Land and Resource Use

This subsection addresses potential effects from the Project on the OLRU VC. This section comprises the following steps as part of the assessment:

- scope of the assessment;
- summary of existing conditions;
- identification and description of potential interactions between the Project and the VC;
- identification and description of mitigation measures applicable to the VC to eliminate, reduce, or control the potential adverse Project-related effects);
- identification and characterization of predicted Project residual effects (i.e., after mitigation), including characterization of significance and assignment of the level of confidence in the predictions; and
- identification and characterization of potential cumulative effects.

Figure 11.2-1 is a graphic representation of the assessment process used in this EIS.

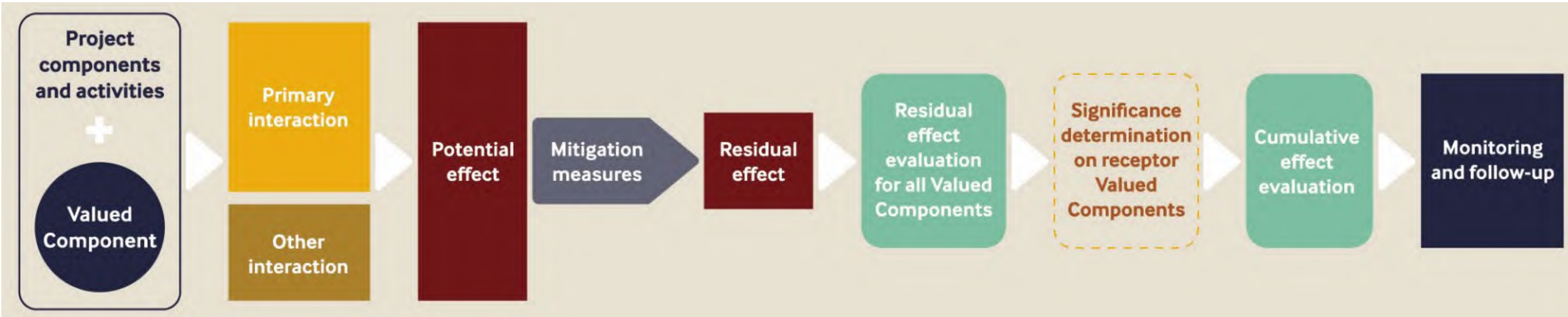

Figure 11.2-1: Environmental Assessment Process for the Wheeler River Project

Other Land and Resource Use considers both recreational and commercial use of resources. Recreational resource use includes hunting and fishing by licensed (non-Indigenous) harvesters. Resource use for commercial purposes includes commercial trapping, commercial fishing, lodge and outfitting services, ecotourism, forestry, and mining, which may be conducted by either Indigenous or non-Indigenous peoples under the authority of provincial licenses or by resource allocations. It is acknowledged that certain activities, such as commercial trapping and fishing have overlap with the Indigenous land and resources use described in Section 13.1, as the resource harvesters often pursue both traditional and commercial harvests simultaneously. Additional topics include access and navigation, cabins, campsites, and parks and protected areas. Placenames, waterbodies, and administrative boundaries discussed in this section are displayed on Figure 11.2-2.

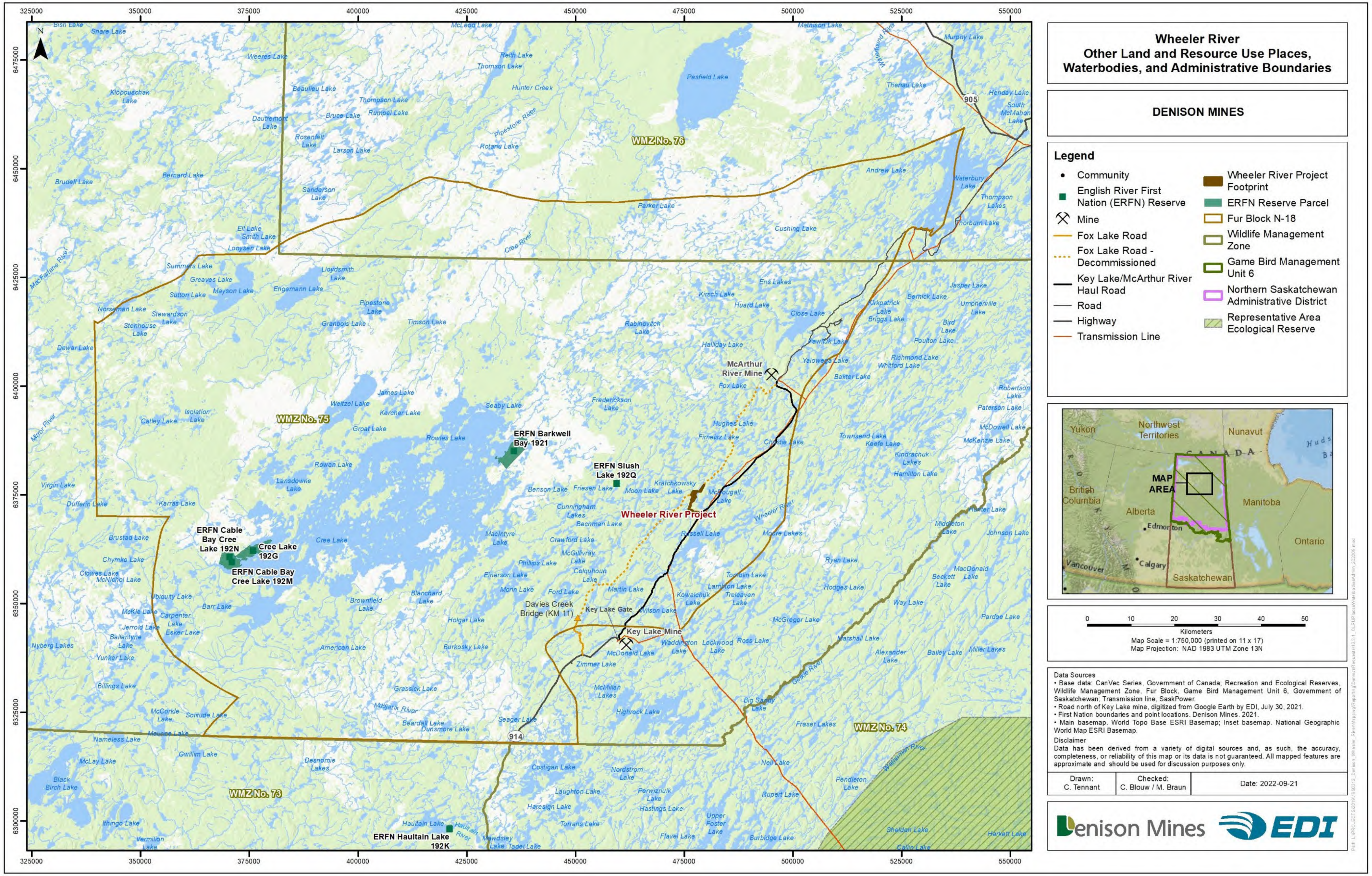

Figure 11.2-2: Other Land and Resource Use Places, Waterbodies, and Administrative Boundaries

11.2.1 Scope of the Assessment

11.2.1.1 Valued Component Selection

Valued Components are aspects of the biophysical and human environments that will likely be affected (adversely or positively) by the Project. The value of a component not only relates to its role in the environment, but also the value people place on it (Denison 2020). An initial VC list was developed for engagement purposes based on a scan of other EAs conducted in northern Saskatchewan. Other Land and Resource Use components, such as commercial and recreational fisheries, mineral claims and outfitters, sport fishing camps, and other recreational uses potentially affected by the Project, were among the VCs identified (Denison 2020). These have since been combined into an OLRU VC. Denison reviewed and considered survey results to develop a VC list that reflects the key environmental, socio-economic, heritage, and human health components and interests to focus the detailed assessment for the EA.

To validate VC selection and as part of engagement activities, Denison sought feedback from ERFN and the Northern Village of Beauval, the Northern Village of Pinehouse Lake, and the Northern Hamlet of Patuanak (hereafter Beauval, Pinehouse, and Patuanak, respectively). In early 2021, Denison prepared and shared an online survey that included information about Denison and the Project, and posed validation questions about the VCs being assessed as part of the EA process. A total of 23 completed surveys were received from ERFN and 62 completed surveys were received from Beauval, and Pinehouse. Denison also met with the MN-S in early 2023 to share information about the Project, including discussion on VCs considered in the assessment; no new VCs were identified as part of that discussion. The information received validated the VC selections made. For example, the following feedback on the VC list was received from surveys conducted in Beauval and Pinehouse:

- "*All of them [VCs] are reasonable and none should be bypassed*" (21-EN-SUR-446.29); and
- "*I feel that the land and water are our best resources and in the not too distant future they will be incredibly valuable. Compromising them seems dangerous*" (21-EN-SUR-446.18).

Denison has also been engaging with the YNLR since 2019 to understand any interests or concerns about the Project that the YNLR may have as the coordinating organization on behalf of seven Athabasca communities: the Hatchet Lake Denesųłiné First Nation, the Black Lake Denesųłiné First Nation, the Fond du Lac Denesųłiné First Nation, and the municipalities of Stony Rapids, Uranium City, Wollaston Lake, and Camsell Portage.

The OLRU VC is important because fishing, hunting, and trapping are social, economic, and recreational activities integral to northern Saskatchewan. Tourism also brings in important economic benefits to the local economy. All these components rely on the abundance and relative distribution of fish and wildlife, a land base on which to carry out activities, and safe access and navigation to the locations where these resources can be harvested. The OLRU VC is distinct from the ILRU VC (Section 11.1) because of its focus on licensed activities, such as commercial trapping, commercial fishing, and licensed recreational (non-Indigenous) hunting and fishing.

Figure 11.2-3 is a graphic representation of the main linkages among the OLRU VC and other VCs, illustrating the flow of assessment information into and from the OLRU VC.

Figure 11.2-3: Integrated Assessment Approach - Key Connections between Other Land and Resource Use and Other Valued Components

11.2.1.2 Key Indicators and Measurable Parameters

To provide focus and analytical rigour to the EA, the effects assessment for each VC identifies relevant KIs and associated MPs (Table 11.2-1). These are defined as follows:

- **Key Indicator**: an important component or aspect of the VC that is expected to be affected (changed) as a result of the Project.
- **Measurable Parameter**: a parameter or metric associated with the KI that can be used to detect and measure Project-related changes.

Key indicators for the OLRU VC include:

- resource availability for harvesting commercial and recreational resources;
- land availability to practice commercial and recreational land use; and
- perceived suitability of lands and resources therein.

The resource availability KI considers hunting, fishing, and trapping for commercial and recreational (non-Indigenous) purposes and is measured by the relative abundance and distribution of fish and wildlife species. Assessment of Project-related effects on fish and wildlife are drawn from fish and wildlife VCs including fish habitat, fish health, furbearers, ungulates, and migratory breeding birds. Important indicator species for OLRU include Northern Pike, Walleye, pine marten, moose, waterbirds and waterfowl, and upland game birds as they are harvested by recreational and commercial fishers, trappers, recreational hunters, and lodge and outfitting clients. Valued Components not of concern to OLRU include plants and woodland caribou. Plants are not an important resource to recreational or commercial harvesters and hunting of woodland caribou by non-Indigenous hunters has been prohibited in Saskatchewan since 1987 (Government of Saskatchewan 2019c).

The land availability KI refers to the land base from which resource users carry out a variety of resource harvesting activities. Project activities may result in a reduction of land available for resource use components such as fishing, hunting, and trapping but also lodge and outfitting service allocation areas, protected areas, and mining and forestry industries. Actual physical barriers to land use such as removal of the Project footprint from the land base can be quantitatively measured by the area directly altered/lost because of Project activities or barriers to travel and access to harvesting locations.

Two additional MPs within the land availability KI include Project-related changes in travel access and navigation including changes in traffic volumes and type; ice, water, and land travel routes; ability to reach and secure shelter at resource user cabins; and the presence of competing resource user groups that can affect the ability to conduct commercial and recreational activities.

Changes to the KI of perceived suitability of lands and resources therein is measured qualitatively because it is driven by the perceptions of resource harvesters. Examples include changes in the aesthetics of land use from noise, changes to a secluded wilderness experience, and other Project-related changes to the landscape that affect perceptions. Project-related changes also may change competition among and between OLRU components. For example, at a workshop in Pinehouse, one participant expressed interest in the balance between different development opportunities by asking "*where's the point where [there is] so much mining activity [it] interferes with tourism development*" (18-EN-VPL-2.59). Perception of land suitability is important to the continuation of licensed commercial and non-Indigenous recreational resource use because harvesters may practice avoidance of areas that are perceived to be tainted, overharvested, or of reduced aesthetic quality.

Table 11.2-1: Key Indicators and Measurable Parameters for Other Land and Resource Use

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Resource availability for commercial and recreational harvests	The Project has the potential to alter the relative abundance and distribution of Walleye and Northern Pike, which are important species for recreational and commercial fishing. The Project has the potential to alter the relative abundance and distribution of moose, which are important for recreational hunting. The Project has the potential to alter the relative abundance of furbearers, particularly pine marten, which are an important species to commercial trapping.	Change in relative abundance and distribution of fish species. Change in relative abundance and distribution of wildlife species. Changes to the health of the resources. Change in continued opportunities for commercial and recreational resource use.
Lands/waters available to conduct commercial and recreational harvests	Continued opportunity and access to lands to practice commercial activities such as trapping, fishing, forestry, and mining; and recreational activities including hunting, fishing (angling), and non-consumptive activities such as visiting parks and protected areas and ecotourism. The Project has the potential to alter safe access and navigation to resource harvest areas and the availability of supporting infrastructure, such as cabins and camping sites, which are important to the continuation of OLRU. The Project has the potential to alter the continued ability to participate in and maintain access to recreational activities provided by parks and protected areas, lodge and outfitting services, and ecotourism, which are important to Saskatchewan residents and tourists.	Change in the area and accessibility of areas for commercial or recreational uses, such as cabins, tourism, guided outfitting, protected areas, mining, and forestry that is altered/lost because of Project activities. Changes in availability/accessibility of waterways.
Perceived suitability of lands and resources therein.	Project-related disturbances can affect OLRU aesthetics and the perceived suitability of resources and resource harvest areas.	Change in esthetic experience (with consideration of traffic, noise, air quality, modification of the wilderness experience). Change in perceived suitability of resources for safe use.

11.2.1.3 Spatial and Temporal Boundaries

11.2.1.3.1 Spatial Boundaries

Three spatial boundaries have been defined for the OLRU VC: the Project Area, a LSA, and RSA (Table 11.2-2; Figure 11.2-4).

Table 11.2-2: Description of Spatial Boundaries and Study Areas

Study Area	Descriptors
Project Area	The area in which all Project components/activities are located. It is expected that all physical disturbances resulting from Construction, Operation, and reclamation activities will occur within this area.
Local Study Area (LSA)	The area established to assess the potential, largely direct effects of the Project on the environment; delineated based on the area over which direct and indirect effects are most likely to occur on VCs. Defined as the Project footprint plus the maximum combined extents on supporting VC RSAs including Aquatic, Terrestrial, Noise, and Health LSAs as changes in these components can affect the other resource use environment. Inclusive of trapping and fishing areas that involve resource user travel through and adjacent to Project activities.
Regional Study Area (RSA)	The area established to assess the potential, largely indirect effects of the Project in the broader, regional context, and provides the regional context over which cumulative effects may occur. Defined as trapping block N-18 and the footprint of the Key Lake Mine to capture regional land use, regional effects on aquatic and terrestrial resources, and the maximum extents of changes to noise and health in combination with other potential development. While cumulative effects are not expected in most areas of the N-18 trapping block, the spatial boundaries of the trapline are a familiar reference for local Indigenous communities and capture the broad land usage patterns of local communities. Trapping blocks are defined regions and have membership that is regulated by a local trapping association and membership is generally only open to local Indigenous community residents[8] though non-Indigenous trappers may also participate as members of the trapping association. If resource use activities were displaced, it is likely this would still occur within the N-18 trapping block area where individual resource users already have familiarity.

[8] The Northern Fur Conservation Block constitutes most of the forested area of northern Saskatchewan. This area was partitioned into 89 Fur Conservation Areas (FCAs or Trapping blocks) in 1946. The FCAs were established to allow recovery of the beaver population, and to function as the units of management whereby the fur harvest of a restricted number of trappers could be managed through an orderly trapline management system that would reduce conflicts and maintain forest trap-lines as commercial entities. Each FCA is composed of a group of registered/licenced trappers, from which a representative council of not more than five members is chosen. Each FCA membership and elected council is responsible for its own administration, organization, and operation. The FCA blocks have authority on issues relevant to their membership and block administration (Government of Saskatchewan 2012).

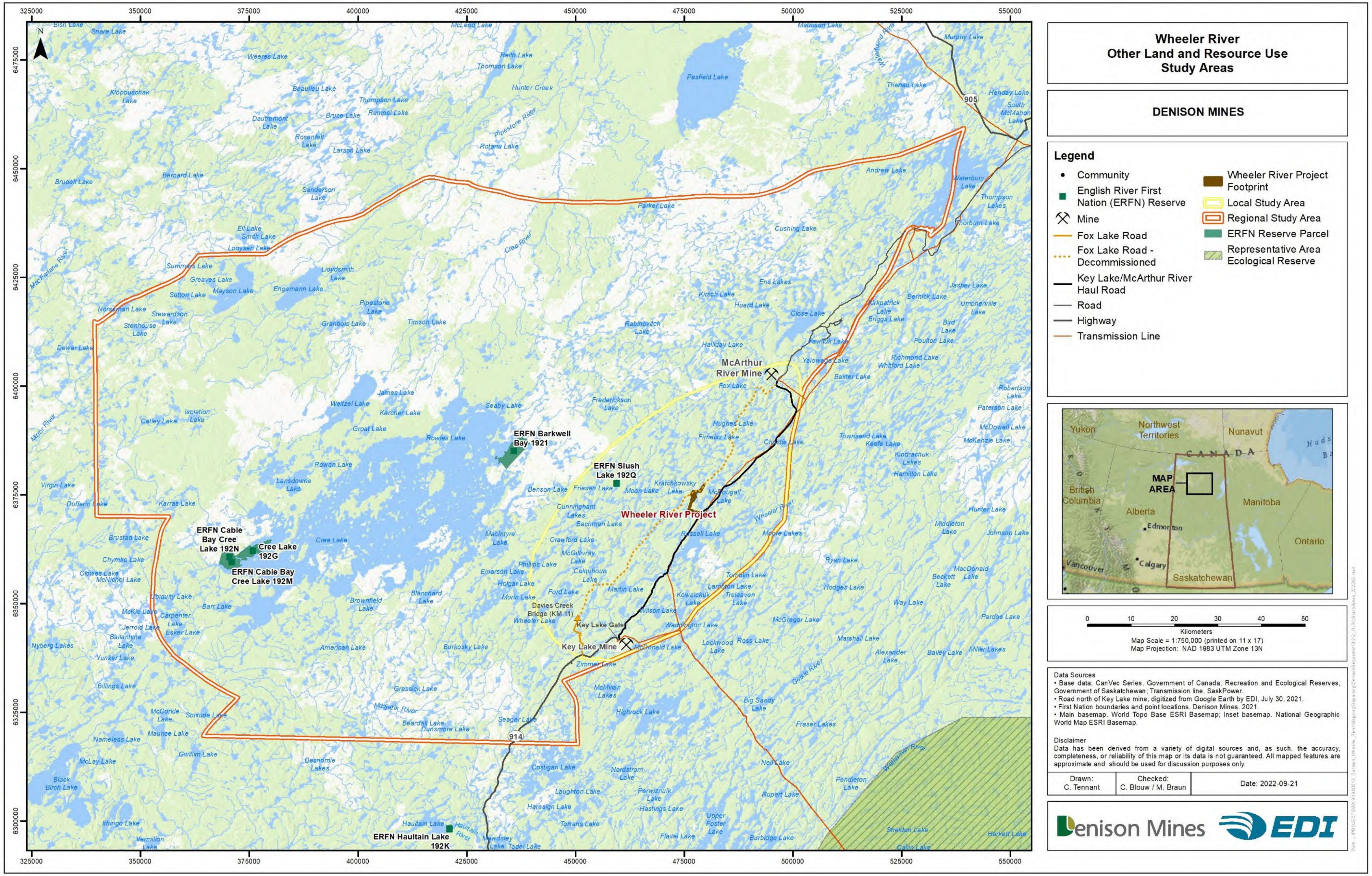

Figure 11.2-4: Other Land and Resource Use Study Areas

11.2.1.3.2 Temporal Boundaries

Temporal boundaries for characterizing components of the OLRU existing environment varied by topic. Commercial trapping and fishing data were presented based on the data available from the Province of Saskatchewan, and with multiple years of data presented where available. Other topics such as recreational fishing and hunting considered data where available, but in some instances is based on licensing quotas which do not always vary from year to year, or are based on self-reported outcomes. For commercial fishing and trapping, the timeframes presented included pre-COVID pandemic years as the pandemic materially affected both the commercial fishing and trapping industries due to community lockdowns and fur marketing/fish processing closures (FFMC 2020).

The temporal scope of the OLRU assessment totals a minimum of 32 years from the initiation of Construction to the completion Post-Decommissioning as defined by the following Project phases:

- Construction: includes the construction of a 7 km access road to the site, an accommodation complex, operations centre, airstrip; a 5 km long road from the site to the airstrip and site roads; wellfield development; water treatment ponds; potable, sewage, and wastewater treatment plants; and a processing plant. The duration of Construction will be approximately two years.
- Operation: includes operation of the wellfield; operation of the processing plan and production; maintenance activities; water withdrawal from groundwater or surface water for potable use, fire suppression, and make-up water in the processing plant; water treatment; waste management; environmental monitoring; package and transport of nuclear substances; reporting to regulators; engagement; and site security. The duration of Operation will be approximately fifteen years.
- Decommissioning: mining chamber remediation; decontamination; asset removal; demolition and disposal; and reclamation. The duration of Decommissioning will be approximately five years. Section 2.3.3 outlines a conceptual decommissioning plan to support the EA for the Project. Denison's decommissioning commitment is to return the land back to the Province of Saskatchewan for unrestricted surface land use post-closure. The conceptual decommissioning plan outlines how radiological, physical, and chemical risks will be managed during Decommissioning so no unreasonable risks remain. Denison will prioritize passive versus active controls to reduce long-term risk.
- A fifteen-year Post-Decommissioning phase will serve to monitor the Project and confirm that it is acceptable for either direct release back to the Crown with no future use restrictions or acceptance into the provincial Institutional Control Program for decommissioned sites.

11.2.2 Influence of Indigenous Knowledge, Local Knowledge and Engagement on the Assessment

At its broadest level, IK can be understood as a body of knowledge built up by a group of people through generations of living in close contact with nature (CEAA 2015). This unique and collective knowledge may also include, but is not limited to, the environmental, cultural, economic, political, and spiritual conditions of a community or region (CEAA 2015). The results of IK collection can influence the assessment by guiding the development and refinement of primary data collection, providing context for interpretation of secondary data, and providing context for the baseline.

Local Knowledge is considered as specialized knowledge developed through long-term association, interaction, and cumulative experience. It is context-specific and unique. As the information is held by an individual, it cannot be validated and vetted through processes commonly applied in the collection of IK, which is considered as community-held and shared knowledge. In this EIS, IK and LK are viewed as complementary and influential alongside western science to produce a full understanding of the potential effects of the Project, whether measurable or perceived. Both forms of information have been given full and fair consideration.

The OLRU components relied on both IK and LK. Local Knowledge was provided by an ERFN trapper, fisher, and resource harvester (ERFN Trapper) who resided in and conducted resource use in the Project region and had observations of other resource users due to guiding and exploration services he has provided. On October 29, 2019, at the Project exploration camp, this ERFN Trapper attended a full-day interview. Notes from this interview were finalized and approved for use on January 2, 2020, and are used in most OLRU components. Unfortunately, prior to the time of filing the EIS, the ERFN Trapper passed away. However, the ERFN considers his use of the area as representative of current and future land users and expects that the relationship to the Project Area will be continued and strengthened through generations of future use.

Lodge owners and outfitters and one cabin owner were interviewed. They provided LK with respect to their present and planned future operations and other resource harvesters observed in the area.

English River First Nation produced two confidential reports for use in the EIS: the *Wheeler River Project – Summary of Health and Socio-Economic Study Results* (ERFN and SVS 2022a); and *Wheeler River Project – Summary of Traditional Knowledge Study Results* (ERFN and SVS 2022b). The first report summarizes results from 16 interviews that were conducted for the health and socio-economic section (ERFN and SVS 2022a). The TK study conducted, analyzed, and presented results from 21 land use interviews, which provided both TK and LK (ERFN and SVS2022b). Details on ERFN's participation in commercial activities such as commercial trapping, commercial fishing, and outfitting were collected as a portion of these interviews. These data are integrated into the existing environment (Section 11.2.3) and effects assessment (Section 11.2.4)

The KML #9 at Pinehouse authored a document to provide their unique voice and perspective on the Project for the EIS (KML 2022). While there is an overall consensus of support for the Project, two of the primary interests raised the need to have "*confidence in the continued success of the new mining application [in situ recovery or ISR] on [their] traditional territories*" and the potential cumulative effects to land use and land users due to the Highway 914 extension project (KML 2022).

The MN-S submitted *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) to Denison in October 2023. The Métis knowledge summarized therein included secondary literature approved for use by the MN-S and primary information collected during interviews with nine Métis citizens from NR1 and NR3, exclusive of information from the KML at Pinehouse who formally revoked its delegated Duty to Consult from the MN-S.

In March 2022, the Ya'Thi Néné authored a report entitled *An Exploration of Recorded Athabasca Denesųłiné Traditional Knowledge, Land Use and Occupancy Information in the Vicinity of Denison Mines Wheeler River Project* (YNLR 2022) and shared this with Denison. This report focused primarily on the Athabasca Denesųłiné First Nations including Hatchet Lake, Black Lake, and Fond du Lac. Indigenous Knowledge and LK within this report, as well as publicly available information, have been integrated into the EIS with focus on the Athabasca Denesųłiné communities. The March 2022 report is included as an appendix to the EIS (see Appendix 3-A in Section 3).

An Engagement Database was used to store and retrieve engagement, IK, and LK data. The Engagement Database is continuously updated and adapted to store comments made by Interested Parties organized by topic categories. Engagement, LK, and IK comments are stored in the Engagement Database for integration into the existing environment and assessment sections. Within the database, records are given unique identification numbers (e.g., 21-EN-SUR-446.52). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment. Appendix 11-A provides a summary of unique identification numbers referenced within Section 11.2.

Additional LK was sourced from long-term resource users such as cabin owners and lodge and outfitting service providers. A survey was conducted in January 2020 when Denison sent all known local cabin and lodge leaseholders a survey in the mail to be completed regarding their interests in the Project. Denison received five responses from the survey, which has informed its understanding of leaseholder uses in the area and interests regarding elements to be assessed as part of the EA (refer to EIS Section 4.4.3.2 for additional details). In 2021, several interviews were conducted with lodge and cabin owners to understand baseline levels of OLRU.

In some cases, the information provided in the EIS has been generalized to safeguard resources. For example, to protect the resource and interests of individual holders of information, specific fishing locations, lodge and outfitter's cabins and assets, and other features are not displayed on maps.

This approach respects the privacy of IK and LK held by local residents, business owners, trappers and fishers. As an alternative, harvests have been noted in a broad sense for consideration in the EA.

Triangulating IK, LK, and western data sources supported data validation of other land and resource components including, for example, defining appropriate study areas inclusive of active commercial trapping and fishing areas and providing context for and confirming trends related to the reliance on pine marten for fur trapping and Walleye for commercial fishing. Taken together, IK, LK and western data sources provided a more accurate and complete description of the existing environment and enabled better assessments to be made.

11.2.3 Existing Environment

11.2.3.1 Hunting

The Saskatchewan Ministry of Environment (SK MOE) manages the conservation and allocation of wildlife resources on behalf of all Saskatchewan residents. Many resource management tools are used to manage species abundance and to reduce conflict between resource users. Tools include hunting seasons, management areas, considering other land use activities, limiting firearm types, and harvest limits. In addition to these tools, the SK MOE has developed a wildlife allocation policy to determine how harvestable game is allocated to hunters and manage resource management conflicts (SK MOE 2017a).

This subsection describes licensed resident hunting and the management zones, districts, and units used to conduct wildlife management (see Figure 11.2-4). For each game species, the following is described: the maximum harvest or “bag limit” and seasons within which it is lawful to hunt, the number of licenses allocated, and hunting success rates. Guided hunting conducted through licensed outfitters is described in Section 11.2.3.4.

11.2.3.1.1 Wildlife Management Zones

The Wildlife Management Zones and Special Areas Boundaries Regulations, 1990 (Government of Saskatchewan 2014) define Wildlife Management Zones (WMZs) as areas for managing, harvesting, controlling, or regulating wildlife. Wildlife Management Zones are defined based on several factors including ecosystem classification and by land tenure or ownership. Wildlife Management Zones are primarily used to help with species conservation, as the goal is to have hunters harvest the surplus of a species. For the management of big game, the LSA is within WMZ 75. The RSA extends into WMZs 74, 75, and 76.

Game birds are managed under two different management units: gamebird districts and gamebird management units. Migratory birds such as geese, ducks, cranes, coots, and snipe are managed in two areas: the North and the South Game Bird districts. Both the LSA and RSA are located within the North Game Bird District. For the purposes of managing upland bird harvests, six Game Bird

Management Units (GBMU) exist in the province (Conkin 2018). Game Bird Management Unit 6, the 'Forest GBMU' covers approximately the northern third of the province and contains both the LSA and RSA.

11.2.3.1.2 Big Game Hunting

In WMZ 75, big game licenses are issued to Saskatchewan resident hunters for moose hunting from September 1 to November 30. Bear licenses are available to both Saskatchewan and Canadian residents for hunting in spring from April 15 to June 30 and fall from August 25 to October 14. Harvest of one moose or bear of either sex is permitted (Government of Saskatchewan 2019c). For hunters who reside outside of Saskatchewan or outside of Canada, guided hunts are available for one bull-moose in WMZ 75 (see Section 11.2.3.4). Other big game species, such as white-tailed deer, mule deer, elk, or pronghorn, are not hunted in WMZ 75 due to the absence or low abundance of these species. Wolf, though also classified as big game, is trapped by licensed trappers in this area. Licensed harvest of woodland caribou was closed province-wide in 1987 in response to declining populations and remains closed (SK MOE 2017b).

One tool used to understand how game populations are responding to current management strategies is the Hunter Harvest Survey (Government of Saskatchewan 2019b). Survey responses for the 2019 and 2020 hunting seasons reported number of hunters and harvests and enabled estimates of total harvests by species and WMZ (estimated total number of hunters and harvests). These are presented in Table 11.2-3 for WMZ 75 (Tokaruk 2021).

Table 11.2-3: Reported and Estimated Annual Licensed Hunter Participation and Harvest by Species in Wildlife Management Zone 75

Years	Moose				Black Bear			
	Reported[1]		Estimated Total[2]		Reported[1]		Estimated Total[2]	
	Hunters[3]	Harvest	Hunters	Harvest	Hunters[4]	Harvest	Hunters	Harvest
2019	9	2	42	9	4	2	14	7
2020	14	3	27	6	6	2	10	4
Average	**12.5**	**2.5**	**34.5**	**7.5**	**5.0**	**2.0**	**22.0**	**5.5**

Notes:

1 As reported through annual hunting surveys for the 2019 and 2020 hunting seasons.

2 Estimated total calculated from survey response rates.

3 Saskatchewan residents (non-Indigenous).

4 Saskatchewan and Canadian residents (non-Indigenous).

Based on the last two years of data, the average annual estimated moose harvest by licensed hunters in WMZ 75 was 7.5 by 34 hunters, and the average annual estimated black bear harvest was 5.5 by five hunters. It is likely that these harvests were conducted in other portions of WMZ 75 due to restricted access to the LSA. For example, Highway 914 ends at the Key Lake mine site located 35 km south of the Project. The private Key Lake - McArthur River haul road beyond, known locally as the "haul road", is restricted by the Cameco Key Lake gatehouse (Denison 2020). Access is granted by application, which limits public use of the road and, therefore, access by recreational hunters (Wheeler River Key Person Interview [KPI] Program 2021).

11.2.3.1.3 Migratory Waterfowl Game Bird Hunting

The North Game Bird District is open for hunting from September 1 to December 16 annually. Species permitted to be harvested include Canada, Cackling, and White-fronted Geese; White and Blue Phase Snow Geese, and Ross' Geese; Sandhill Cranes; and ducks, coots, and snipe. Based on 2020 harvest survey results, no respondents reported harvesting in 2019 (Tokaruk 2021).

11.2.3.1.4 Upland Game Bird Hunting

Upland bird species hunting is permitted from September 15 to December 31 for species such as Sharp-tailed, Spruce, and Ruffed Grouse; Gray Partridge; and Ptarmigan (Government of Saskatchewan 2019b). Harvest effort and harvests of upland game birds in GBMU 6 is provided in Table 11.2-4. Due to access restrictions beyond the Key Lake gatehouse, it is likely that upland game bird hunting and harvests occurred elsewhere in WMZ 75.

Table 11.2-4: 2019 Upland Game Bird Harvest and Harvest Effort in Game Bird Management Unit 6

Species	Number of Hunters Who Reported Hunting	Reported Effort (days)	Harvest
Ptarmigan	2	12	8
Ruffed Grouse	1	20	2
Sharp-tailed Grouse	1	20	0
Spruce Grouse	5	45	53

Source: Tokaruk 2021, Reported through the 2020 annual hunting survey for the 2019 hunting season.

11.2.3.2 Commercial Trapping

Commercial trapping is conducted under the authority of a Provincial fur licence and is practiced by both Indigenous and non-Indigenous people. Commercial trapping can be distinguished from domestic/subsistence trapping (described in Section 11.1.3.2) because the fur is sold whereas subsistence trapping is an activity that produces food and fur for sustenance and traditional use. Indigenous people often conduct commercial trapping and domestic/subsistence trapping concurrently. Indigenous peoples in the region have a long history of commercial trapping in northern Saskatchewan spanning from the post-contact period to the present day.

From the mid-1700s to the early 1900s, contact with European peoples became more frequent and the Dene people were encouraged to move into the boreal forest by the HBC to gain their active participation in the fur trade (Yerbury 1976, Gillespie 1976). Before this, the Dene people had little need for or experience with trapping animals. By the 1800s, trapping had become an important part of Indigenous livelihoods including for the Métis, who had settled in the area; the fur trade provided tools, such as steel traps, and more access to European goods (Calloway 1998). The Métis are considered as the “children of the fur trade” and were actively engaged in establishment of the original fur trading routes in northern Saskatchewan (MN-S and Two Worlds Consulting 2023). Individual trappers harvested within large territories, rotating areas where they felt animals were being depleted. They practiced a seasonal round self-regulated by local families and bands according to local pressures and fur resources. Should the resources fail in one area, they could move to a more productive region nearby. These family trapping areas were passed from generation to generation (Gulig 1997). The ERFN (ERFN and SVS 2021a) describe a seasonal pattern of settlement along the Churchill River system in summer and families dispersing in winter to trap and hunt in locations such as Haultain, Costigan, and Foster lakes including the areas between Cree Lake and the Churchill River (Jarvenpa 1980). *The Wheeler River Project: Métis Knowledge Study Report* noted the importance of trapping as an economic activity, which relied on familial kinship and the full support of Métis women for success (MN-S and Two Worlds Consulting 2023).

By the 1930s, the Great Depression had pushed many people from the south into the north, and the number of licensed non-Indigenous trappers approached half the number of Indigenous trappers in the north. The provincial game branch began leasing trap lines in the north to anyone who wanted to purchase the rights to an area, which was set out in a trapline lease. This structure was problematic, as the government-imposed regulations interfered with what had traditionally been self-regulated by local families and bands according to local pressures and fur resources. Indigenous trappers and communities were not consulted in the establishment of these leased traplines until after non-Indigenous interests were satisfied (Gulig 1997).

A system of extensive fur conservation blocks was organized in the 1940s with the intention that communities could sustain themselves through hunting, trapping and commercial fishing (Tough and McGregor 2007). *The Fur Act* (Government of Saskatchewan 1953) designated “fur blocks” for the purpose of managing and conserving fur resources. The northern fur block was further divided into community sections called FCAs. Quotas were placed on beaver and muskrat, and these were trapped on a community basis, the number for each person depending on the population levels (Bureau of Publications for the Department of Natural Resources 1948).

Since the 1970s, the fur industry in Canada has encountered volatility in world prices followed by major setbacks on the world market. The European Union’s ban on leg-hold traps and its demand for more humane methods to trap animals increased the cost of supplies for trappers and decreased the market and the price for furs as public interest in the product waned.

Since then, animal rights groups have had an impact on reducing the demand for fur products, which has affected their prices (Myers and Summerville 2004). With relatively low fur prices and the high cost of accessing trap lines, the number of trappers has been decreasing. Saskatchewan fur harvest statistics from 1970 to current day illustrate a declining trend in the number of trappers and pelts harvested (Government of Saskatchewan 2021a). As noted in *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023), "A 1992 study found that the total average value of furs in Saskatchewan declined by 84 percent between the years of 1983–84 to 1990–91 (McNab and Arlen 1992)."

Trapping provides benefits to trappers and their families, including money from fur sales, meat from certain species, and some use of furs for domestic purposes. *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) explains:

> *"Pelts and furs are no longer a significant part of the Saskatchewan economy, but trapping is still an important source of money for some families (Massie n.d.). For example, the total value of the trapping harvest in the Northern Fur Conservation Area was approximately $229,000 between 2020 and 2021* (Koback, n.d.)."

Trapping continues to be a source of supplemental income for many, bringing in between $1.5 and $6 million per annum for 4,500 trappers (Government of Saskatchewan n.d.a). In northern Saskatchewan, the fur-bearing animals that have consistently been trapped are beaver, muskrat, squirrel, marten, mink, weasel, fox, and otter. Other rarer species that have been trapped in the northern region include wolf, lynx, fisher, wolverine, and bear (Hay 2007).

Each fur block has a fur block chairperson, who is tasked with coordinating trappers in a fur block and participating on a co-management board with the province. Some fur blocks have trappers assigned to zones and other fur blocks are open, with trappers working larger areas. Trappers frequently shift their activity throughout a fur block to adjust to changes in animal density and movement.

To be eligible to trap, trappers must be Saskatchewan residents and hold a FCA Fur License purchased annually from October 1 to September 30. The Fur License covers the winter trapping season followed by time to prepare pelts for sale. Trapping areas are typically passed down intergenerationally (MN-S and Two Worlds Consulting 2023). Trapping is generally conducted in winter between November and March when fur is at its best or 'prime' quality (Government of Saskatchewan 2012).

The ERFN documented a multi-generational history of trapping between Cree Lake and Moon Lake in the RSA east of the proposed Project (ERFN and SVS 2022b). These trails were noted to be important historic trapping trails and are used currently for guiding or subsistence hunting instead of trapping (ERFN and SVS 2022b). ERFN and SVS (2022b) reported that lynx, muskrat, fisher, fox, otter, and mink were harvested along the trail both prior to the last 10 years and within the last 10 years. The MN-S identified trapping areas proximal to Highway 914, near Key Lake and Costigan Lake, northeast of the ERFN's Mawdsley Lake Reserve #192R, and east of the ERFN's Haultain Lake Reserve #192K towards High Rock Lake and the Iceland River (MN-S and Two Worlds Consulting

2023). The YNLR described trapping activity by one of its Athabasca Denesųłiné member at Keefe Lake to the east of the RSA but did nor report any trapping in N-14 (YNLR 2022).

In the last five years for which fur production data were available for the N-18 trapping block, an average of 176 marten pelts were taken each year for an average annual value of $14,929 (Government of Saskatchewan 2015, 2016, 2017, 2018a, 2019a). The annual average value of production for all species was $15,303. Marten, therefore, contributed to just under 98% of the total annual average value of furs produced between 2013/2014 and 2017/2018. Though other species were harvested, including red and cross fox, lynx, mink, and otter, they contributed little to the average production and value of the fur. Wild fur harvests and cash values for the last five years for which data are available are shown in Table 11.2-5.

The ERFN Trapper who conducted resource use within the LSA reported that his trapping activity was generally conducted at Moon Creek, along the Wheeler River to Russell Lake, and back to Kratchkowsky Lake. He commented that commercial trapping had declined due to decreasing fur prices. Marten was noted as an exception, though marten fur prices also have declined in recent years. Marten is typically caught during the winter months (November to April) using a tree mounted box, bait, and a body grip trap (19-LK-ERFNTrap-134.161).

Table 11.2-5: Fur Block N-18 Wild Fur Harvest and Value for 2013/2014 to 2017/2018

Species	2013/14		2014/15		2015/16		2016/17		2017/18		Five-Year Average	
	Quantity	Value $	Quantity	Value $	Quantity	Value $	Quantity	Value $	Quantity	Value $	Quantity	Value $
Fox - Cross	1	47	-	-	-	-	-	-	-	-	1	47
Fox - Red	3	111	1	21	3	37	-	-	1	15	2	46
Lynx	1	157	-	-	-	-	-	-	-	-	1	157
Marten	366	32,164	57	5,086	114	7,279	114	11,287	230	18,830	176	14,929
Mink	43	983	18	227	7	76			9	150	19	359
Otter	-	-	1	46	-	-	-	-	-	-	1	46
Total / Average	**414**	**33,462**	**77**	**5,380**	**124**	**7,392**	**114**	**11,287**	**240**	**18,995**	**194**	**15,303**

Sources: Government of Saskatchewan 2015, 2016, 2017, 2018a, 2019a.

*2018/2019 and 2019/2020 data were not compiled for trapping block N-18.

11.2.3.3 Fishing

This subsection contains information on the following topics: commercial fishing and recreational fishing, also known as angling. Commercial fishing, by definition, is fishing for profit under the authority of a commercial fishing license. These licences are issued to either Indigenous rights-holders or non-Indigenous individuals. Recreational fishing is fishing for sport or leisure and, though fish are consumed, they are not considered to be subsistence harvests. Angling licences are required to authorize non-Indigenous people to fish for recreation. This subsection describes licensed commercial fishing and licensed angling conducted in the LSA. Both commercial and recreational fishing are subject to The Fisheries Regulations (Government of Saskatchewan 2022). Indigenous fishing for food was described in Section 11.1.

11.2.3.3.1 Commercial Fishing

Fishery operations north of Prince Albert were established around 1891 (Gulig 1995). Initially, those fisheries fed local markets in La Ronge and Prince Albert (Gulig 1995) and were limited by a lack of transportation to larger markets. "Between 1823–1888, 35% of the commercial fishers contracted by the HBC fishery were found to be of Métis ancestry, although this is believed to be an underrepresentation" (Coates et al 2023; MN-S and Two Worlds Consulting 2023). Enabled by lower transportation costs and access to markets associated with the 1906 arrival of the Canadian Northern Railway in Prince Albert (Chief Office of the Canadian National Railway 1906), fishing began expanding rapidly in areas north of Prince Albert by 1905/1906 (Gulig 1995). During World War I and in the years following, a major expansion occurred in the commercial fishing industry as countries secured export markets (Webmaster—jkcc.com 2020). In the years between the world wars, fish production doubled (Gulig 1995). "*During the 20th century, many Métis in NR1 and NR3 were part of the commercial fishing industry*" (MN-S and Two Worlds Consulting 2023).

The Wheeler River Project: Métis Knowledge Study Report (MN-S and Two Worlds Consulting 2023) explained:

> *"With decline of the fur trading industry, commercial fishing became one of the main sources of income for Métis, despite the challenges in obtaining licenses and fishing enough for both economic and subsistence purposes (Golder Associates Ltd. 2022). There was employment for fishers in the processing plants, especially for the population around Lac La Ronge, Buffalo Narrows, and Snake Lake. Between 1960s to 1970s commercial fishers in Northern Saskatchewan landed about 11 million pounds of fish annually valued at $2 million from roughly 170 lakes (McNab and Arlen 1992). The commercial fishing industry in Saskatchewan has since slowed for a variety of reasons, including decline in fish stock from overharvesting to impacts from industrial activities and other environmental factors."*

Cree lake, located in the RSA, is substantially larger than other regional lakes and has a 287,000 kg round weight total quota, of which 217,000 kg is a combined quota for Lake Whitefish, Northern Pike, and Walleye plus a 70,000 kg Lake Trout quota (Demuth 2020). Though provincial harvest records date back to 1920, evidence was not located to suggest that Cree Lake was fished prior to 1945 (Government of Saskatchewan 2021c). Between 1945 and 1949 average annual production was just under 170,000 kg and from 1950 to 1990 production averaged just over 70,000 kg annually. From 1990 onwards, commercial fishing shifted to winter only (DPRA 2013) and between 1990 and 2011, averaged under 7,000 kg annually. Provincial records reflect that Cree Lake has not been fished since 2011.

The declining production in Cree Lake was reflective of the northern Saskatchewan commercial fishery in general. Increasing transportation costs beginning in the 1970s raised the cost of production and prices paid to commercial fishers for whitefish did not keep pace with the costs of fishing throughout the 1980s (Ebener et al. 2008). During this time, many small fishery operations went out of business (Ebener et al. 2008). By 1992, as part of the Royal Commission on Aboriginal Peoples, the local president of the Fishermen's association of Buffalo Narrows testified that the commercial fishery was no longer viable in the region (MacDonald 1992).

In addition to Cree Lake, approximately 20 smaller lakes in the LSA have been assigned quota ranging from as little as 500 kg to 4,100 kg round weight mixed quota for Walleye, Northern Pike, and Lake Whitefish. Lake Trout generally have lower quotas that range from 300 kg to 2,000 kg round weight (Government of Saskatchewan 2021c). These lakes were fished intermittently from the mid-1960s to the mid-1980s, and though harvests have occurred as late as 2009/2010 on some smaller lakes, most production had tapered off between the late 1990s and the 2000s (Government of Saskatchewan 2021c). Participants in *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) noted commercial fishing occurred in Lac Roche Lake, Haultain Lake, Costigan Lake, Doré Lake, Quarter Lake, and Clark Lake.

The ERFN Trapper described his past commercial fishing activities, including technique, location, timing, and targeted species. Fishing patterns in the LSA involved pulse fishing followed by a two-year fallow period on lakes such as Russell Lake, Moore Lake, Kratchkowsky Lake, and Moon Lake. The fishery targeted Walleye for its high market value, though Northern Pike, Lake Whitefish, and Lake Trout were also caught. Some Walleye caught in Russell Lake were reported to have large cysts (19-LK-ERFNTrap-134.134). The ERFN and SVS (2022a) listed and mapped additional lakes that were commercially fished including Wheeler, MacDougall, and Martin lakes, which were fished both in the last 10 years and prior to the past 10 years (ERFN and SVS 2022b). Hughes and Firniesz lakes were fished over ten years ago (ERFN and SVS 2022b). Fishing activities occur during the winter once the lake is frozen, gutted fish are sold to the plant in Pinehouse and are said to go to Winnipeg, Manitoba (19-LK-ERFNTrap-134.85). The YNLR provided mapped points of fishing sites (including commercial fishing) for its Athabasca Denesųłiné members within its traditional territory (Nuhenéné), but all fishing locations were outside of the RSA (YNLR 2022).

Most commercial fishers sell their catch through a local co-operative in their communities to the Fresh Water Fish Marketing Corporation (FFMC). Both the communities of Pinehouse and ERFN have small fish processing facilities for local commercial fishers that are managed by a commercial fish broker called Hunters, based out of Big River, Saskatchewan. The fish plant in Patuanak was reported to be non-operational (ERFN and SVS 2022a). The fish processed in facilities like these have typically been marketed to the FFMC. Some commercial fishers also market their catch to small processors and for local consumption (InterGroup 2011).

No commercial fish harvests were reported from LSA lakes for the past five years (Government of Saskatchewan 2021c).

11.2.3.3.2 Recreational Fishing

Recreational fishing is typically conducted from shore, from a boat, or through ice, and is authorized by an angling licence available for purchase from the Government of Saskatchewan. A licence is required for non-Indigenous people to access the fish resource.

Waterbodies in the LSA and RSA are within the Northern Zone, a zone established for fisheries management to manage fishing seasons, catch limits, and any special regulations. Information pertaining to fisheries management is located in the Saskatchewan Angling Guide where fishing seasons, catch limits and any special regulations are published (Government of Saskatchewan 2021d). The fishing season is open from the third week of May to the second week of April. Catch limits refer to the maximum number and size of fish you are allowed to have in your possession (Government of Saskatchewan 2021d). Under general catch limits, for example, Northern Pike and Walleye have a limit of five and four fish, respectively, and not more than one fish caught can be over 75 cm and 55 cm, respectively (Government of Saskatchewan 2021d).

Recreational fishing is not common in the LSA because of the gated access at the terminus of Highway 914. Public access to the private Key Lake – McArthur River haul road is restricted by a gate staffed 24-hours per day (Wheeler River KPI Program 2021). Local workforce members from the Cameco Arthur River/Key Lake operations have been occasionally observed fishing on local waterbodies but the area is not accessible by public (Wheeler River KPI Program 2021). Local cabin owners are permitted through the gate and also conduct recreational fishing from cabins (Wheeler River KPI Program, 2021) Maintaining access to fish resources (20-LK-LEASESUR-267.74) and limiting any additional public access to fish resources (20-LK-LEASESUR-267.58, 20-LK-LEASESUR-267.62) are important to local resource users.

Guided sport fishing opportunities are available and described in Section 11.2.3.4.

11.2.3.4 Lodge and Outfitting Services

This subsection describes lodge and outfitting services offered in the LSA. No ecotourism operators were found to be active in the LSA.

Between 620 and 630 Saskatchewan lodge and outfitting operations are licensed each year (SK MOE 2017a). Outfitters offer a wide variety of hunting and angling services and although anyone can access outfitting services, 90% of hunters using outfitting services are non-residents. In 2006, it was estimated that the industry brought in over $40 million to the Saskatchewan economy (SK MOE 2017a).

Currently, outfitting opportunities for big game, migratory birds, and angling are fully allocated, making it difficult to start up any new facilities in Saskatchewan (Government of Saskatchewan n.d.b). The province is known for black bear and moose hunting opportunities (Tourism Saskatchewan n.d.).

Outfitting licenses are issued annually by the SK MOE and include the following conditions:

- the type of fishing and/or hunting activity allowed;
- the species and amounts that may be harvested;
- where and when an outfitter or guide is authorized to provide services;
- the number of clients that can be served at one time or annually;
- the type of equipment that an outfitter can provide; and
- other terms and conditions considered appropriate for fish and wildlife management.

Outfitters can offer fishing and/or hunting services, depending on the suitability of the area in which they operate. In accordance with The Outfitter and Guide Regulations, 2004 (Government of Saskatchewan 2021d), Outfitters pay a one-time application fee and annual fees based on the number of categories in which they offer services (big game such as white-tailed deer, moose, or bear; fishing and game birds). Big-game outfitters also pay a resource allocation fee for each client. Outfitter clients are required to buy hunting and fishing licenses.

Many outfitters and lodges provide guided and self-directed fishing activities during the open-water season. This will usually include a shore lunch and eating fish at the lodge or camp. Many of the lodges follow the practice of catch and release. A few of the lodges offer services that bring clients to other nearby lakes, either by float plane or by all-terrain vehicle (ATV). In the northern WMZs, most of the outfitters and lodges have limited road access, relying on float planes and small private landing strips. Lodge and outfitting services also provide employment opportunities for local guides. The ERFN and SVS (2022a) reported, for example, that guiding/outfitter services are provided by ERFN members for fishing and hunting around the Cree Lake area.

Outfitting businesses in the LSA have been impacted by several challenges. Prior to the COVID-19 pandemic, outfitting business remained consistent (Wheeler River KPI Program 2021). The years of

2019 and 2020 were difficult for lodge and outfitting businesses in general as they lost American clientele due to travel restrictions associated with the COVID-19 pandemic (Ackerman 2021, Wheeler River KPI Program 2021).

Two active outfitting and lodge operations are present in the LSA including the Wheeler River Lodge and Plaisted Camps. The Close Lake Lodge is currently inactive, though the cabins are used for recreational purposes and are described in Section 11.2.3.7.

Wheeler River Lodge

The Wheeler River Lodge is a remote fishing and hunting camp located approximately 32 km northeast of the Project (Wheeler River Lodge 2020). The lodge operates from the third week of May to the first week of August and hosts up to 10 guests at a time. On an as-needed basis, two part-time guides are employed seasonally. The lodge is accessible by float plane from Otter Lake (just north of La Ronge). Fishing for Walleye, Northern Pike, Lake Trout, Arctic Grayling, and Lake Whitefish occurs on waterbodies from Russell Lake to the Moore Lakes as well as several walk-in lakes plus the Wheeler River (Wheeler River KPI Program 2021). Spring black bear hunts are offered and, if there is interest, the season is extended for fall moose hunts (Wheeler River KPI Program 2021).

Plaisted Camps

Plaisted Camps is a fly-in fishing lodge on Russell Lake, located approximately 17 km south of the Project (Plaisted Camps n.d.). In operation since the 1950s (19-LK-ERFNTrap-134.40), Plaisted Camps offers clients a remote and secluded, fly-in trophy fishing experience. In addition to Russell Lake and the Wheeler River, where Walleye, Northern Pike, Lake Trout, Lake Whitefish, and Arctic Grayling can be fished, an additional dozen or more lakes are available for day use (Plaisted Camps n.d.). A main lodge and separate log cabins are available for up to 10 guests at a time (Wheeler River KPI Program 2021). The main areas of operation for Plaisted Camps are on Russell Lake and the Wheeler River, but the waterbodies between the Wheeler River headwaters and downstream to the Moore Lakes are also used. Additional cabins are planned to provide outcamps for more extended fishing trips further from the main lodge on Russel Lake (Wheeler River KPI Program 2021).

11.2.3.5 Parks and Protected Areas

A review was conducted to document the presence of protected areas including representative areas[9], National Historic Sites, Provincial parks, and existing or proposed Indigenous Protected

[9] The Representative Areas Network (RAN) program is Saskatchewan's commitment to set aside representative natural areas throughout the province that preserve unique and special features for both humans and nature (SERM 2000).

Conserved areas. No protected areas occur in the LSA or the RSA. No proposed or existing Indigenous Protected and Conserved Areas are present in the LSA or RSA.

11.2.3.6 Forestry

Forests cover more than half of Saskatchewan (34.3 million ha) and almost one third of these forests are commercially viable (11.7 million ha; Government of Saskatchewan n.d.c). About 5.3 million ha are considered productive enough for timber harvest. The Forest Resources Management Regulations (Government of Saskatchewan 2020a) define forest operations as the harvesting, use, renewal, or maintenance of a forest product, and includes all related activities.

Both the LSA and RSA are within the non-commercial forest zone; commercial forestry activity is not conducted in these study areas. The nearest commercial forest zone is located approximately 250 km south of the Project and is known as the North West Timber Supply Area (TSA) (Government of Saskatchewan 2020c). The North West TSA has an annual harvest volume available of 316,220 m^3 per year (Government of Saskatchewan 2020c), which includes both hardwood and softwood timber.

11.2.3.7 Recreational Cabins

Based on Crown Land Leases active in late 2019, 13 cabin owners were identified within 22 km of the Project (InterGroup 2019). Of these, one was identified to be the ERFN Trapper whose cabin use is discussed in Section 11.1 and another's lease had been cancelled**.** Of the remaining 11 leaseholders, five leaseholders and one lodge owner responded to a Crown Lease land use survey conducted by Denison in January 2020. Two of the four cabin owners indicated that they spent two to five weeks per year at their cabins and two spent five to 10 weeks. All four are within 10 to 15 km of the Project and in the LSA. The cabins serve a base from which activities such as fishing, hunting, boating, ATV riding, and time with family are conducted. An additional former lodge operation (Close Lake Lodge) has since been identified and uses the cabins there in a similar manner (Wheeler River KPI Program 2021).

11.2.3.8 Mining and Exploration

To protect the environment and human health, mining activities are regulated under The Mineral Industry Environmental Protection Regulations, 1996 (Government of Saskatchewan 1996). The establishment of a mine begins with mineral exploration and guidelines on how to conduct exploration are published in the Mineral Exploration Guidelines of Saskatchewan (Saskatchewan Mineral Exploration and Government Advisory Committee 2012). To conduct exploration on Crown Lands, several permits are required depending on the location. The permit holder has exclusive rights to prospect for minerals in the permit area and to convert any or all the permit area into a claim or claims. After exploration is completed, the permit holder may wish to apply for a mineral disposition under The Mineral Tenure Registry Regulations (Government of Saskatchewan 2020b). A mineral disposition is defined as any rights granted by the mineral owner under a lease or any other instrument that grants the right to explore for, drill for, produce, or otherwise extract minerals (Law Insider 2021).

About 184 mineral dispositions have been made to 16 companies/company groups that are within or partially overlap the LSA (Figure 11.2-5; Table 11.2-6). No inactive dispositions occur in the LSA. Though mineral dispositions are continuous in the area, they do not necessarily lead to active mines as they must be proven to be cost effective first.

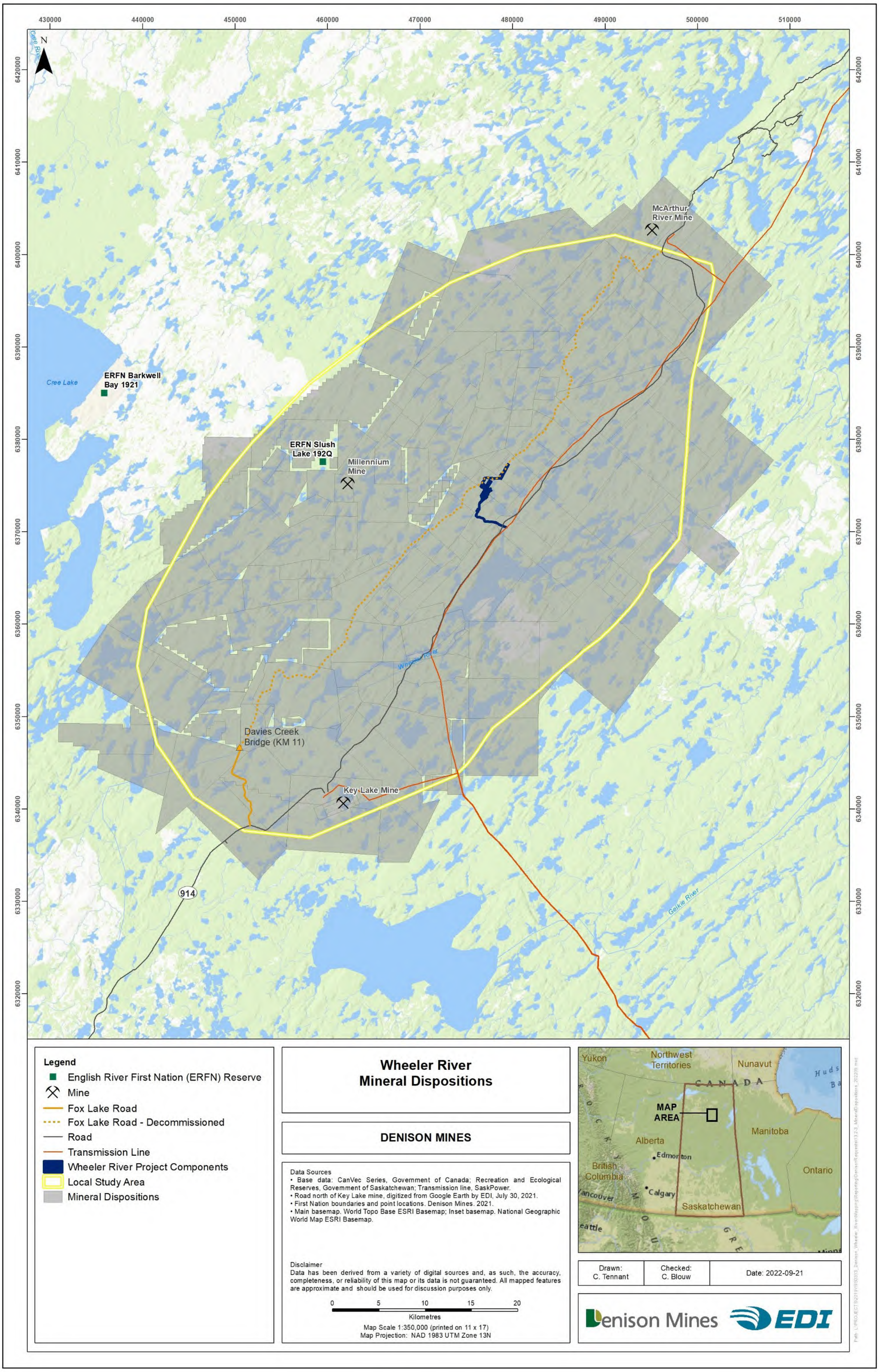

Figure 11.2-5: Mineral Dispositions

Table 11.2-6: Active Mineral Dispositions that are Within or Partially within the Local Study Area

Active Mineral Dispositions	Number of Parcels
Cameco Corp.	55
CanAlaska West McArthur Uranium Ltd., Cameco Corp.	4
CanAlaska West Uranium Ltd	7
Denison Mines Inc.	33
Gem Oil Inc.	3
GTUranium Energy Inc.	2
Hathor Exploration Ltd.	3
JCU (CANADA) Exploration Co. Ltd., Denison Mines Corp., Denison Mines Inc.	19
Orano Canada Inc.	16
Cameco Corp., Denison Mines Corp., Orano Canada Inc.	2
Phalanx Disposition Management Ltd.	1
Rio Tinto Exploration Canada Inc.	24
Ryan Kalt	3
Skyharbour Resources Ltd.	9
T. Young; M. Mason	2
UEX Corp.	1
Grand Total	**184**

Source: Saskatchewan Conservation Data Centre (2021).

One additional mine site occurs in the LSA and one mill. The Key Lake Mine was active between 1983 and 1997 and a mill has operated there since 1983 (CNSC 2020). The mill processed uranium ore from the McArthur River Mine (CNSC 2020) until February 2018 when weak uranium markets led to a suspension of uranium production. The McArthur River Mine was in safe state of care and maintenance until early 2022 and is in the RSA northwest of the LSA (Cameco 2021). As of February 9, 2022, Cameco announced it would restart the McArthur River Mine and the Key Lake Mill (CBC 2022).

11.2.3.9 Indigenous Perspectives on Other Land and Resource Use

The existing environment for OLRU collectively describes the activities and land uses that have intersected with ILRU over time. In some instances, these uses are complementary – with activities such as commercial trapping and fishing having connections to traditional Indigenous uses, and often being undertaken by the same individuals. Similarly, many Indigenous people participate in guiding and outfitting, which contribute to their economic well-being.

The ERFN have identified how the environment as been affected by developments that have or are taking place, with people noting:

> *"The whole area is sensitive now, with all the things going on. It's disturbing the environment; the environment has been disrupted. So, the animals, the birds and the fish are all affected, especially when there is mining activities;" and*
>
> *"We basically had an isolated community before the roads came in, and so on and so forth, and basically, we had used the rivers and lake systems for our transportation and some of that area had been fly-in areas, where people used to gather and hunt, and trap at the same time… there is the construction of roads, the 914, that's the Key Lake Road, that goes right across the Churchill River. That has also created stress on the land itself."*
>
> (ERFN and SVS 2022b).

The ERFN feels that the Nuhtisyekwi Benéne has experienced many cumulative effects in relation to their land use and occupancy. This included the impact of past mining activity, linear developments, exploration trails and cutlines, the use of heavy equipment and clearing of land, dumping and contamination left by past mining activities, and other developments such as forestry, other industry and climate change – all of which contribute to the environmental changes they are witnessing (ERFN and SVS 2022b).

The KML have also expressed concerns about how other activities have affected their land use practices. These include issues with the "cumulative impacts from historical legacy exploration and mining" along with the trauma associated with "armed government officers and other land users not historically from the area or fully versed in the land use rights of (their) community members" (KML 2022). The KML feel that they "will inherit severe impacts from increased development and access to (their) territory" (KML 2022).

The Wheeler River Project: Métis Knowledge Study Report (MN-S and Two Worlds Consulting 2023) identified numerous OLRU activities and associated programs/policies that have affected their ability to undertake traditional pursuits, including:

- imposed government programs and policies, such as the establishment of the Treaties; game laws and fishing restrictions created by the federal and provincial governments; and creation of the Primrose Lake Air Weapons Range;
- changes to wildlife behaviour, particularly changes to woodland caribou behaviour as a result of habitat loss, climate change, and other environmental changes; and
- development activities, including various on-going uranium operations; access roads and highways; creation of campgrounds and recreation areas; presence of lodges, outfitters, and tourism; hydroelectric and transmission facilities; and abandoned mines.

11.2.4 Assessment of Project-related Effects

11.2.4.1 Potential Project – Valued Component and Key Indicator Interactions

The Project will require the construction, operation, and decommissioning of several components (as described in Section 2). Potential interactions between these Project components and activities and the OLRU VC and its associated KIs are summarized by Project phase and activity in Table 11.2-7.

Potential interactions in Table 11.2-7 are ranked as:

- **Primary Interaction** (✓): Project activity is expected to interact with the VC / KI which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- **Other Interaction** (✓): Project activity is expected to interact with the VC / KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- **No Interaction:** Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

Table 11.2-7: Potential Project Interactions for Other Land and Resource Use

Project Phase/Activity	Other Land and Resource Use		
	Resource Availability	Land Available to Practice Commercial and Recreational Harvests	Perceived Suitability of Lands and Resources Therein
Construction Activities			
Development of access roads and air strip	✓	✓	
Site preparation and earthworks; clearing, leveling and grading of the project area	✓	✓	
Power generation – generators	✓	✓	
Installation of main substation and distribution of power around site	✓	✓	
Wellfield and freeze hole drilling; ground freezing	✓	✓	
Batch plant operation (concrete); crusher at borrow area	✓	✓	
Development of surface infrastructure (camp, operations centre, plants, ponds, pads and support facilities)	✓	✓	
Waste management (composting, domestic and industrial landfill operation, recycling)	✓	✓	✓

Project Phase/Activity	Other Land and Resource Use		
	Resource Availability	Land Available to Practice Commercial and Recreational Harvests	Perceived Suitability of Lands and Resources Therein
Water management (including treatment and site runoff)	✓	✓	✓
Groundwater supply		✓	✓
Surface water withdrawal	✓	✓	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	✓	✓	
On-site and off-site operation of vehicles and transport of materials	✓	✓	
Air transportation for workers	✓	✓	
Regulatory site inspections			
Engagement – site visit from Interested Parties			
Employment and Expenditures			
Operation Activities			
Operation of the ISR wellfield	✓	✓	
Wellfield and freeze wall drilling	✓	✓	
Operation and expansion of freeze wall		✓	
Batch plant operation (grout and cement); crusher in borrow area	✓	✓	
Expansion of pond and pads	✓	✓	
Operation of the processing plant and production of uranium concentrate	✓	✓	✓
Water withdrawal from groundwater or surface water body	✓	✓	✓
Management of surface water (including seepage and site run-off)	✓	✓	✓
Water treatment, both domestic and industrial	✓	✓	✓
Water release to surface water body	✓	✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	✓	✓	✓
Hazardous waste management (temporary storage, handling, and off-site transportation)	✓	✓	✓
Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates	✓	✓	✓
On-site and off-site operation of vehicles and transport of materials	✓	✓	
Power supply – primarily power from the grid, also generators and back-up generators	✓	✓	

Project Phase/Activity	Other Land and Resource Use		
	Resource Availability	Land Available to Practice Commercial and Recreational Harvests	Perceived Suitability of Lands and Resources Therein
Package and transport of nuclear substances	✓	✓	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	✓	✓	
Air transportation for workers	✓	✓	
Progressive decommissioning and reclamation	✓	✓	
Regulatory site inspections			
Engagement – site visit from Interested Parties			
Employment and Expenditures			
Decommissioning Activities			
Site water management, treatment, and release	✓	✓	✓
Mining horizon remediation and thawing of freeze wall		✓	
Process water treatment and release	✓	✓	
Closure of ISR and freeze wells and related infrastructure		✓	
Decontamination of surface facilities and injection, recovery, and monitoring wells	✓	✓	
Asset removal (including site power transmission lines and electrical infrastructure)	✓	✓	
Demolition and disposal of non-salvageable surface infrastructure and materials	✓	✓	
Remediation of contaminated areas (wellfield, pads, ponds, domestic water treatment location, and process plant area)	✓	✓	✓
Generators	✓	✓	✓
Waste management (composting and landfill operation)	✓	✓	✓
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)	✓	✓	✓
On-site and off-site operation of vehicles and transport of materials	✓	✓	✓
Reclamation of disturbed areas	✓	✓	✓
Regulatory site inspections			
Engagement – site visit from Interest Parties			
Employment and Expenditures			
Post-Decommissioning Activities			

Project Phase/Activity	Other Land and Resource Use		
	Resource Availability	Land Available to Practice Commercial and Recreational Harvests	Perceived Suitability of Lands and Resources Therein
Environmental monitoring	✓	✓	
Regulatory site inspections			
Engagement - Site visit from interested parties			

Not all activities are expected to interact with the resource availability of the species resource users depend on. For example, ground freezing (after site clearing has been completed), groundwater supply and release, and operation of freeze wall were deemed to have no interaction and were not carried forward in the effects assessment as they are not expected to result in detectable changes in the MPs associated with OLRU.

Land available to conduct OLRU pertains primarily to the Project site and laydown areas (the Project Area) within which all other Project infrastructure and activities will be situated. Recreational and commercial land use will be restricted in the Project Area for safety reasons. Because other activities, except off-site transportation, are contained within the Project Area they are not carried forward into the effects assessment as they are encompassed within the Project Area.

Perceived suitability of lands and resources therein pertains to concerns with respect to noise, air quality, water and waste management activities, changes in the wilderness setting and changes in competition for resources during Construction and Operation, and in Operation, the treatment of waste rock and radioactive plant precipitates and the packaging and transport of nuclear substances. In Decommissioning, Project activities pertaining most to the perceived suitability of lands and resources include removal of hazardous and nuclear substances, remediation of contaminated sites, reclamation of disturbed sites, and the treatment of hazardous waste that will meet regulatory requirements. Final closure will rely on long-term monitoring to demonstrate successful final rehabilitation.

It is recognized that some interactions are the primary contributors to potential adverse effects on VCs and KIs. While all interactions are considered in the effects assessment, the primary contributors (i.e., the grey shaded cells in Table 11.2-7) will be the focus of the effects assessment for OLRU.

11.2.4.2 Potential Project-related Effects

Based on the timing and nature of the interactions identified in Table 11.2-7, the following adverse effects on the OLRU have the potential to occur during the lifetime of the Project:

- changes to resource availability:
  - terrestrial resource availability;
  - aquatic resource availability;
  - health of the resources;
- land available to conduct recreational and commercial harvests:
  - availability/accessibility of land;
  - availability/accessibility of waterways;
- changes to the perceived suitability of land and resources therein:
  - aesthetics of resource use; and
  - perceived suitability of resources for safe use.

The pathway analysis identifies potential Project-related effects on OLRU, identifies mitigation measures for these potential Project-related effects, and determines whether any of the potential Project-related effects can be sufficiently mitigated such that they are not expected to cause a residual adverse effect. Mitigation measures for each potential effect are summarized in Section 11.2.5.

11.2.4.3 Resource Availability for Harvesting Commercial and Recreational Resources

11.2.4.3.1 Terrestrial Resource Availability

Development of access roads and air strip and clearing, level and grading of the Project site laydown and associated infrastructure as well as direct and indirect mortality may alter the distribution and abundance of terrestrial wildlife important to commercial trapping and recreational hunting. Potential effects are predicted to begin in Construction, continue through Operation, and cease when reclamation activities have been completed in the Decommissioning phase when Project components are removed, and activities cease. Terrestrial species important to recreational hunting and commercial (i.e., trapping) harvests include moose and pine marten[10].

Moose: The potential effect of alteration and/or loss of habitat on moose is based on vegetation removal and/or ground disturbance due to construction of Project components and infrastructure and edge effects. Clearing of vegetation within the Project Area during Construction will result in a loss of potential moose habitat (Section 9.3.4.2 in Section 9). The alteration of moose habitat is typically associated with sensory disturbances that may include anthropogenic noises, vehicle

[10] Woodland caribou hunting is not permitted as a recreational harvest (Government of Saskatchewan 2019c)

traffic, aircraft traffic, and increased predator access (Section 9.3.4.2 in Section 9). Noise from Project Construction, Operation, and Decommissioning activities, including the camp, may contribute to alteration of potential moose habitat through displacing moose from using habitats around these features. Habitat alteration through sensory disturbance effects (such as noise, dust deposition, and artificial light) is expected to result in reduced habitat quality and effectiveness near Project components, beyond the Project site, and into the Wildlife LSA. Direct habitat loss has been mitigated by reducing the size of the Project Area to the extent practicable during Project design.

Vehicle collisions are the most likely source of direct mortality for moose. Effective mitigation measures (e.g., breaks in snowbanks; speed limits; and exclusion fencing around contaminated waste pads and ponds) will be implemented to reduce moose mortality.

After mitigation, residual effects to moose are characterized as adverse, low, 500 m around the Project Area and on the Key Lake – McArthur River haul road, medium-term and reversible (Section 9.3.6.2.1 in Section 9).

Pine Marten: The potential effect of alteration and/or loss of habitat on furbearers, specifically pine marten, is based on vegetation removal, the removal of important features (e.g., dens or lodges) and ground disturbance (Section 9.3.6.3.1 in Section 9) because marten rely on relatively undisturbed forest habitats. Noise and dust from Project Construction, Operation, and Decommissioning activities, including the camp, access roads, and the airstrip, may affect furbearer habitat availability around these features. Vehicle collisions are the most likely source of direct mortality for pine marten. Effective mitigation measures (e.g., breaks in snowbanks; speed limits; and exclusion fencing around contaminated waste pads and ponds) will be implemented to reduce pine martin mortality.

After mitigation, residual effects to furbearers are characterized as adverse, low magnitude, around the Project Area and on the Key Lake – McArthur River haul road, long-term (greater than 38 years) because of the time required for available habitat to regenerate following disturbance and reversible (Section 9.3.6 in Section 9).

Though adverse, Project effects on moose and pine marten are of low magnitude and are reversible. These effects on resource availability are not expected to affect recreational hunting (including outfitting activities) and commercial trapping for the following reasons:

- Recreational hunting has not been confirmed to occur at the Project site.
- Recreational hunting within the OLRU LSA is limited due to access restrictions north of the Key Lake gate, which limits access to non-Indigenous resource harvesters, except for those accessing a recreational cabin (access to outfitting operations in the LSA are by air).

- Only a limited number of recreational cabin leaseholders are permitted through the Key Lake gate at the northern terminus of Highway 914 and few resource harvesters are reported to bypass the Key Lake gate via the decommissioned Fox Lake Road.
- Outfitting operations in the LSA including the Wheeler River Lodge and Plaisted Camps operate more than 15 km north and south of the Project site, respectively, and focus primarily on fishing.
- Trapping activity in the LSA was known to be conducted by a single ERFN Trapper, who is now passed away. However, use by the ERFN Trapper is considered as representative of future use of the area. If/when the trapline is transitioned to a different trapper, Denison will work collaboratively with the individual to permit access where it is safe to do so, and to provide compensation for losses to trapping income, if applicable.

Given the limited residual effects on resource availability, this pathway has not been carried forward for a residual effects assessment.

11.2.4.3.2 Aquatic Resource Availability

Altered aquatic habitat and water management, including treatment and surface water withdrawal, have the potential to affect aquatic furbearers and fish, thus reducing or displacing opportunities to conduct OLRU. Potential effects are predicted to begin in Construction, continue through Operation, and cease when reclamation activities have been completed in the Decommissioning phase when Project components are removed, and activities cease. Aquatic furbearer species important to commercial (i.e., trapping) harvests are mink and, and less importantly, muskrat. Aquatic species important to recreational fishing include Walleye, Northern Pike, Lake Trout, Lake Whitefish, and Arctic Grayling.

Mink and Muskrat: The potential effect of alteration and/or loss of habitat on aquatic furbearers is based on the removal of important features (e.g., dens or lodges), and/or changes to water bodies due to construction of Project components and infrastructure (Section 9.3.4.2 in Section 9). Mink require riparian areas in forests, and muskrats prefer marshy and open water habitats; any changes to these areas will reduce available habitat.

Noise from Project Construction, Operation, and Decommissioning activities, including the camp, access roads, and the airstrip, may affect aquatic furbearer habitat availability around these features. Habitat alteration through sensory disturbance effects (such as noise, dust deposition, and artificial light) will result in reduced habitat quality and effectiveness near Project components and infrastructure reaching beyond the Project Area into the Wildlife LSA. The overall effect of habitat alteration and/or loss on furbearers is expected to be minimal during Post-Decommissioning as regeneration of vegetation is expected to continue within reclaimed areas. After mitigation, the residual effects to aquatic furbearers are characterized as adverse and low magnitude because of minimal mink and muskrat habitat alteration and local to the Project site and a 500 m buffer around the Project site (Section 9.3.6 in Section 9). Effects are predicted long-term, but reversible because the alteration of available furbearer habitat is expected to be reversed as sensory disturbances diminish with the end of Project Operation activities and subsequent Decommissioning of Project components.

Walleye, Northern Pike, Lake Trout, Lake Whitefish, and Arctic Grayling: Negligible aquatic habitat loss is predicted in LA-5 (also known as Whitefish Lake) due to the installation of a discharge pipeline and diffuser configuration. The total area of the lake substrate that would be overprinted by the pipeline is expected to be approximately 135 m^2, which will constitute less than 0.05% of the lake's surface area (Section 8.3.6 in Section 8). No other alteration, disruption, or destruction of aquatic habitat in the aquatic environment LSA (Section 8.3.6 in Section 8) is expected. Project-induced changes to the abundance and distribution of fish is, therefore, not expected. The effect, if any, is expected to be undetectable to fishers and is, therefore, not carried forward for residual effects assessment.

11.2.4.3.3 Health and Abundance of the Resources

Contaminated waste management, storage, and disposal of process waste rock and radioactive plant precipitates, and package and transport of nuclear substances, spills, or accidents may affect fish and wildlife abundance and distribution, thus reducing or displacing opportunities to conduct OLRU. Potential effects are predicted to begin in Construction, continue through Operation, and cease when reclamation activities have been completed in the Decommissioning phase when Project components are removed, and activities cease. The risks to terrestrial wildlife for possible major accidents and malfunctions are presented in (Section 14) and summarized below.

An ERA was conducted to consider both radiological and toxicological risks to ecological receptors such as terrestrial and aquatic invertebrates, terrestrial and aquatic vegetation, fish, and terrestrial and riparian mammals and birds, several of which are important to recreational and commercial resource users. A summary of results is presented in subsequent text, and comprehensive results are presented in Section 10.

For radiological COPCs, predicted radiation doses on ecological receptors were compared to benchmarks set by the Canadian Standards Association (CSA 2012) to yield a HQ. If the HQ is less than or equal to one (1), this suggests low risk to the ecological receptor because exposure estimates do not exceed levels known to cause adverse effects. If the HQ is greater than one, adverse effects may be possible, and further assessment would be warranted. Results for the radiological assessment indicated no predicted exceedances of the radiation dose benchmark for the ecological receptors. This includes receptors residing and feeding in and around Whitefish Lake, McGowan Lake, and Russell Lake including moose, Northern Pike, White Sucker, muskrat, American mink, Canada Goose, Lesser Scaup, Mallard, and Common Loon.

For non-radiological COPCs, chronic dose-based TRVs for birds and mammals were based on endpoints (i.e., growth and reproduction) considered relevant for assessing the persistence of wildlife populations. Results indicated no expected exceedances of the TRVs (HQ<1) for terrestrial and riparian receptors for all non-radiological COPCs during all phases of the Project, including for invertebrates, vegetation, mammals, and birds. This includes receptors residing and feeding in and around Whitefish Lake, McGowan Lake, and Russell Lake, as listed previously.

All species have the potential to be impacted by accidents and malfunctions (see Section 14). These events primarily refer to unintentional release of radioactivity, fuel, and hazardous chemicals into the environment (Section 14). In comparison with the aquatic environment, terrestrial release of hazardous materials is easier to manage due to less mobility of the released materials with the soil and potentially groundwater. The accidents and malfunctions report (Section 14) contains assessments of the probability of occurrence (i.e., likelihood), predictions of the potential effects (i.e., severity), and the overall risk of seven types of accidents and malfunction. Conclusions indicated a terrestrial release of radioactivity and chemicals due to a vehicle accident would be unlikely, of minor severity, and low risk (Section 14). Additional accident and malfunction scenarios considered for the aquatic environment included release of fuel and hazardous compounds into surface water (unlikely, moderate severity, low overall risk); radioactivity into surface water (highly unlikely, moderate severity, low overall risk); and the loss of freeze capacity or freeze wall affecting groundwater (highly unlikely, moderate severity, and moderate overall risk) (Section 14). Overall, the risk level has been reduced to as low as reasonably possible.

Given that there are no predicted radiological and non-radionuclide COPC exceedances that would affect the growth, reproduction, and survival of terrestrial and aquatic ecological receptors, potential effects on recreational and commercial resource use are unlikely because the MP: changes in the relative abundance and distribution of fish and wildlife species, is unlikely. Therefore, the potential for radionuclide and non-radionuclide COPCs affecting fish and wildlife abundance and distribution is negligible and this pathway is not carried forward for a residual effects assessment.

11.2.4.4 Land Available to Practice Commercial and Recreational Land Use

11.2.4.4.1 Availability/Accessibility of Land

Development of access roads and air strip, and clearing, level and grading of the Project site laydown area may alter or displace opportunities to conduct OLRU. The Project Area is the area within which the Project and all components/activities are located (i.e., the area of maximum physical disturbance) (Section 2). Within the Project Area, restrictions to land available to conduct OLRU are expected to begin in Construction, continue through Operation and end when reclamation of disturbed areas is completed in Decommissioning. Controlling access to the property will be accomplished by the construction of both a north and south security gate (Section 2). While some progressive reclamation may occur during Operation, the Project Area consisting of 169.6 ha, will remain restricted to OLRU harvesters for safety purposes until Decommissioning is completed.

To minimize land that is disturbed by the Project, the Project Area has been reduced to the extent practicable and much of the proposed Project footprint has been developed within previously disturbed areas, including roads currently used for exploration activities (Section 2.4.5 in Section 2).

Other Land and Resource Use was known to be conducted by the ERFN Trapper, who is considered by the ERFN as representative of future uses by their community. Resources harvested included commercial fishing in the OLRU RSA and commercial trapping in the Project Area and OLRU LSA (Fur Block N-18) within the past 10 years. Routes for both fishing and trapping included a circuit from Moon Creek, along the Wheeler River to Russell Lake, and back to Kratchkowsky Lake. *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting) also identified NR1 and NR3 citizen participation in trapping and commercial fishing. Commercial fishing waters are not expected to be affected by the Project (Section 8.3.6 in Section 8). Commercial fishing licenses may be reissued to a new operator if there is interest. With respect to the resumption of trapping by one or more licensed trappers, licenced Fur blocks N-18 and N-16 (to the south) have been amalgamated under a co-management regime between the province and ERFN (19-EN-ERFN-137.1). The N-18/N-16 Fur Block Chairperson and membership may select member(s) to resume trapping in areas formerly trapped by the ERFN trapper (Government of Saskatchewan 2012). The lands available for trapping will be reduced by 169.6 ha (1.69 km^2) due to limiting access to the Project site for safety reasons. The land that will become unavailable amounts to 1.69 km^2 of N-18's 17,694 km^2 area or less than 1/10,000 of its total area. This reduction in land available for trapping does not support carrying forward this pathway for residual effects assessment. Although the active trapper passed away prior to the filing of the EIS, should a future trapper take over the area the loss of commercial income and other mitigation options are discussed in Section 11.2.5.

11.2.4.4.2 Availability/Accessibility of Waterways

Water withdrawal and discharge from groundwater or surface water body may affect water levels, and thus affect water and ice-based navigation by resource users or affect the safety thereof. Potential effects are predicted to begin in Construction and continue through Operation while camp facilities are still in operation and decline in Decommissioning as infrastructure is removed.

The Project will source fresh water from a shallow groundwater well but may draw from both a groundwater source and a surface water source (a water withdrawal). The Project will operate a discharge line for treated water that will be located in a suitable area of the lake bottom to minimize disruption of fish habitat (a water discharge). Water withdrawal and discharge rates were modeled to understand Project-related changes in the water levels of lakes in proximity to the Project, including LA-1, LA-5 (also known as Whitefish Lake), and LA-6 (NewFields Canada Mining & Environment 2021). The following changes were predicted: the maximum change in water level in LA-1 is predicted to be a drop in water levels by 0.0037 m for withdrawal and an increase in water levels by 0.0032m for discharge. In LA-5, the maximum withdrawal is expected to drop lake levels by 0.0041 m and under discharge conditions, the lake level will increase by 0.0032 m. Changes to water levels for LA-6 are expected to be negligible (NewFields Canada Mining & Environment 2021).

The predicted sub-centimetre change in water levels under both intake and discharge scenarios are not expected to be detectible to resource users or affect travel on LA-1, LA-5 and are not expected to occur on LA-6 and other waterbodies in the region in any season. Therefore, water and ice-based navigation by resource users is predicted to remain unchanged and this pathway will not be carried forward for residual effects assessment.

11.2.4.5 Suitability of Lands and Resources

11.2.4.5.1 Aesthetic Experience

Changes to the perceived suitability of land may occur due to Project-related disturbances to resource harvesters such as traffic, noise, air quality, changes to the 'wilderness experience', and changes in competition for resources. Potential effects are predicted to begin in Construction, continue through Operation, and cease when reclamation activities have been completed in Decommissioning when Project components are removed, and activities cease. While the Project Area will be restricted to resource users for safety reasons, disturbances in areas very local to the Project Area and along roadways such as local access roads and the Key Lake to McArthur River haul road where Project traffic is operating. Disturbances assessed under this pathway include increases in traffic; noise; air quality, changes to the 'wilderness experience', and changes in competition for resources. These disturbances are likely to be most detectable during Construction when construction activities are at their peak and decline somewhat in Operation due to acclimatization to the Project, except for traffic which will increase during Operation.

Traffic

The KML #9 have expressed concerns with respect to increases in traffic associated with Project activities including increased risk of heavy haul vehicle incidents with land users (KML 2022) KML have made clear they do not desire "any increased risk of traffic and potential harassment during our harvesting efforts" (KML 2022). Also, five of six leaseholders who responded to the cabin survey in 2020 and one outfitter indicated that increased traffic was one of their concerns about the Project[11]. Land users north of the Key Lake gatehouse would expect to see an increase in traffic of 23% during Construction to 30% during Operation (Denison 2022). However, from a total volume basis, this amounts to an additional 14 trucks a day during Construction and 18 trucks a day during Operation (or less than one truck per hour if operating on a 24-hour basis). Decommissioning traffic volumes are expected to be similar to traffic volumes during Operation. Several proven mitigation

[11] 20-LK-LEASESUR-267.99, 20-LK-LEASESUR-267.100, 20-LK-LEASESUR-267.101, 20-LK-LEASESUR-267.103, 20-LK-LEASESUR-267.104, 20-LK-LODGESUR-267.102.

options are planned to reduce the risks associated with increased traffic (see a full list in Section 12.3.5 in in Section 12).

Noise

The main sources of noise will be local to the Project Area and conservatively, within 10 km from the outer boundaries of the Project Area (Independent Environmental Consultants 2022a). Noise generated during Construction is related to air and ground transport of people and goods, the operation of a concrete batch plant and crusher, operation of power generators, drilling of holes for the freeze wall and wellfield, and construction of the freeze plant. Noise during Operation will operate similar to Construction except the generator sets will only be used under emergency conditions and operation of the ISR plant and shipping of yellowcake will begin (Section 4.1 in Section 4). The Noise assessment (Section 4.4 in Section 4) predicted no exceedances of either the federal or provincial sound level criteria (Section 4.5 in Section 4). Incremental increases in noise from baseline were predicted for one seasonal cabin owner at McGowan Lake during Construction at +5.1 dBA in daytime (a moderate impact) and +4.6 dBA during the night (a low impact). Noise during Operation was predicted to be +3.4 dBA during daytime and +2.7 dBA at night (a low and marginal impact, respectively). Based on a meeting held in 2020, the local cabin leaseholder potentially affected by the change in noise indicated he can sometimes hear noise from existing exploration activities and was not concerned with noise should the Project proceed (20-LK-LEASE-328.10). Mitigation and monitoring measures for these effects are well established and effective, and are described in greater detail in Section 11.2.5.

Should noise monitoring results exceed predictions or if the leaseholder has future concerns about noise levels, Denison remains open to meeting with the leaseholder and working on noise mitigation strategies to reduce noise effects as needed.

Air Quality

The main sources of dust and air emissions will be local to the Project Area and, conservatively, the Air Quality LSA is defined as a bounding box offset by 20 km from the centre of the Project Area (Independent Environmental Consultants 2022b). Air quality has been identified as a concern for Interested Parties (19-EN-ERFN-140.27). The assessment of air quality was modelled from meteorological data collected in 2016 to understand potential dispersion patterns of COPCs such as TSP and two sizes of PM ($PM_{2.5}$ and PM_{10}), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and carbon monoxide (CO).

Fugitive dust can come from unpaved roads, wind erosion (e.g., at borrow sites, the waste pads, or landfill site), and through material handling. Dust is measured by the amount of TSP and PM in the atmosphere. During Construction and Operation, the maximum predicted 24-hour concentrations of TSP and PM_{10} are above the Project criteria along a small section of the northwest property boundary and at locations outside of the site around the haul road, with the overall maximum occurring next to the haul road. During Decommissioning, fugitive dust is reduced though still in exceedance of Project criteria at off-property areas along the haul road. One of the largest contributors to the exceedances is unpaved road dust (Section 4.5 in Section 4).

Combustion of diesel, gasoline, or propane fuel results in emissions of gaseous COPCs including NO_2, SO_2 and CO. Modelling results predicted no exceedances of the Project criteria for CO or SO_2 during Construction, Operation or Decommissioning. During Construction, NO_2 concentrations of 224% of the Project criteria northwest of the property boundary were predicted and during Operation and Decommissioning, short-term NO_2 exceedances are predicted at the site near the northwest property boundary only during emergency use of the generators (i.e., when power is not available from the grid) (Section 4.5 in Section 4). Nitrogen dioxide concentrations are predicted to be highest near the centre of the Project Area, where the diesel generators will be located, indicating that the largest contributor to NO_2 concentrations during all Project phases is expected to be on-site power generation (Section 4.5 in Section 4).

Predicted concentrations of metals and radon are all below their applicable Project criteria throughout the Air Quality LSA and during all Project phases.

Mitigation for these effects is well established and effective, and are described in Section 11.2.5.

In summary, sources of air pollution such as SO_2, CO, and radon gas will not surpass criteria in any Project phase. Total suspended particulate, PM, and NO_2 levels are expected to be exceeded at a location northwest and within 250 m of the property boundary during Construction and Operation (assuming for NO_2 that the generator sets will need to be running during Operation). Criteria for TSP and PM caused by fugitive road dust are also anticipated to be exceeded during Construction, Operation, and to a lesser extent, Decommissioning within 300 m of either side of the haul road and in the Air Quality LSA.

Given that no current commercial or recreational land use has been identified within 400 m of the property boundary (where TSP, PM and NO_2 criteria levels are predicted to be exceeded), this assessment focusses on the portion of the haul road where TSP and PM may be exceeded. This portion of the roadway (within 20 km of the Project) is used by recreational resource users such as cabin leaseholders, but not by outfitter clientele because local outfitting operations are fly-in only. Other commercial activities such as commercial trapping and fishing that may resume are likely to be conducted in similar locations. Therefore TSP, PM and NO_2 are not expected to affect future user groups.

To control road dust during summer (May to October), water and/or chemical dust suppressant will be applied to all site roads (Section 6.1.5 in Section 6). In the winter months (November to April), natural mitigation from snow/ice can help control unpaved road). Additionally, vehicle speeds at the Project site are limited to 40 km/h along the site haul roads, which will also limit the amount of road dust generated (Section 6.1.5 in Section 6). The roads are also maintained during the summer months using a grader, which is a lesser source of PM along the roads.

In addition to the mitigation measures identified, other strategies to avoid or reduce the likelihood of TSP and PM exceedances include:

- Limit material handling activities during dry conditions and high winds.
- Optimize the number of vehicle and equipment movements and minimize travel distances, where possible.
- Collect dust measurements during construction, operations, and decommissioning, and determine whether the actual impact of Project activities is lower than what was modelled (Section 4.6 in Section 4).

The limited number of resource users that travel on unpaved roadways and accompanying dust would be a routine occurrence for drivers in this area, and when combined with proven mitigation measures, suggests that effects on resource users will be negligible.

Modification of the Wilderness Experience

Resource based tourism, such as those opportunities offered by local outfitters depends on attributes associated with natural and relatively undeveloped settings including natural features such as spawning grounds for fish, natural forests, quality fishing spots, shore lunch sites, and limited road access are critical to preserving the values that these operations rely on (CPAWS—Wildlands League and Ontario Nature 2005). This 'wilderness experience' for which top dollar is paid includes attributes such as inaccessibility, isolation from visual and auditory impacts, and high-quality environmental resources (e.g., fish and wildlife). Within the tourist industry, the wilderness experience caters to up-market individuals willing to pay up to twice as much as clients of road-accessible tourism (CPAWS—Wildlands League and Ontario Nature 2005). Some resource users are sensitive to changes in this experience and may perceive a disturbed environment to be unusable, thereby reducing lands available for resource use.

While it is generally difficult to predict individual perceptions, three primary circumstances mitigate potential effects on the 'wilderness experience'. The most important is that resource tourism in the OLRU focusses on recreational fishing by outfitters' clients instead of hunting. Given that there are no fishing allocations present on waterbodies near the Project Area (Russell Lake is the closest lake on which outfitters operate), visual impacts are eliminated, and the notion of an "inaccessible wilderness experience" can be maintained. A second factor is that the Project is not predicted to have impacts on fish habitat (Section 8.3.6 in Section 8) and fishing pressures from the Project workforce are expected to be reduced by a both a lack of transportation to fishing locations and limited opportunity to store or cook fish harvests which would maintain the fish resource for Indigenous subsistence use as a priority and secondly, for outfitters operating in the OLRU LSA (Section 8.3.5 in Section 8). The third factor is that Denison has reduced the proposed Project Area by proposing infrastructure be developed within previously disturbed areas, including roads currently used for exploration activities, thereby minimizing additional landscape disturbance (Section 2.4 in Section 2). Progressive reclamation will also contribute to minimizing visual disturbances associated with the Project site (Section 2.3 in Section 2).

Increases in Competition for Resources

The presence of the Project workforce will increase the numbers of people in the OLRU LSA by an estimated 300 during construction and 180 during Operation and Decommissioning (Section 13.3.2.1 in Section 13). Resource user groups that have the potential to observe increasing numbers of workforce personnel include cabin leaseholders and outfitter clientele, particularly if personnel pursue recreational activities off site during their downtime. One cabin owner expressed concern about overfishing on McGowan Lake (which is downstream from the Project) by Denison staff (20-LK-LEASE-328.14). The closest lake used by local outfitters is Russell Lake. Overall management of the fish resource is recognized as a responsibility of the Province of Saskatchewan though use of the fish resource by the Project workforce is considered. Workforce members will be transported to site by a fly-in/fly-out rotation or Denison shuttle and will therefore eliminate fishing on local lakes during commute to the site and during time off work. Denison site vehicles will not be available for recreational purposes. While at the Project site and off duty, workers may still opt to fish local waterbodies. Workforce fishing will be discouraged through the absence of fish storage or cooking facilities and the restricted availability of transportation to fishing areas via trucks or boats. A lack of transportation to fishing areas will curtail the geographic extent of any workforce fishing and a lack of facilities to store or cook fish will limit the quantity of harvest (Section 8.3.5 in Section 8).

To prevent entry of land users from entering the Project Area, Denison will control access to the property with both a north and south security gate.

Overall, given a lack of resources to access fishing locations and store fish harvests, workforce fishing is expected to cause minimal disturbances to local cabin leaseholders and/or outfitters. Denison is committed to maintaining positive relations with all local interested parties and will be open to discussions on any issues or concerns that arise.

Summary of Effects

Potential Project disturbances considered under this pathway included increases in traffic, noise, air quality, modification of the wilderness experience, and increases in competition for resources. These disturbances will be most detectible in locations proximal to the Project site. Effects have the most potential to affect cabin leaseholders due to their use of ground travel, hunting and fishing activities, and general proximity to the Project. Outfitters and their clientele will not be affected by project disturbances due to use of air transportation for accessing outfitting operations and use of waterbodies more distant from the Project (the closest is Russell Lake). Currently, commercial fishing and commercial trapping is not presently active in the OLRU LSA but new licensees may be active in the future.

Increased traffic may be observable to cabin leaseholders, and any future commercial trappers/fishers, but is only expected to be the addition of one truck per hour. Noise will be detectable by a seasonal cabin owner at McGowan Lake and this has the potential to result in a moderate impact during Construction and a low to marginal impact in Operation. This cabin owner has indicated that he is not concerned about noise impacts. Dust is an expected feature on unpaved roadways and can be reliably mitigated. Changes to a disturbed landscape have been mitigated by reducing the Project Area to the degree possible and developing areas disturbed previously. Overall, with the exception of dust which has proven mitigation strategies, the overall disturbances are negligible and there are a limited number of resource users who will experience them to any detectible degree. Therefore, this pathway is not carried forward for residual effects assessment.

11.2.4.5.2 Perceived Suitability of Resources for Safe Use

Perceived suitability of lands and resources may be affected by hazardous and contaminated waste management, groundwater supply and surface water withdrawal, and the package and transport of nuclear substances. Potential effects are predicted to begin in Operation and cease when reclamation activities have been completed in Decommissioning when Project components are removed, and activities cease. Concerns raised relate primarily to the ISR mining method, which is new to Canada and, therefore, a method that resource users have little experience with.

Perspectives from outfitters interviewed as part of a KPI interview program were mixed as one of the two operating in the OLRU LSA expressed concern about contamination, while the other was considered the Project "*secure environmentally*" (Wheeler River KPI Program 2021). Differing perceptions of risk also arise from the ISR mining technique being proposed, which is a common method of mining uranium globally, but has not been done in Canada before. One individual from Pinehouse stated "*Pros – no mill, no tailings; seems safter, more economical, and better than the other options. In theory, this option looks really good*" (18-EN-VPL-2.29) but… "*Cons- not enough information to understand the pros and cons of this option*" (18-EN-VPL-2.30).

Section 2.6.1 in Section 2 of the Project Description describes the extensive review of mining methods that led to the decision to adopt the ISR mining method. Historical work evaluated 32 mining methods to extract uranium from the deposit. Methods were evaluated through an increasingly rigorous process and considered factors such as: safety, environment, production rates, capital costs, operating costs, schedule, operational flexibility, and risk. In addition, specific workshops were held in local Indigenous and non-Indigenous communities to capture community input into the selection of a preferred mining method. After several years of study, the ISR mining approach was selected as the best overall option.

As part of engagement activities, several questions were asked about the integrity of the freeze wall and the potential to lose containment of the mining solution and/or uranium. For example, at a youth workshop, one participant asked about difficulties with freezing technology experienced at other mining operations (21-EN-YOUTH-445.5). One leaseholder expressed concern about treated effluent being released to LA-5 or “Whitefish Lake”, which is upstream from the lake on which he has a cabin (20-LK-LEASE-328.11). A similar concern was raised by the ERFN Trapper, who asked about the suitability of fish for commercial sale from Russell Lake (19-LK-ERFNTrap-134.255). Others asked about Decommissioning and monitoring activities such as thawing the freeze wall and monitoring and protecting groundwater (19-EN-ERFN-140.26).

The Accidents and Malfunctions section (Section 14) noted that thawing of the freeze wall is not immediate, and the wall is, therefore, resistant to temporary loss of power as it takes a minimum of one year for the freeze wall to thaw. This freeze and thaw time frame is very large compared with the time required to repair and establish the freeze capacity. Interruption of the freeze capacity due to mechanical failure of the freeze plant is perceived to be a major concern, but there is low risk that such an event would result in the migration of mining fluids beyond containment (Section 14). The preliminary remediation plan is to monitor the groundwater until it meets an acceptable limit and then allow the freeze wall to thaw.

With respect to treated effluent release into LA-5 (Whitefish Lake), surface water quality modelling conservatively estimated that COPCs will remain below the most restrictive criteria for the protection of aquatic life (Section 8.2.4.2 in Section 8).

Denison has ongoing engagement planned to meet with Interested Parties and Indigenous communities to continue informing the public about the ISR mining method and to share results of monitoring throughout the life of the Project.

11.2.5 Mitigation Measures

Mitigation in this EIS is defined as the elimination, reduction, or control of potential adverse effects of the Project on the environment throughout all Project phases. Project-specific mitigation measures include Project design; implementation of BMPs; development of management plans; implementation of emergency response programs; and provision of training, education, and awareness.

Though mitigation measures have been presented in the effects assessment (Section 11.2.4), a summary of mitigation methods is provided under each OLRU KI.

11.2.5.1 Resource Availability

Mitigation measures that protect fish and wildlife are documented in Section 8.1.5 in Section 8 and Section 9.3.5 in Section 9, respectively. Given that effects to resource availability are likely to be undetectable to resource harvesters including existing recreational users and any future commercial fishers or trappers, mitigation measures are not required for the OLRU resource availability KI and no residual effects are expected.

11.2.5.2 Availability of Lands/Waters

To minimize land that is disturbed by the Project, the Project Area has been reduced to the extent practicable and much of the proposed Project footprint has been developed within previously disturbed areas, including roads currently used for exploration activities (Section 2.4.5 in Section 2). With respect to land activities, recreational hunting is not known to occur. It may be reasonable to expect commercial trapping to resume in the future with a small reduction in area (169.9 ha). While mitigation for trapping is not planned because no active trapping currently occurs in the OLRU LSA, should new trappers be assigned by the ERFN N-18/N16 trappers association, trapping may be re-established.

Aquatic habitat (where fishing takes place) is expected to be reduced by approximately 135 m^2, which will constitute less than 0.05% of LA-5's surface area and is predicted to have no effect on fish abundance and distribution (Section 8.3.6 in Section 8). Changes to aquatic habitat elsewhere is not anticipated to occur. Water surface elevations (which can affect water and ice navigation and commercial fishing) are not expected to change to any detectable degree (NewFields Canada Mining & Environment 2021). Mitigation measures for the availability of waters suitable for resources use is, therefore, not required.

Surface lease agreements, which are required to conduct mining in Saskatchewan, also contain commitments for environmental protection, occupational health and safety, and socio-economic benefits for residents of Saskatchewan's North (Government of Saskatchewan 2018). One provision within surface lease agreements is compensation for commercial loss of income. Payments are typically made to individuals who: 1) held a lease or permit to use the lands immediately prior to the establishment of the mine's surface lease; and 2) used the land to generate commercial income, such as from trapping (Government of Saskatchewan 2018b). Should the need arise, compensation for loss of income may be disbursed to the trapper selected to take up trapping in the Project Area.

11.2.5.3 Perceived Suitability of Lands and Resources Therein

Mitigation measures for the perceived suitability of lands and resources therein KI are required to reduce the impacts of traffic, noise, dust dispersion, air emissions, and the potential for COPCs to enter the environment. The ISR mining method is new to Canada and, despite the exercise of due diligence, trust will also need to be built with Interested Parties who have little experience with this mining method.

Traffic

Several mitigation options are planned to reduce the risk of increased traffic as follows (see a full list in Section 12.3.5 in Section 12):

- Air transportation will be used to transport most workers between the Project site and communities at designated pick-up and drop-off points.
- Advanced driver training will be provided on the transport of nuclear substances.
- An Emergency Response Plan will be developed in case there is a spill during the transportation of dangerous goods or hazardous products.
- All materials transported by truck will be compliant with any weight restrictions or permits, spring road restrictions, or geometric constraints set out by the Saskatchewan MOHI.
- Denison will maintain roads within the Project site and the main access road to the site.

Noise

Noise mitigation includes the following strategies:

- The use of high-quality, low sound emission equipment and regular maintenance will reduce noise associated with Project activities (Section 2).
- High-noise activities will be located further away from human receptor(s), such as a local leaseholder (Section 4.4.3.2 in Section 4);
- Noise-generating equipment will be situated behind on-site obstructions (Section 6.2.5 in Section 6);
- Monitoring will take place, including collecting sound level measurements from these sources (e.g., in the vicinity of the wellfield, the concrete batch plant, and along the access road from Highway 914) once they are operating and determine whether its actual impact is lower than that which was modelled (Section 6.2.5 in Section 6).

Air Quality

Air quality on site also has the potential to affect resource users. Effects are expected to be localized primarily to the Project site and also along unpaved road corridors such as Project access roads and the Key Lake to McArthur River haul road.

To control road dust during summer (May to October), water and/or chemical dust suppressant will be applied to all site roads (Section 6.1.5 in Section 6). In the winter months (November to April), natural mitigation from snow/ice can help control unpaved road dust. Additionally, vehicle speeds at the Project site are limited to 40 km/h along the site haul roads, which will also limit the amount of road dust generated (Section 6.1.5 in Section 6). The roads are also maintained during the summer months using a grader, which is a lesser source of PM along the roads.

Air emissions will be reduced by:

- directing processing plant exhaust from drying and packaging areas through a stack prior to release outside of the building;
- designing the stack height based on results of air dispersion modelling to be an appropriate height for optimal dispersion; and
- employing battery-powered light vehicles where practical to reduce air emissions and noise levels and improve energy efficiency (Section 2).

In addition to the mitigation measures identified, other strategies to avoid or reduce the likelihood of TSP and PM exceedances include:

- limiting material handling activities during dry conditions and high winds;
- limiting vehicle and equipment speeds on unpaved roadways/surfaces;
- optimizing the number of vehicle and equipment movements and minimize travel distances, where possible;
- maintaining unpaved roads via grading or other maintenance practices to reduce the amount of fine particles available for dispersion; and
- collecting dust measurements during Project phases to determine whether the actual effect of Project activities is lower than what was modelled (Section 6.1.8 in Section 6).

Waste Management

Denison has designed numerous mitigation features to prevent release of any harmful substances into the environment that may affect people's perception of the suitability of lands and resources (see also Section 2). Denison will minimize potential release of radiological and non-radiological waste by implementing the following:

- A wash bay will be made available to clean items, equipment, and vehicles that may have been in contact with potentially contaminated materials. Contaminated water from the wash bay will be collected in a sump tank and routed to the water treatment plant for treatment and discharge.
- Bulk storage tanks for processing chemicals will sit inside appropriately designed and sized concrete secondary containment basins, physically separated from the containment basins for other chemical systems.
- Surface pipelines will be designed to have secondary containment or catchment and have leak detection systems in place at key locations.
- Contaminated wastes (e.g., mineralized drill cuttings, solid impurities removed from mining solution, dewatered reject solids) will be properly contained on a double lined waste pad with leak detection capabilities and an associated monitoring program.
- Radiological clearance scanning will be conducted as required for any items, equipment, and vehicles leaving the Project Area.

- A freeze wall will be established around the uranium deposit to reduce groundwater disturbance.
- Mining solution and process water will be reused throughout the mining process, reducing water use requirements to the extent feasible and reducing the volume of treated effluent requiring discharge. Make-up water will be preferentially sourced from site runoff where possible.
- Double-walled HDPE or equivalent piping will be used in the wellfields and will be freeze protected and secured to minimize pipe movement.
- The ISR wellfield and processing plant will be designed to re-use most of the solutions inside each circuit; any excess water will be released to a surface water body once acceptable water quality is achieved. All effluent released to surface water will meet federal and provincial regulatory discharge limits.
- All contaminated areas, such as waste ponds and pads, will be fenced to avoid contact with workers and wildlife. Fences will be monitored and maintained.
- Ponds will maintain a minimum freeboard of at least 1.0 m.
- Having two ponds allows for increased operational flexibility, as one pond can be undergoing monitoring while the other pond is releasing water to Whitefish Lake (LA-5). All effluent released to surface water will meet federal and provincial regulatory discharge limits.

The ISR Mining Method

Because the ISR mining method is a new technology in Canada (but not in other parts of the world), additional engagement, education, and outreach will continue to be conducted by Denison to promote two-way communication with all land users and community members throughout the life of the Project. By committing to this approach, Denison will continue collaboration with communities to build long-lasting, respectful, trusting, and mutually beneficial relationships.

Despite the mitigation tools to be implemented, it should be noted that how potential effects are perceived can be highly variable among resource users and dependent on proximity to the effect. For example, Project-related effects such as noise and dust can cause avoidance of the area by some resource harvesters while others may be undeterred. Sensitivities among individuals may vary, with one person perceiving an effect much differently than another (e.g., magnitude may be high for some and negligible for others). Typically, the magnitude of perceived effects declines with increasing distance from the Project and Project activities, such as traffic.

11.2.6 Residual Effects Evaluation

11.2.6.1 Residual Effects Characterization

As noted in Section 11.2.4, effects pathways under the resource availability and land availability KIs have not been carried forward for residual effects characterization due to a lack of effect and/or proven and effective mitigation. This section summarizes residual effects of the Project (i.e., after mitigation) on the remaining KI: perceived suitability of lands and resources therein.

The approach to assessing residual Project effects on the perceived suitability of lands and resources therein KI follows the methodology outlined in Section 5.8 in Section 5. Each residual effect is assessed in the context of the Project activities that will occur within each Project phase. Each residual effect is then characterized based on the combined predicted residual effect for all phases.

General definitions of the Residual Effects Characteristics are provided in Table 5.8-1 in Section 5. Mitigation measures for changes to the OLRU VC are described in Section 11.2.5. Residual effects characteristics specific to OLRU are defined in Table 11.2-8.

Table 11.2-8: Other Land and Resource Use – Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Negative effect or effect is not desirable. **Positive** – Beneficial effect or effect is desirable.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Low** – Minimal amount of change detectable by resource harvesters. **Moderate** – Moderate amount of change detectable by resource harvesters. **High** – High amount of change detectable by resource harvesters.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the OLRU LSA. **Regional** – Effect extends beyond the OLRU LSA into the OLRU RSA. **Beyond Regional** – Effect extends beyond OLRU RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions. **Partially Reversible** – A residual effect that partially diminishes to baseline conditions. **Irreversible** – A residual effect that will not diminish to baseline conditions.

Residual Effect Characteristic	Definition	Rating
Context	The extent to which the VC or KI has been affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its ability to recover from that effect (i.e., resilience)	**Low** – VC/KI has high resilience to stress and is able to accommodate change. **Moderate** – VC/KI has moderate resilience to stress and is able to accommodate some change. **High** – VC/KI has weak resilience to stress and is unable to accommodate change.
Likelihood	Likelihood that the residual effect will occur including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability the residual effect will occur. **Unlikely** – A low probability the residual effect will occur.

The characterization of residual effects is based on the review of the existing environment (Section 11.2.3), the assessment of Project-related effects and proposed mitigation measures, IK, KPIs, and professional judgment. All residual effects (independent of their significance rating) are carried forward to the CEA. In terms of confidence:

- A low level is assigned when the VC/KI and/or the Project interaction is not well understood, and/or the mitigation measures have not been proven effective.
- A moderate level is assigned where the VC/KI is understood and/or the mitigation measures have been proven effective elsewhere.
- A high level is assigned when the VC/KI and Project interactions are well understood, and the mitigation measures have been proven effective.

Table 11.2-9 provides a summary of the KIs that were or were not carried through to the residual effects assessment, along with a summary of mitigations. Table 11.2-7 provides the potential Project interactions (primary interactions and secondary interactions) for OLRU.

Table 11.2-9: Summary of Key Indicators Considered in the Residual Effects Assessment

Key Indicator	Measurable Parameter	Consideration for the Residual Effects Assessment	Mitigations (Section 11.2.5)
Resource Availability	Terrestrial resource availability	Given the limited residual effects on resource availability, this pathway has not been carried forward for a residual effects assessment. Reasons include recreational hunting has not been confirmed to occur at the Project site, recreational hunting within the OLRU LSA is limited due to access restrictions, there are a limited number of recreational cabin leaseholders permitted through the Key Lake gate, outfitting operations in the LSA focus primarily on fishing, and trapping activity in the LSA was known to be conducted by the ERFN trapper.	Mitigation measures that protect wildlife are documented in Section 9.3.5 in Section 9. Given that effects to resource availability are likely to be undetectable to resource harvesters, including existing recreational users and any future commercial trappers, mitigation measures are not required for the OLRU resource availability KI and no residual effects are expected.
	Aquatic resource availability	Project-induced changes to the abundance and distribution of fish are not expected. The effect, if any, is expected to be undetectable to fishers and is not carried forward for a residual effects assessment.	Mitigation measures that protect fish are documented in Section 8.1.5 in Section 8. Given that effects to resource availability are likely to be undetectable to resource harvesters, including existing recreational users and any future commercial fishers, mitigation measures are not required for the OLRU resource availability KI and no residual effects are expected.
	Health and abundance of resources	Given that there are no predicted radiological and non-radionuclide COPC exceedances that would affect the growth, reproduction, and survival of terrestrial and aquatic ecological receptors, potential effects on recreational and commercial resource use are unlikely because the MP: changes in the relative health and abundance of fish and wildlife species, is unlikely. Therefore, the potential for radionuclide and non-radionuclide COPCs affecting fish and wildlife health and abundance is negligible and this pathway is not carried forward for a residual effects assessment.	Mitigation measures that protect fish and wildlife are documented in Section 8.1.5 in Section 8 and Section 9.3.5 in Section 9, respectively. Mitigation measures for human health are described in Section 10.1.5 in Section 10. Given that effects resource availability are likely to be undetectable to resource harvesters, including existing recreational users and any future commercial fishers or trappers, mitigation measures are not required for the OLRU resource availability KI and no residual effects are expected.
Land available to practice commercial and recreational harvests	Availability/ accessibility of land	Other land and resource use was known to be conducted exclusively by the ERFN Trapper, who is considered by ERFN as representative of future uses by their community. The lands available for trapping will be reduced by 169.6 ha (1.69 km2) due to limited access to the Project site for safety reasons. The Project Area (169.9 ha or 1.696 km^2) makes up less than 0.1% of the LSA (approximately 2,620 km^2). The land that will become unavailable amounts to 1.69 km^2 of N-18's 17,694 km^2 area or less than 1/10,000 of its total area. This reduction in land available for trapping does not support	To minimize land that is disturbed by the Project, the Project Area has been reduced to the extent practicable and much of the proposed Project footprint has been developed within previously disturbed areas, including roads currently used for exploration activities (Section 2.4.5 in Section 2). With respect to land activities, recreational hunting is not known to occur. It may be reasonable to expect commercial trapping to resume in the future with a small reduction in area (169.9 ha). While mitigation for trapping is not planned because no active trapping currently

Key Indicator	Measurable Parameter	Consideration for the Residual Effects Assessment	Mitigations (Section 11.2.5)
		carrying this pathway forward for a residual effects assessment.	occurs in the OLRU LSA, should new trappers be assigned by the ERFN N-18/N16 trappers association, trapping may be re-established. Surface lease agreements, which are required to conduct mining in Saskatchewan, also contain commitments for environmental protection, occupational health and safety, and socio-economic benefits for residents of northern Saskatchewan.
	Availability/ accessibility of waterways	The predicted sub-centimetre change in water levels under the intake and discharge scenarios is not expected to be detectible to resource users or affect travel on LA-1 or LA-5. Travel is not expected to occur on LA-6 or other waterbodies in the region in any season. Therefore, water and ice-based navigation by resource users is predicted to remain unchanged and this pathway will not be carried forward for a residual effects assessment.	Aquatic habitat (where fishing takes place) is expected to be reduced by approximately 135 m^2, which will constitute less than 0.05% of LA-5's surface area and is predicted to have no effect on fish abundance and distribution (Section 8.3.6 in Section 8). Changes to aquatic habitat elsewhere are not anticipated to occur. Water surface elevations (which can affect water and ice navigation and commercial fishing) are not expected to change to any detectable degree (NewFields Canada Mining & Environment 2021). Mitigation measures for the availability of waters suitable for resources use are, therefore, not required. Surface lease agreements, which are required to conduct mining in Saskatchewan, also contain commitments for environmental protection, occupational health and safety, and socio-economic benefits for residents of northern Saskatchewan.
Perceived suitability of lands and resources	Aesthetic experience	Potential Project disturbances considered under this pathway included increases in traffic, noise, and air quality, modification of the wilderness experience, and increases in competition for resources. These disturbances will be most detectible in locations proximal to the Project site. Effects have the most potential to affect cabin lease holders due to their use of ground travel, hunting and fishing activities, and general proximity to the Project. Overall, with the exception of dust, which has proven mitigation strategies, the overall disturbances are expected to be negligible and there are a limited number of resource users who will experience them to any detectible degree. Therefore, this pathway is	For further information related to mitigation measures for traffic, noise, air quality, waste management, and the ISR Mining Method, see Section 11.2.5.

Key Indicator	Measurable Parameter	Consideration for the Residual Effects Assessment	Mitigations (Section 11.2.5)
		not carried forward for a residual effects assessment.	
	Perceived suitability of resources for safe use	Perceived suitability of lands and resources may be affected by hazardous and contaminated waste management, groundwater supply and surface water withdrawal, and the package and transport of nuclear substances. Potential effects are predicted to begin in Operation and cease when reclamation activities have been completed in Decommissioning when Project components are removed, and activities cease. Concerns raised relate primarily to the ISR mining method, which is new to Canada and, therefore, a method that resource users have little experience with. This pathway is carried forward for a residual effects assessment.	Information related to mitigation measures for traffic, noise, air quality, waste management, and the ISR Mining Method see Section 11.2.5.

11.2.6.2 Summary of Project-related Residual Adverse Effects on OLRU

The Project is expected to affect OLRU in an adverse way. With the implementation of Project mitigation measures, overall, residual effects on OLRU are expected to be adverse, low magnitude during all Project phases, located primarily in the LSA, and medium-term in duration. Residual effects to OLRU are expected to be continuous in frequency, low in context, and fully reversible following decommissioning.

11.2.6.3 Perceived Suitability of Lands and Resources Therein

A summary of residual environmental effects on perceived suitability of lands and resources therein is located in Table 11.2-10. Overall, the assessment predicts that effects to OLRU are likely, adverse, and low in magnitude due to effective and proven mitigation measures available. Effects will occur within a small portion of the LSA and will be most noticeable in proximity to the Project Area and adjacent to roadways. The duration of effects will be medium-term, with effects occurring frequently over the life of the Project. Residual effects will be fully reversible by the Post-Decommissioning stage. Context is considered low due to resource users being resilient and adaptive to new and changing conditions.

Table 11.2-10: Other Land and Resource Use – Summary of the Characteristics Ratings for Residual on Perceived Suitability of Lands and Resources Therein

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Perception of suitability of lands and resources may result in avoidance of areas and selection of alternate areas to carry out land use activities.
Magnitude	Low	Presently few resource users practice land use in Project affected areas and only a sub-set may perceive lands to be unsuitable.
Geographic Extent	Local	Effects are expected to be contained within the OLRU LSA including land in close proximity (up to 400 m) around the Project Area, and up to 300 m on either side of local access roads and the Key Lake – McArthur River haul road.
Duration	Medium-term	Project Construction to Post-Decommissioning is 38 years. Effects on resource users will be most detectable during Construction and Operation and declining throughout the Decommissioning phase.
Frequency	Frequent	Project disturbances are expected to occur on a regular basis throughout the duration of the Project.
Reversibility	Fully Reversible	Project-related disturbances are expected to cease once Project infrastructure is removed, the site is remediated, and activity returns to baseline levels.
Context	Low	Resource users are able to adapt and change to new conditions and exhibit resiliency to changing conditions.
Likelihood	Likely	The Project will likely have some effect on OLRU.

11.2.6.4 Significance and Confidence

All changes to KIs for OLRU are expected to be undetectable to resource users, except for the perceived suitability of lands and resources KI. While it is difficult to predict individual perceptions on the suitability of land proximal to the Project for OLRU, resource users may experience disturbances from traffic, noise, air quality changes, a loss of a ‘wilderness experience’, and increased competition for resources. Some perceptions may be strong enough to cause them to avoid practicing commercial and recreational use in areas proximal to the Project. Overall, the following key points reduce the magnitude of this potential effect (and therefore its potential to be significant):

- Other Land and Resource Use is not known to be conducted in the immediate vicinity of the Project Area though use of the Key Lake – McArthur River haul road is used or has the potential to be used in the future by all resource user groups admitted through the Key Lake gate.
- The current number of commercial and recreational resource users admitted through the Key Lake gate is strictly limited to those who lease property, hold commercial licenses, or those who operate outfitting businesses (access for subsistence harvesters is described in Section 11.1).
- Not all resource users will be sensitive to the Project and its activities.

- Resource users are accustomed to the presence of the McArthur River Mine and the Key Lake Mill and have considerable experience with uranium mining in the region.
- Resource users are able to adapt and change to new conditions and exhibit resiliency to changing conditions.

Therefore, the overall conclusion relative to changes to OLRU is **not significant**.

The overall confidence in the determination is moderate. The range of certainty is based on proven mitigation strategies that have been successful in similar contexts such as management of noise, traffic, dust, and competition for resources. A slightly lower degree of certainty is applied to perceptions of the safety of the ISR mining method because, while regionally residents have long-standing experience with uranium mining, the ISR method is new in their experience and additional engagement will be required to inform citizens on how the operations work and the degree to which environmental health is protected.

11.2.7 Cumulative Effects

Projects considered in the cumulative effects assessment (Section 5.9 in Section 5; see also Table 11.2-11) were systematically examined for temporal and spatial overlap. Temporal overlap occurs when the project is a reasonably foreseeable development meaning that the project is a future certainty or is reasonably foreseeable[12] and this development will take place within the planning horizon and expected life cycle of the Project (i.e., within 38 years; IAA 2018). Existing projects were not considered as part of CEA because they were captured and assessed within baseline conditions. Spatial overlap was considered within the OLRU RSA where Project interactions may occur. Projects that met both criteria were carried forward for CEA.

Table 11.2-11: Summary of Cumulative Effects for Indigenous Land and Resource Use

Project Description	Project Type	Temporal Overlap	Spatial Overlap (within the OLRU RSA)	Carry forward for Cumulative Effects Assessment
Cameco Cigar Lake Mine	Existing Mine	Existing	Yes	Considered as part of existing environment
Cameco Key Lake Operation	Existing Mill[1]	Existing	Yes	Considered as part of existing environment
Cameco McArthur River Operation	Existing Mine[2]	Existing	Yes	Considered as part of existing environment
Cameco Millennium Mine	Potential Future Mine[3]	Project on pause with no certainty on start date	Yes	No

[12] The physical activity is expected to proceed, e.g., the proponent has publicly disclosed its intention to seek the necessary EA or other authorizations to proceed.

Project Description	Project Type	Temporal Overlap	Spatial Overlap (within the OLRU RSA)	Carry forward for Cumulative Effects Assessment
Wheeler River (Gryphon) Project	Potential Future Mine[4]	Project not currently being pursued by Denison	Yes	No
Courtenay Lake	Campground/Recreation Site	Existing	Yes	Considered as part of existing environment
Geikie River	Campground/Recreation Site	Existing	Yes	Considered as part of existing environment
Cree Lake Winter Trail	Completed Road	Existing	Yes	Considered as part of existing environment
Fox Lake Winter Road	Completed Road	Existing	Yes	Considered as part of existing environment
Key Lake Road	Completed Road	Existing	Yes	Considered as part of existing environment
MacFarlane Lake Winter Road	Completed Road	Existing	Yes	Considered as part of existing environment
Thin Creek Bridge	Completed Road	Existing	Yes	Considered as part of existing environment
Waterbury Lake Local Access Road	Completed Road	Existing	Yes	Considered as part of existing environment
Highway 914 All Weather Road	Future Road (Proposed)	Yes	Yes	Yes
Various lodges and outfitters	Outfitter and lodging	Existing	Yes/No	Considered as part of the existing environment

1, 2 Both the Cameco McArthur River Mine and the Key Lake Mill were moved from active operations to care and maintenance in January 2018 because of sustained low uranium prices (Cameco 2018). The McArthur River Mine was in safe state of care and maintenance until early 2022. On February 9, 2022, Cameco announced plans for the McArthur River and Key Lake operations gradual return to production (Cameco 2021).

3, 4 The proponent has not publicly disclosed its intention to seek the necessary EA or other authorizations to proceed.

Many of the projects listed in Table 11.2-11 are considered as part of the existing environment and are, thus, already considered in the context of the residual effects assessment. Other projects lack spatial or temporal overlap with the Project and, thus, are not carried through the CEA.

The only project carried forward in the CEA is the Highway 914 Extension project. The Highway 914 extension project EIS was filed on September 3, 2022 (Stantec 2021). The project is described as follows by Stantec (2021):

“Saskatchewan Ministry of Highways (MOH or the Ministry) is proposing a highway extension project consisting of the construction of 50.7 kilometres (km) of all-weather highway that will extend the existing Highway 914 starting near the McArthur River mine site to an existing road near the Cigar Lake mine site… The purpose [of] the Project is to create an alternate travel route for residents of Saskatchewan’s northernmost

communities. Several communities have one road option to access the southern areas of the province (Provincial Highway 905). Development of the Project would provide a secondary route for vehicles travelling to and from the north" (p. vii).

The first four years of the Highway 914 extension project construction will consist of the construction of the roadway between the McArthur River Mine and the Cigar Lake Mine. This portion of the roadway has no spatial overlap with the OLRU LSA and, therefore, no cumulative effects. Assuming that both projects will start their construction phases simultaneously, there would be no overlapping cumulative effects during the construction phases of both projects. Both projects would become active during their operation phases when spatial overlap would occur because industrial, public, and recreational traffic will flow freely along the length of the road between the Key Lake Mill and the Cigar Lake Mine. Public access on the roadway will eliminate the need to check in at the access gate at the Key Lake Mill.

Highway 914 is presently gated at the Key Lake Mill at the southern extent of the OLRU LSA, which restricts access to areas north of the Key Lake Mill and along the Key Lake to McArthur River haul road. Increased access to the area was identified as a concern by a trapper, lodge owner, and two cabin leaseholders[13] and is expected to begin in the Project Operation phase and continue until Post-Decommissioning is complete.

Improved access to OLRU RSA via the Highway 914 extension and a bypass of the Key Lake gate is expected to affect the suitability of lands and resources therein due to increased traffic, noise, dust, and increases in competition for resources. Competition for resources is of particular concern as the highway extension could introduce resource users from other communities who would otherwise have to travel substantial distances to access the area. As noted, the magnitude of these effects is relative to individual resource user perspectives ranging from no effect to a perception that the area has become completely unsuitable for land use. Though the Highway 914 extension will not shorten travel to the south by Athabasca Denesųłiné communities and, therefore, the original route (Highway 905) may be preferred, opportunistic Indigenous land use may increase due to new lands becoming accessible by the Highway extension. It should be noted that Indigenous land use is prioritized for allocation above all other resource uses other than for conservation purposes under Section 35(1) of the Constitution Act, 1982. The KML (2022) propose that "Denison review our perspective and approach with solutions to either mitigate impact, find a work around, or ensure remediation or compensation. Our preference is always to ensure [that] impacts to the land and resources we value are either nil or minimal. Where we have proposed solutions, we want to know the role Denison can play and resources that can be allocated. This must be communicated thoroughly to KML and our community".

[13] 19-LK-ERFNTrap-134.226, 19-EN-LEASE-138.1, 19-EN-LODGE-141.1, 20-LK-LEASESUR-267.58, and 20-LK-LEASESUR-267.62

Recreational land use also may increase due to resource users arriving from the south and may affect perceptions of competition for resources. Lodge and outfitters operating in the OLRU LSA are remote fly-in operations and are not affected by increased traffic and though cabin owners may experience increased traffic, dust, and noise on their commute, it is not expected to affect the enjoyment of their cabins. A local lodge owner also raised concerns about the potential for increases in vandalism or theft as the road opens up the area (19-EN-LODGE-141.1); such events, if they occur, would be the responsibility of law enforcement to respond to.

A summary of the CEA is presented in Table 11.2-12. Overall, the potential cumulative effect is characterized as being adverse and of low magnitude as the magnitude of these effects is relative to individual resource user perspectives. Cumulative effects are expected to be confined to the OLRU RSA around the Project Area and adjacent to roadways, medium-term (approximately 35 years with assumptions about when the projects will overlap), and frequent from Operation to the end of Decommissioning. Residual effects are expected to be fully reversible by Post-Decommissioning, with context assessed as low due to resource users being resilient and adaptive to new and changing conditions, and likelihood assessed as likely. Cumulative effects are predicted to be **not significant**. Confidence is moderate because it relies on individual perceptions of suitability, which can be variable.

Table 11.2-12: Summary of Cumulative Effects for Other Land and Resource Use

Cumulative Effects	Project Phases	Cumulative Effects Characterisation[1]								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Perception of reduced suitability of land and resources therein	Operation – Post-Decommissioning	L	RSA	MT	FF	FR	L	L	NS	M

[1] Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility: Fully Reversible (FR), Partially Reversible (PR), Irreversible (IR)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (U), Likely (L)
Significance: Not-Significant (NS), Significant (S)
Level of Confidence: High (H), Moderate (M), Low (L)

Climate Change Considerations

The Project must also be considered in the context of climate change. The sensitivities of the Project to severe weather (e.g., extreme temperatures and excessive precipitation) and forest fires have been examined as they have the potential to adversely affect the Project. Events including flooding, tornadoes, and forest fires, which are likely to become more frequent and/or more severe under climate change have been considered in the Accidents and Malfunctions (Section 14). The Project will be designed, constructed, operated, and maintained relative to applicable regulations, codes, and standards. Detailed plans and procedures would be developed for the Project that are site specific.

Based on a consideration of the mitigation strategies to be applied, past experience, and application of BMPs, effects of a changing climate on the Project are expected to be **not significant**.

11.2.8 Monitoring and Follow-up

For the purposes of this EIS, monitoring and follow-up are defined as follows:

- Monitoring programs are designed to meet regulatory requirements (e.g., permit or license conditions), and/or to demonstrate compliance with environmental commitments made in the EIS.
- Follow-up programs are those that are proposed to address any uncertainties identified during the EA process (e.g., to verify predictions made during the EA; determine the effectiveness of proposed and implemented mitigation measures) and to determine if and when to implement adaptive management measures.

No monitoring or follow-up activities are proposed for the OLRU VC.

11.2.9 Other Land and Resource Use Summary

Other Land and Resource Use activities that tend to occur in the OLRU LSA include trapping, commercial fishing, and leaseholders and cabin owners. Commercial fishing and trapping in the OLRU LSA was known to be conducted exclusively by the ERFN Trapper, who has since, unfortunately, passed away prior to the time of filing the EIS. If/when the trapline is transitioned to a different trapper, Denison will assume a similar approach to working collaboratively with the individual to permit access where it is safe to do so, and to provide compensation for losses to income, if applicable. Based on Crown Land Leases active in late 2019, 13 cabin owners were identified within 22 km of the Project site (InterGroup 2019). Of these, one was identified to be the ERFN Trapper and another's lease had been cancelled**.** The current number of commercial and recreational resource users admitted through the Key Lake gate is strictly limited to those who lease property, hold commercial licenses, or those who operate outfitting businesses.

The various phases of the Project will have different effects on OLRU and its KIs: change to resource availability (including terrestrial and aquatic resource availability and the health of resources); land available to conduct recreational and commercial harvests (including the availability and accessibility of land and waterways); and changes to the perceived suitability of land and resources (including aesthetics of resource use and perceived suitability of resources for safe use). The KIs of resource availability, land available to conduct recreational and commercial harvests and perceived suitability of land and resources for aesthetics of resource use were not carried forward to residual effects assessment and can be eliminated, reduced, or controlled through mitigation measures.

The perceived suitability of lands and resources for safe use may be affected by hazardous and contaminated waste management, groundwater supply and surface water withdrawal, and the package and transport of nuclear substances. Potential effects are predicted to begin in Operation and cease when reclamation activities have been completed in Decommissioning when Project components are removed and activities cease. Concerns for safe use relate primarily to the ISR mining method, which is new to Canada, and therefore a method that resource users have little experience with. As a result, the perceived suitability of lands and resources for safe use was carried through to the residual effects assessment.

Mitigation measures for OLRU KIs include Project design, implementation of BMPs, development of management plans, implementation of emergency response programs, Surface Lease Agreements, provision of training, education, and awareness, and mitigations to reduce risks associated to increased traffic, noise, air quality, waste management, and the ISR mining method. The primary commercial resource harvester passed away prior to the filing of the EIS, and it is assumed that if those allocations are transitioned to a future user/users that Denison would enter into a similar relationship with that individual(s), which may include the negotiation of an agreement pertaining to access and compensation for potential commercial losses.

With the implementation of Project mitigation measures, overall, residual effects on OLRU perceived suitability of lands and resources for safe use are expected to be adverse, low magnitude during all Project phases, located primarily in the LSA, and medium-term in duration. Residual effects are expected to be continuous in frequency, low in context, and fully reversible following Decommissioning. The overall conclusion relative to changes to OLRU is **not significant** and the overall confidence in the determination is moderate to high. The determination of a confidence of high is based on proven mitigation strategies. A slightly lower degree of certainty is applied to perceptions of the safety of the ISR mining method because, while regional residents have long-standing experience with uranium mining, the ISR method is new in their experience and additional engagement will be required to inform citizens of how the operations work and the degree to which environmental health is protected.

The only project carried through to the CEA relative to land and resource use was the Highway 914 All Weather Road Extension Project, which could result in potential changes to resource abundance and distribution and access considerations. Access is central to the analysis as the Highway 914 All Weather Road Extension Project has the potential to introduce resource users to the area who could otherwise have to travel considerable distances to access the LSA and RSA. This presents the potential for competition for existing resource users and strain on resource availability, as well as contribute to increasing traffic volumes and associated noise and dust. Increased access to the area was identified as a concern by a trapper, lodge owner, and two cabin leaseholders[14]. Lodge owners and outfitters operating in the OLRU LSA are remote fly-in operations and are not affected by increased traffic. Cabin owners and any future commercial trappers and fishers may experience increased traffic, dust, and noise on their commute; however, it is not expected to affect their enjoyment of their cabins or land and resource use. Effects to land and resource use are likely and would occur in a social context where resource users are considered highly resilient and adaptive to changes. Consideration of Highway914's cumulative effect to land and resource use does not alter the determination of significance, although Denison and the Province of Saskatchewan should continue to engage with potentially Interested Parties on their concerns of the projects. No monitoring or follow-up activities are proposed for OLRU.

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11.3 Heritage Resources

This subsection addresses potential effects from the Project on the Heritage Resources VC. This section comprises the following steps as part of the assessment:

- scope of the assessment;
- summary of existing conditions;
- identification and description of potential interactions between the Project and the VC;
- identification and description of mitigation measures applicable to the VC to eliminate, reduce, or control the potential adverse Project-related effects);
- identification and characterization of predicted Project residual effects (i.e., after mitigation), including characterization of significance and assignment of the level of confidence in the predictions; and
- identification and characterization of potential cumulative effects.

Figure 11.3-1 is a graphic representation of the assessment process used in this EIS.

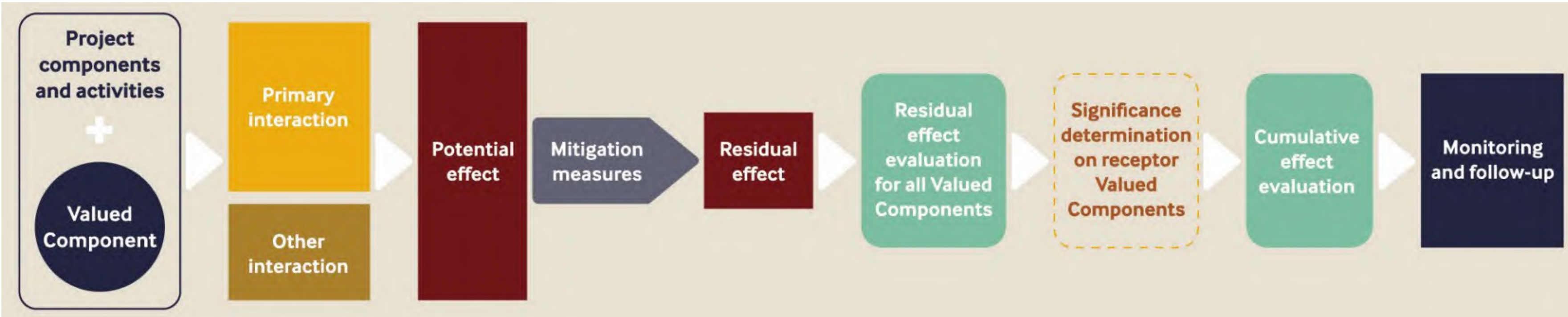

Figure 11.3-1: Environmental Assessment Process for the Wheeler River Project

11.3.1 Scope of Assessment

Heritage resources include both physical and cultural heritage as defined by the Technical Guidance for Assessing Physical and Cultural Heritage or any Structure, Site, or Thing that is of Historical, Archaeological, Paleontological, or Architectural Significance under the *Canadian Environmental Assessment Act*, 2012 (CEAA 2015). For the purposes of this EIS, physical and cultural heritage or any structure, site, or thing that is of historical, archaeological, paleontological, or architectural significance will be referred to as heritage resources. Lands or resources are considered a heritage resource based on the values that are placed on it (CEAA 2015). This value originates from its association with one or more important aspects of human history or culture; historical, archaeological, paleontological or architectural significance; and association with a particular groups' practices, traditions or customs.

In Saskatchewan, heritage resources are the property of the Provincial Crown and are protected under *The Heritage Property Act* (Government of Saskatchewan 2019). Heritage resources include Precontact period and Historic period archaeological sites, built heritage sites and structures of historical and/or architectural interest, and paleontological sites. The Saskatchewan Ministry of Parks, Culture and Sport, Heritage Conservation Branch (HCB) administers The *Heritage Property Act* and has identified two primary triggers for determining if a Heritage Resources Impact Assessment (HRIA) is required for a project (per section 63 of *The Heritage Property Act*) (Government of Saskatchewan 2019). An area is considered heritage sensitive based on the presence of known heritage resources and the potential for new heritage resources to be discovered. The extent of previous land disturbance and nature and scope of the project are also taken into consideration. Additional screening criteria for northern Saskatchewan (northern parklands and boreal forest) to determine heritage potential include:

- within 500 m of a Site of a Special Nature (per. S. 64 of *The Heritage Property Act*), or other previously recorded site(s), unless the site has been determined to have low interpretive value;
- along dry, upland margins of a major bog or fen;
- within 250 m of watercourses or lakes;
- within 50 m of historic trails;
- within 250 m of strandlines; and
- on escarpments (defined by two or more contour intervals within 200 m), prominent uplands, and hills/ridges (including eskers) within 500 m of a water source.

For Indigenous groups, lands and resources identified as heritage or cultural resources may also fit under current use of lands and resources for traditional purposes (CEAA 2015). For the purposes of this EIS, any heritage sites that may fit under the current use of lands and resources for traditional purposes, including cultural landscapes and cultural sites, will be discussed under Section 11.1 and the remainder of this section will only discuss heritage resources as defined by *The Heritage Property Act* (Government of Saskatchewan 2019).

11.3.1.1 Valued Component Selection

Heritage Resources were selected as a VC because Project activities may result in effects to Heritage Resources. Archaeological sites were identified in the Project Area during the baseline studies (see Section 11.3.3) and, therefore, the Project Area is considered heritage sensitive, and the Project has the potential to impact heritage sites (Golder 2017; 2020).

The IK shared by ERFN, KML, and YNLR were reviewed and indicated that the Project Area, LSA, and RSA show continued use of these areas by the communities (ERFN 2011; ERFN and SVS 2022b; KML 2011, 2018; KML and NVP 2022a, 2022b; YNLR 2022). Figure 11.3-3 shows the traditional territories and reserve parcels for ERFN, KML, and YNLR, and the LSA and RSA for the Heritage Resources VC. Figure 11.3-4 shows the location of known archaeological sites in the RSA (Golder 2017, 2020). The use of the area suggests that archaeological resources may be present.

Figure 11.3-2 is a graphic representation of the main linkages among the Heritage Resources VC and other VCs, illustrating the flow of assessment information from the Heritage Resources VC.

Figure 11.3-2: Integrated Assessment Approach - Key Connections between Heritage Resources and Other Valued Components

11.3.1.2 Key Indicators and Measurable Parameters

Archaeological sites were chosen as a KI for the Heritage Resources VC because two known archaeological sites are located in the Project Area (Table 11.3-1). No built heritage sites or paleontological sites occur in the Project Area, so they were not included as KIs for the Project (see Section 11.3.3). Archaeological sites are protected by *The Heritage Property Act* and are considered a non-renewable resource. Construction and other activities associated with the Project have the potential to impact or disturb archaeological sites. The number of sites potentially impacted during the Project will be used as the MP for the Heritage Resources VC as this potential effect can be actively measured.

Table 11.3-1: Key Indicators and Measurable Parameters for Heritage Resources

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Archaeological sites	Archaeological sites are protected by The Heritage Property Act and are considered a non-renewable resource.	• Change in the number of known archaeological resources directly or indirectly altered/lost as a result of Project activities.

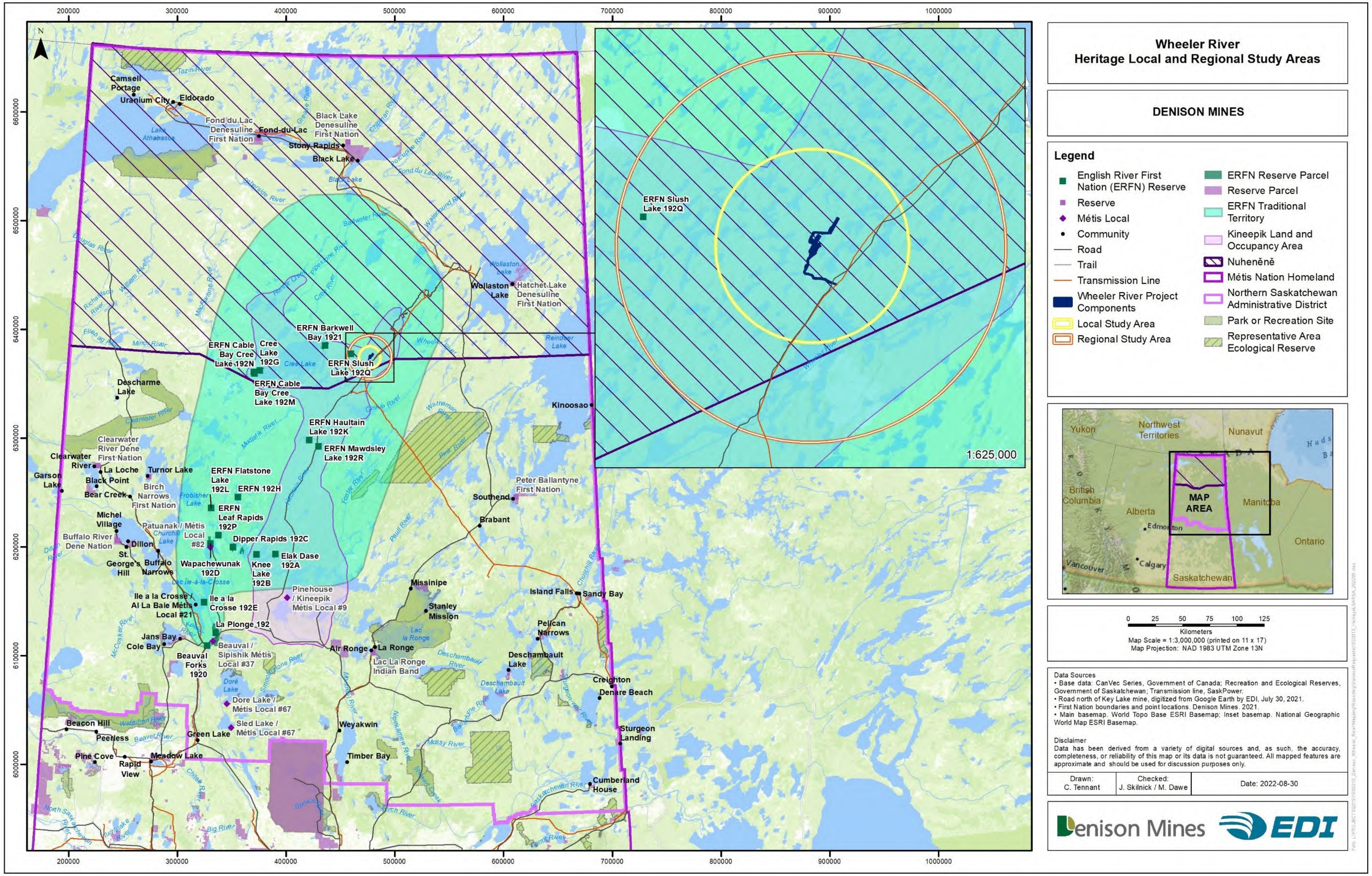

Figure 11.3-3: Heritage Local and Regional Study Areas

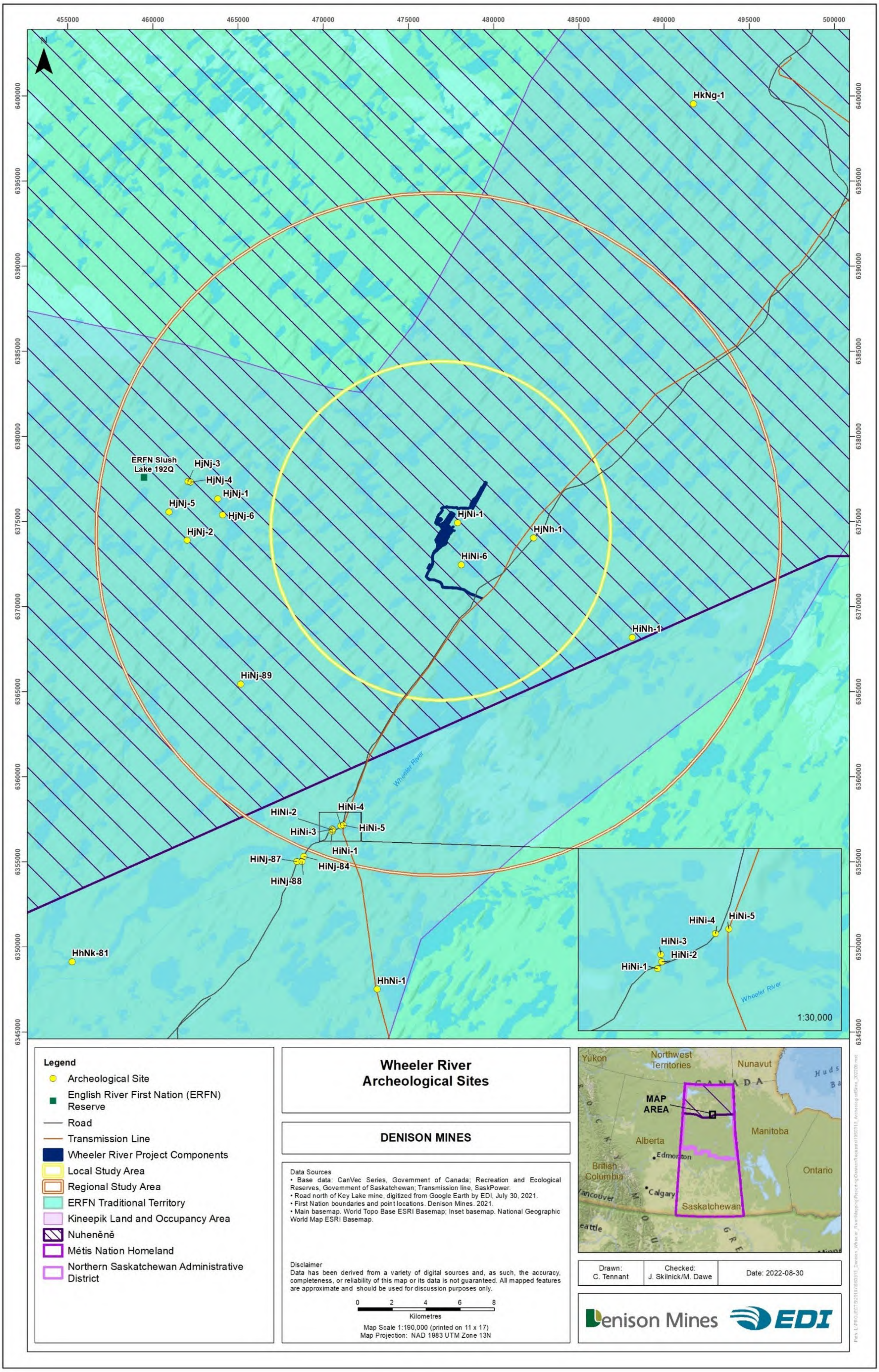

Figure 11.3-4: Archeological Sites

11.3.1.3 Spatial and Temporal Boundaries

Both spatial and temporal boundaries were considered in determining the potential effects to Heritage Resources. The Project Area is defined as the area within which all the Project components/activities are located and where all the physical disturbances will be located. As such, this is the area with the potential to affect Heritage Resources and will be the primary focus of the heritage assessment. The LSA and RSA for heritage resources were established to determine the size and nature of archaeological sites that may be encountered within the Project Area. The LSA was set to a 10-km radius from the Project Area and the RSA is a 20-km radius from the Project Area to gather a better understanding of the regional Heritage Resources.

Effects to Heritage Resources could occur in the Project Area throughout the life of the mine. Potential effects could occur during Construction, as this phase will have the majority of the ground disturbance activities. It is possible that potential effects could occur during Operation, Decommissioning and Post-Decommissioning if ground disturbance occurs during these phases.

11.3.2 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

To properly assess physical heritage, historic and present-day land-use and cultural practices on the land should be considered as they can illustrate continued land use in an area and are a good indicator that an area has high heritage potential (Korejbo 2011). To help assess heritage potential, TLU maps from ERFN, KML, and YNLR were reviewed to identify records of land uses and cultural practices in the Project Area.

Field assistants from local Indigenous communities were involved with the HRIA baseline studies, allowing for in-field consultation during the assessment to make sure that areas deemed to have potential by the land users were surveyed (Golder 2017; 2019). The Heritage Resource Management Plan (HRMP) was informed by engagement with ERFN, who recommended that the HRMP should include a mechanism to involve Indigenous communities where appropriate (21-EN-ERFN-591.1; 21-EN-ERFN-591.2) (see Appendix 11-B).

Denison has recorded and stored information regarding IK, LK, and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 21-EN-SUR-446.52). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment. Appendix 11-A provides a summary of unique identification numbers referenced within Section 11.3.

11.3.3 Existing Environment

The existing environment was examined at three spatial levels: Project Area, LSA (10-km radius), and RSA (20-km radius). A site search was requested from the HCB for both archaeological and paleontological sites. No known paleontological sites were located in the Project Area, LSA, or RSA. The known archaeological resources located within the Project Area, LSA, and RSA are summarized in Table 11.3-2.

Table 11.3-2: Archaeological Resources within the Project Area, Local Study Area, and Regional Study Area

Location	Borden No.	Site Type	Cultural Affiliation	Permit No.
Project Area	HiNi-6	Artifact Find	Unknown Precontact	17-091
Project Area	HjNi-1	Artifact Find	Unknown Precontact	19-065
LSA	HjNh-1	Artifact Find	Unknown	93-058
RSA	HiNh-1	Artifact/Feature Combination	Unknown	03-000
RSA	HiNi-1	Artifact Find	Unknown Precontact	78-000
RSA	HiNi-2	Artifact Find	Unknown Precontact	78-000
RSA	HiNi-3	Multiple Features	Historic First Nation	78-000
RSA	HiNi-4	Artifact Scatter	Unknown Precontact	90-037
RSA	HiNi-5	Artifact Find	Unknown Precontact	99-072
RSA	HiNj-89	Artifact Find	Unknown Precontact	11-000
RSA	HjNj-1	Artifact Find	Unknown	07-183
RSA	HjNj-2	Artifact Scatter	Unknown Precontact	07-183
RSA	HjNj-3	Artifact Scatter	Unknown	07-183
RSA	HjNj-4	Artifact Find	Unknown	07-183
RSA	HjNj-5	Artifact Find	Unknown	07-183
RSA	HjNj-6	Artifact Scatter	Unknown Precontact	10-187

In total, 16 archaeological sites are located within the study area, 2 in the Project Area, 1 in the LSA, and 13 in the RSA (Table 11.3-2). The sites consist of artifact finds (n=10), artifact scatters (n=4), artifact/feature combination (n=1), and a multiple feature site (n=1). Six of the sites could not be assigned a cultural or temporal affiliation. Nine of the sites are Precontact period sites and the remaining site, HINi-3, is a Historic First Nations site. Diagnostic artifacts were not identified at the sites to allow for a more specific cultural affiliation. The two sites identified in the Project Area were identified during the baseline studies completed for the Project (see Appendix 11-C and Appendix 11-D for baseline reports). The goal of a baseline field assessment is to determine the nature of archaeological sites, the types of landforms in which sites are located, and the characteristics of artifacts that may be found within the baseline study area. Two baseline HRIAs were completed for the Project Area. These studies are detailed in their own stand-alone reports (Golder 2017; 2020). Changes to the Project (i.e., expansion of the Project Area or the addition of new infrastructure) must be submitted to the HCB for their review, and additional HRIAs may be required.

The original footprint was submitted to the HCB and it was determined that portions of the Project were located in heritage sensitive terrain (i.e., previously undisturbed, hilly terrain with prominent uplands in close proximity to permanent water sources) and an HRIA, pursuant to section 63 of *The Heritage Property Act*, was required (HCB File No. 16-2102; Government of Saskatchewan 2019). A baseline HRIA was completed during the summer of 2017 under Archaeological Investigation Permit No. 17-091 (Golder 2017). This investigation examined several proposed access roads for the Project and approximately 393 ha were surveyed using pedestrian survey, the inspection of surface exposures, the excavation of 258 shovel probes, and 5 shovel tests. A single site, HiNi-6, was recorded after a large, grey quartzite secondary flake was identified in a shovel test on a terrace overlooking McGowan Lake. The site is located near, but not in conflict with, the proposed access road for the Phoenix Site. Additional shovel tests were excavated to assess the size, nature, and significance of the site; however, no additional artifacts or heritage resources were identified during the assessment. Based on the results of the HRIA, the HCB determined that HiNi-6 was of limited interpretive value, and there were no concerns with the development proceeding as planned within the surveyed areas (HCB File No. 16-2102, December 14th, 2017). Regulatory approval as per section 63 of *The Heritage Property Act* (Government of Saskatchewan 2019) was granted for the Project (HCB File No. 16-2102, December 14, 2017). Furthermore, Denison will not be developing the proposed access road adjacent to HiNi-6 and the site will not be affected.

The Project footprint was refined in 2019 and submitted to the HCB for review. The HCB determined that several areas of the refined footprint would have the potential to affect heritage sensitive terrain that had not been surveyed during the 2017 HRIA and an additional HRIA was required (HCB File No. 19-993). The HRIA was completed in summer 2019 under Archaeological Investigation Permit No. 19-065 and included heritage sensitive areas in the Phoenix buffer area, as well as additional areas along the previously assessed access roads, near the air strip, and areas of high heritage potential located immediately adjacent to the buffer area (Golder 2019; Appendix 11-D). The Phoenix buffer area was defined for the purposes of the 2019 HRIA and is comprised of approximately 284 ha that surrounds the Phoenix Infrastructure. In total, approximately 284 ha were surveyed using a pedestrian survey, the inspection of surface exposures, and the excavation of 212 shovel probes and 5 shovel tests. A single archaeological site, HjNi-1, was identified just outside of the Phoenix buffer area along a terrace that was deemed to have high heritage potential. A single flake was identified on the surface of an existing road that overlooks the confluence of a lake and a creek. The road was further examined for additional artifacts and five shovel tests were excavated near the road; however, no additional artifacts or heritage resources were identified during the assessment. Based on the results of the HRIA, the HCB determined that HjNi-1 was of limited interpretive value, and there were no concerns with the development proceeding as planned within the surveyed areas. Regulatory approval as per section 63 of *The Heritage Property Act* (GS 80) was granted for the Project (HCB File No. 19-933 February 12th, 2020).

A review of Canada's Historic Places database and Saskatchewan Heritage Property Directory was completed to determine if any registered built heritage or natural heritage sites are located within the Project Area, LSA or RSA (CHP 2021; HCB 2021). No registered sites were identified.

11.3.4 Assessment of Project-related Effects

11.3.4.1 Potential Interactions Between the Project and Valued Components/Key Indicators

Project activities were assessed for their potential to interact with Heritage Resources (Table 11.3-3). Interactions are not anticipated for activities that will not disturb the ground. Following the construction of infrastructure (both above and below ground), the operation of the mining infrastructure is not anticipated to interact with Heritage Resources because it will not cause ongoing ground disturbance. The ISR mining will occur at depths well below those of Heritage Resources (i.e., known resources have been identified on the surface and at approximately 15 cm below surface).

Table 11.3-3: Potential Project Interactions for Heritage Resources

Project Phase/Activity	Valued Component
	Heritage Resources
Construction Activities	
Development of access roads and air strip	✓
Site preparation and earthworks; clearing, leveling and grading of the project area	✓
Power generation – generators	
Installation of main substation and distribution of power around site	
Wellfield and freeze hole drilling; ground freezing	✓
Batch plant operation (concrete); crusher at borrow area	
Development of surface infrastructure (camp, operations centre, plants, ponds, pads and support facilities)	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	
Water management (including treatment and site runoff)	
Groundwater supply	
Surface water withdrawal	
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	
On-site and off-site operation of vehicles and transport of materials	✓
Air transportation for workers	
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Operation Activities	
Operation of the ISR wellfield	

Project Phase/Activity	Valued Component
	Heritage Resources
Wellfield and freeze wall drilling	
Operation and expansion of freeze wall	
Batch plant operation (grout and cement); crusher in borrow area	
Expansion of pond and pads	✓
Operation of the processing plant and production of uranium concentrate	
Water withdrawal from groundwater or surface water body	
Management of surface water (including seepage and site runoff)	
Water treatment, both domestic and industrial	
Water release to surface water body	
Waste management (composting, domestic and industrial landfill operation, recycling)	
Hazardous waste management (temporary storage, handling, and off-site transportation)	
Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates	
On-site and off-site operation of vehicles and transport of materials	✓
Power supply – primarily power from the grid, also generators and back-up generators	
Package and transport of nuclear substances	
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	
Air transportation for workers	
Progressive decommissioning and reclamation	
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Decommissioning Activities	
Site water management, treatment, and release	
Mining horizon remediation and thawing of freeze wall	
Process water treatment and release	
Closure of ISR and freeze wells and related infrastructure	
Decontamination of surface facilities and injection, recovery and monitoring wells	
Asset removal (including site power transmission lines and electrical infrastructure)	✓
Demolition and disposal of non-salvageable surface infrastructure and materials	
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)	✓
Generators	
Waste management (composting and landfill operation)	

Project Phase/Activity	Valued Component
	Heritage Resources
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)	
On-site and off-site operation of vehicles and transport of materials	✓
Reclamation of disturbed areas	✓
Regulatory site inspections	
Engagement – site visit from Interested Parties	
Post-Decommissioning Activities	
Environmental monitoring	
Regulatory site inspections	
Engagement - Site visit from Interested Parties	

11.3.4.2 Potential Project-related Effects

Potential Project-related effects for Heritage Resources are limited to the areas where ground disturbance (both mechanical and natural) will occur and are primarily limited to the immediate Project Area. Two HRIA baseline studies were completed to identify any heritage resources that may be affected by the Project. However, despite the completion of two HRIAs, unidentified Heritage Resources have the potential to be located within the proposed Project and may be unintentionally disturbed and discovered during the construction of access roads and the air strip. These activities could result in the destruction of heritage sites or the loss of context for the archaeological or cultural resources. The loss of context for archaeological sites reduces their interpretative and cultural value. A HRMP has been developed to mitigate potential effects of the Project to Heritage Resources.

11.3.4.2.1 Potential Effect 1 – Development of Access Roads and Air Strip

During Construction of the Project, construction of access roads and the air strip will require ground disturbance. Potential effects to archaeological resources will be limited to the areas where ground disturbance is occurring and will be limited to the Project Area. Two archaeological sites were identified in the Project Area (see Section 11.3.3) during the baseline HRIAs (Golder 2017, 2019; Appendix 11-C, Appendix 11-D). Neither site will be affected during Construction because they are located outside of the construction footprint for the proposed access roads and air strip. Furthermore, the sites were determined to have limited interpretive value and the HCB had no concerns with the development proceeding as planned. Changes were made to the Project footprint as a result of the baseline HRIAs. Specifically, the Project footprint was changed to avoid impacts to HiNi-6, and it is not in potential conflict with the proposed access roads or air strip. HjNi-1 was identified after a single artifact was observed on the surface of an existing dirt road, located outside of the Phoenix buffer area. The road was inspected for additional artifacts and five shovel probes were excavated near the site. No further artifacts were observed, and assessment of the site established that the site had limited interpretive potential. The results of the assessment determined that additional archaeological work at HjNi-1 would not result in the recovery of significant archaeological data and additional archaeological work was, therefore, not recommended. Additional testing and surveys were completed in areas of high potential in the Phoenix buffer area, and no additional sites were identified. It is not anticipated that the development of the access roads or air strip will affect the previously identified archaeological sites.

11.3.4.2.2 Potential Effect 2 – Site Preparation and Earthworks; Clearing, Leveling and Grading of the Project Area

During Construction of the Project, it will be necessary to clear, level, and grade the Project Area. Potential effects will be limited to the areas where ground disturbances occur and will be limited to the Project Area. No known archaeological sites exist in the Project Area that will be impacted during Construction.

11.3.4.2.3 Potential Effect 3 – Wellfield and Freeze Hole Drilling, Ground Freezing

Wellfield construction and freeze hole drilling will require the grading and levelling of the area followed by the drilling of freeze holes. Potential effects will be limited to the areas where ground disturbances are occurring and will be limited to the Project Area. No known archaeological sites exist in the Project Area that will be impacted during the construction of the wellfield or during the freeze hole drilling.

11.3.4.2.4 Potential Effect 4 – Development of Surface Infrastructure (camp, operations centre, plants, ponds, pads and support facilities)

Construction of the surface infrastructure will involve ground disturbance, including the grading and levelling of the area. No known archaeological sites occur in the Project Area that will be impacted during the construction of the surface infrastructure. Potential effects will be limited to the areas where ground disturbance are occurring and will be limited to the Project Area.

11.3.4.2.5 Potential Effect 5 – On-site and Off-site Operation of Vehicles and Transportation of Materials

The operation of vehicles, both on site and off site, will occur throughout the life of the Project (i.e., Construction, Operation, and Decommissioning). The increase in traffic throughout the Project Area, LSA, and RSA could potentially affect Heritage Resources. Several known heritage resources are located along Highway 914 (HiNi-1, HiNi-2, HiNi-3, HiNi-4, HiNi-5, and HjNh-1). No additional work was recommended at these sites and, except for HiNi-3 and HiNi-5, were destroyed during the construction of Highway 914 by the Province of Saskatchewan. Given the high number of sites located along Highway 914, potential exists for additional, unknown archaeological sites to be located along the highway. An increase in traffic along the roads (both on site and off site) could lead to the need for additional maintenance (e.g., grading, road widening), which could affect heritage sites. However, any major construction for Highway 914 would be the jurisdiction of the Saskatchewan MOHI and they would be responsible for submitting the project to the HCB for review and approval. As the sites identified along Highway 914 were impacted by the construction of the Highway and any new construction work must be submitted to the HCB for review and approval, the potential of on-site and off-site operation of vehicles to affect heritage sites is considered low.

11.3.4.2.6 Potential Effect 6 – Decommissioning Activities

During Decommissioning of the Project, asset removal (including site power transmission lines and electrical infrastructure), remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area) and the reclamation of disturbed areas have the potential to cause ground disturbance. The majority of the ground disturbance will occur in previously disturbed areas, minimizing potential effects on Heritage Resources. No known archaeological sites occur in the Project Area that will be affected during the decommissioning of the surface infrastructure. Potential effects will be limited to the areas where new ground disturbance is occurring and will be limited to the Project Area.

11.3.5 Mitigation Measures

An HRMP has been developed to mitigate potential effects of the Project to Heritage Resources. The HRMP was developed based on heritage BMPs and informed by engagement activities with ERFN (21-EN-ERFN-591.1; 21-EN-ERFN-591.2). The HRMP summarizes the archaeological context of the Project Area including a culture history for northern Saskatchewan, previous archaeological research in the Project Area, and known archaeological sites in the Project Area, LSA, and RSA, the regulatory context for heritage resources in Saskatchewan, steps in the HRIA process. The plan also outlines steps Denison will take if a new heritage site is identified during activities taking place over the life of the Project. The management of archaeological resources includes the assessment of the discovery by a qualified archaeologist and mitigation measures including avoidance of the site, shovel testing, systematic and intensive shovel testing, excavation, and/or construction monitoring. The HRMP outlines mechanisms for Indigenous engagement including the communities, implementation of appropriate cultural protocols, the potential for storage of artifacts outside of the Royal Saskatchewan Museum, and the inclusion of Indigenous field assistants when possible. See Appendix 11-B for the HRMP.

11.3.6 Residual Effects Evaluation

Potential residual effects of the Project to Heritage Resources could consist of a decrease in the number of Heritage Resources in the Project Area, due to destruction of a Heritage Resource during ground disturbance activities. Following the implementation of the mitigation measures outlined in the HRMP, the likelihood of this residual effect is considered low and residual effects on Heritage

Resources are expected to occur infrequently and can be mitigated with the HRMP. This is based on the type and number of known Heritage Resources as well as the location of the resources within the Project Area. Two archaeological sites were identified during baseline studies. These sites are artifact find sites located near bodies of water. These sites were deemed to have low interpretive value and additional work or mitigation measures were not required by HCB for the sites. Furthermore, the HCB had no additional concerns with these sites and work could proceed as planned. Based on the low occurrence of known heritage resources in the Project Area and the location of the heritage resources in areas where extensive development is not planned, it is not anticipated that a large number of new Heritage Resources will be identified during the life of the Project. Given the low number of Heritage Resources in the Project Area, the majority of activities that could disturb Heritage Resources are located in low heritage sensitive areas, and the implementation of the HRMP, it is unlikely that the residual effect, (i.e., destruction of Heritage Resources without proper assessment) will occur.

Should unknown archaeological and cultural resources be identified during the Project, effects will be mitigated using the HRMP. While effects to archaeological resources are irreversible, they can be mitigated by following the HRMP, either avoiding additional damage to the resource or assessing the resource according to *The Heritage Property Act* before continuing with work (Government of Saskatchewan 2019).

11.3.6.1 Residual Effects Characterization

Table 11.3-4 presents the definition of effects characteristics for the Heritage Resources VC. Table 11.3-5 provides a summary of the characteristic ratings for Heritage Resources.

Table 11.3-4: Heritage Resources – Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Negative effect or effect is not desirable. **Positive** – Beneficial effect or effect is desirable.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Low** – Minimal number of heritage resources with low interpretive value impacted during the operation of the mine relative to the current number of heritage sites located within the Project Area. **Moderate** – Moderate number of heritage resources with low interpretive value impacted during the operation of the mine relative to the current number of heritage sites located within the Project Area. **High** – High number of heritage resources with low interpretive value or a small number of heritage resources with high interpretive value impacted during the operation of the mine relative to the current number of heritage sites located within the Project Area.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the VC LSA (10-km radius from the Project Area).

Residual Effect Characteristic	Definition	Rating
		Regional – Effect extends beyond the VC LSA into the VC RSA (20-km radius from the Project Area). **Beyond Regional** – Effect extends beyond VC RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning and is permanent).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs minimally or not at all. **Frequent** – Effect occurs several times over the course of the Project. **Continuous** – Effect occurs any time there is ground disturbance.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Irreversible** – Effects to heritage resources are permanent but additional effects can be mitigated.
Context	The extent to which the VC or KI has been affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its ability to recover from that effect (i.e., resilience)	**Low** – Low number of heritage sites in the Project Area suggest that there are a limited number of sites to impact. **Moderate** – Low number of heritage sites in the Project Area suggest that there are a limited number of sites to impact and any impacts will be minimal and can be mitigated. **High** – High: Low number of heritage sites in the Project Area suggest that there are a limited number of sites to impact, however if ground disturbances occur in the immediate site area, sites may be impacted and could require salvage excavations and ultimately the site may be destroyed.
Likelihood	Likelihood that the residual effect will occur including consideration of the likelihood that the mitigation will be successful.	**Likely** – There is a moderate to high probability that the Heritage Resources will be affected. **Unlikely** – There is a low probability that Heritage Resources will be affected.

Table 11.3-5: Heritage Resources – Summary of the Characteristics Ratings for Residual Effect

Residual Effect Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Any residuals effects to Heritage Resources would be adverse as it indicates that there may be a negative effect to Heritage Resources.
Magnitude	Low	A minimal amount of change in the number of Heritage Resources in the Project Area is anticipated.
Geographic Extent	Project Area	The residual effect will be limited to the Project Area because ground disturbance is limited to the Project Area.
Duration	Long-term	Heritage Resources are non-renewable resources. Any impacts to heritage resources cannot be undone.

Residual Effect Characteristic	Rating	Summary Rationale for Rating
Frequency	Infrequent	Given the low number of Heritage Resources expected in the Project Area, residual effects would occur infrequently.
Reversibility	Irreversible	Heritage Resources are non-renewable resources. Any impacts to Heritage Resources cannot be undone.
Context	Moderate	Heritage Resources are often affected by environmental and socio-economic activities. However, given the low occurrence of Heritage Resources in the Project Area and the low interpretive value of the sites it is anticipated that mitigation measures using the HRMP will be adequate. Should the Project affect Heritage Resources, those effects cannot be undone.
Likelihood	Unlikely	Given the low number of Heritage Resources in the Project Area, the majority of activities that could disturb Heritage Resources are located in low heritage sensitive areas, and the implementation of the HRMP, it is unlikely that the residual effect, (i.e., destruction of Heritage Resources without proper assessment) will occur.

11.3.6.2 Significance and Confidence

The potential residual effect to Heritage Resources from the Project is anticipated to be **not significant**. There is a high level of confidence that the existing HRIAs and the HRMP will be able to mitigate any adverse residual effects.

11.3.6.3 Summary of Project-related Residual Adverse Effects on Heritage Resources

Following the implementation of the mitigation measures outlined in the HRMP, the likelihood of this residual effects is considered low and residual effects on Heritage Resources will occur infrequently and can be mitigated with the HRMP. Known archaeological resources identified in the Project Area were deemed to have low potential for archaeological interpretation and additional work or mitigation measures were not required for the sites; the HCB had no further concerns with these sites and work could proceed as planned. Should unknown archaeological and cultural resources be identified during the Project, effects will be mitigated using the HRMP. While effects to archaeological resources are irreversible, they can be mitigated by following the HRMP, by either avoiding additional damage to the resource by creating a buffer zone around the site, or by assessing the resource according to *The Heritage Property Act* to enable the full interpretation of the site before continuing with work (Government of Saskatchewan 2019). Furthermore, based on the low occurrence of known Heritage Resources in the Project Area (n=2), and the location of the Heritage Resources (near waterbodies, along an existing trail and away from the main developments), there is a low potential for the identification or disturbance of previously unknown archaeological sites throughout the life of the Project. Therefore, any residual effects (i.e., destruction of Heritage Resources) is considered to be negligible.

11.3.7 Cumulative Effects

It is highly unlikely that future projects will have the same footprint as the Project. Therefore, little to no potential for overlap exists between the Project and future projects and, therefore, low potential for cumulative effects on heritage resources.

11.3.8 Monitoring and Follow-up

During Project activities, all personal working on site should be made aware of the HRMP and the possibility of affecting unknown Heritage Resources. Should new Heritage Resources be identified, the HRMP should be followed and additional archaeological assessment and/or monitoring of ground disturbance activities may be required. Any changes to the Project (i.e., expansion of the Project Area or the addition of new infrastructure) that might affect Heritage Resources must be submitted to the HCB for their review, and additional HRIAs may be required.

11.3.9 Heritage Resources Summary

Two Heritage Resources were identified in the Project Area during the baseline studies. Both sites are single artifact finds and were considered to have low interpretive value. The HCB did not require additional assessments of the sites and work could proceed as planned. Potential residual effects of the Project to Heritage Resources could consist of a decrease in the number of Heritage Resources in the Project Area, due to destruction of a Heritage Resource during ground disturbance activities. Given the low number of Heritage Resources within the Project Area, LSA, and RSA, the likelihood of this residual effects is considered low and residual effects on Heritage Resources will occur infrequently. Any changes to the Project (i.e., expansion of the Project Area or the addition of new infrastructure) that might affect Heritage Resources must be submitted to the HCB for their review, and additional HRIAs may be required. An HRMP has been developed to mitigate effects to new Heritage Resources that may be identified during the life of the Project.

11.3.10 References

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Appendix 11-A Engagement Database Summary – Land and Resource Use

See file “S11_App 11-A Land and Resource Use Engagement_Wheeler River.pdf”

Appendix 11-B Heritage Resource Management Plan

See file “S11_App 11-B Heritage Resource Management Plan_Wheeler River.pdf”

Appendix 11-C Heritage Resources Baseline Report (2017)

See file “S11_App 11-C Heritage Resources Baseline Report (2017)_Wheeler River.pdf”

Appendix 11-D Heritage Resources Baseline Report (2019)

See file “S11_App 11-D Heritage Resources Baseline Report (2019)_Wheeler River.pdf”

Denison Mines

Wheeler River Project

Final Environmental Impact Statement

November 2024

Powering
PEOPLE, PARTNERSHIPS AND PASSION.

Wheeler River Project

Final Environmental Impact Statement

Section 12 – Quality of Life

November 2024

Denison Mines Corp.

345 4th Avenue South

Saskatoon, SK, S7K 1N3

Roadmap

This roadmap of the Wheeler River Project Environmental Impact Statement (EIS) has been provided to summarize the main document sections and appendices of the EIS.

Wheeler River Project
Environmental Impact Statement

Executive Summary

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Section 1: Project Introduction and Overview	Section 6: Atmospheric and Acoustic Environment	Section 10: Human Health	Section 14: Accidents and Malfunctions
Section 2: Project Description	Section 7: Geology and Groundwater	Section 11: Land and Resource Use	Section 15: Effects of the Environment on the Project
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Abbreviations, Acronyms, and Units

Abbreviation / Acronym	Definition
AADT	Average Annual Daily Traffic
CDC	Centers for Disease Control and Prevention
CEA	Cumulative Effects Assessment
CNSC	Canadian Nuclear Safety Commission
COI	Communities of Interest
COPC	Constituent of potential concern
CVMPP	Community Vitality Monitoring Partnership Process
Denison	Denison Mines Corp.
EA	Environmental Assessment
EFAP	Employee and Family Assistance Program
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ERFN	English River First Nation
FNIGC	First Nations Information Governance Centre
GDI	Gabriel Dumont Institute
IAA	Impact Assessment Agency of Canada
IK	Indigenous Knowledge
ILRU	Indigenous Land and Resource Use
ISR	In situ recovery
KI	Key Indicator
KML	Kineepik Métis Local #9
KPI	Key Person Interview
KYHR	Keewatin Yatthé Health Region
LK	Local Knowledge
LSA	Local Study Area
MCRHR	Mamawetan Churchill River Health Region
MIHRC	Mining Industry Human Resources Council
MN-S	Métis Nation-Saskatchewan
MOH	Ministry of Highways
MOHI	Ministry of Highways and Infrastructure
MP	Measurable Parameter
NAHO	Northern Aboriginal Health Organization
NR1	Northern Region 1

Abbreviation / Acronym	Definition
NR3	Northern Region 3
NWMO	Nuclear Waste Management Organization
OSU	Oregon State University
Project	Wheeler River Project
RCMP	Royal Canadian Mounted Police
RSA	Regional Study Area
SGI	Saskatchewan Government Insurance
SVS	Shared Value Solutions
TAADT	Truck Average Annual Daily Traffic
TK	Traditional Knowledge
UNDP	United Nations Development Programme
VC	Valued Component
WIPO	World Intellectual Property Organization

Units	Definition
ft	foot
ha	hectare
kg	kilogram
km	kilometre
km/hr	kilometre per hour
km^2	square kilometre
MvKm	million vehicle kilometres

Glossary

Term	Definition
Constituents of potential concern	Contaminant that could be released to the environment as a result of a project and that may change one or more of the environmental components (atmospheric, aquatic, terrestrial).
Indigenous Community of Interest	A community whose traditional land or potential or established Aboriginal and/ or Treaty rights are in proximity to the Project or has existing transportation infrastructure that would be used by the Project. An Indigenous Community of Interest is more likely to experience impacts from the Project.
Indigenous community	An Indigenous community with a potential interest in the Project, including any Indigenous community identified by a Regulatory Agency as having a potential interest in the Project.
Indigenous Knowledge	Indigenous Knowledge is also known as Aboriginal Traditional Knowledge and Traditional Ecological Knowledge. Generally, Aboriginal Traditional Knowledge is considered as a body of knowledge built up by a group of people through generations of living in close contact with nature. Aboriginal Traditional Knowledge is cumulative and dynamic. It builds upon the historic experiences of a people and adapts to social, economic, environmental, spiritual and political change.
Indigenous people	Section 35 of the *Constitution Act, 1867* defines the term "Aboriginal peoples of Canada" as referring to the First Nation, Inuit and Métis peoples of Canada. The term "Indigenous" is used interchangeably with "Aboriginal".
Key indicator	An important component or aspect of the Valued Component that is expected to be affected (changed) as a result of the Project.
Local Knowledge	Specialized knowledge developed through long-term association, interaction, and cumulative experience.
Measurable parameter	A parameter or metric associated with the Key Indicator that can be used to detect and measure Project-related changes.
Northern Saskatchewan Administration District	The Northern Saskatchewan Administration District is defined in the province of Saskatchewan's *Northern Municipalities Act, 2010.* The Northern Saskatchewan Administration District includes approximately 250,000 square kilometres (about 44% of Saskatchewan's land area) but is home to only 38,000 people or less than 4% of the province's population. Residents of the Northern Saskatchewan Administration District live in over 40 communities, which include incorporated municipalities (towns, villages, hamlets and settlements – most of which self-identify as Métis communities), First Nation reserves, and unincorporated areas. More than 80% of people who live in the Northern Saskatchewan Administration District self-identify as Indigenous.
Valued Components	Valued Components are aspects of the biophysical and human environments that may be affected (adversely or positively) by the Project. The value of a component not only relates to its role in the environment, but also the value people place on it.

12 Quality of Life

Section 12 of the Environmental Impact Statement (EIS) for the Wheeler River Project (the Project) is focused on Quality of Life. The integrated biophysical and human environment assessment approach is illustrated in Figure 12-1. As a guide for EIS reviewers, Figure 12-2 provides a preview of the Valued Components (VCs) associated with the assessments completed in this section of the EIS.

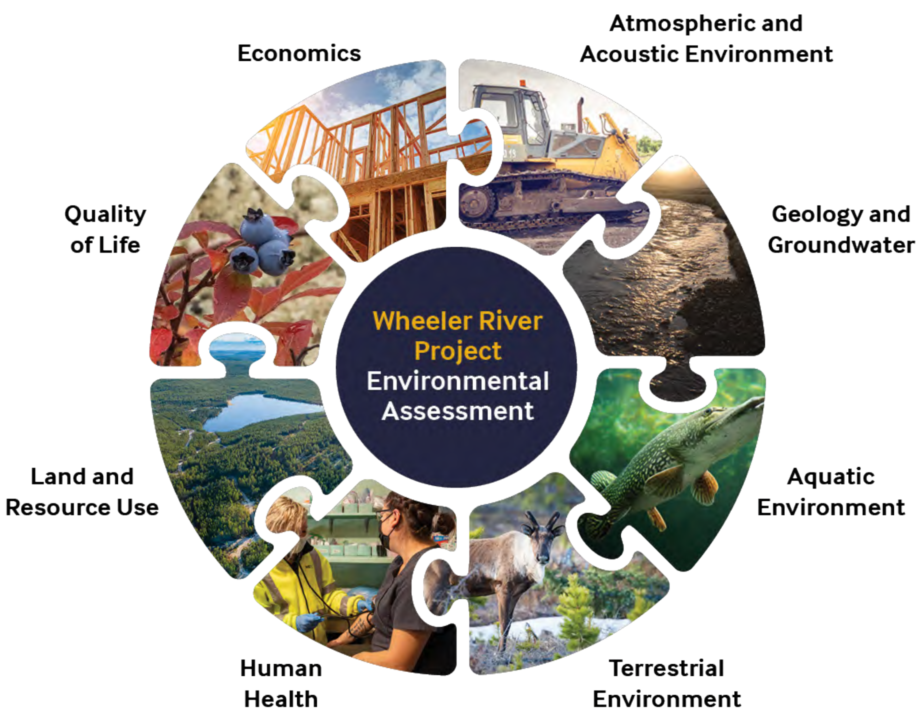

Figure 12-1: Biophysical and Human Environment Assessments for the Wheeler River Project Environmental Assessment

Figure 12-2: Quality of Life - Valued Components

12.1 Cultural Expression

Cultural expression is integral to the identities of Indigenous communities, embodying knowledge, skills, values, and beliefs. Cultural expression can be measured by several components, including land-based resource use and subsistence activities, dance, music, art, ceremonies, crafts, performances, and any other artistic or cultural expressions (WIPO n.d.). Cultural expression can be defined by forms in which a traditional culture is expressed, which are passed down for generations, and form part of the identity and heritage of an Indigenous community (WIPO n.d.). Further, the protection of cultural expression enhances cultural diversity and preserves cultural heritage (WIPO n.d.).

The expression of culture can be seen through land and resource use activities amongst traditional landscapes that are lived in, the travel routes and sites between them, and the relationships to those sites (Ehrlich 2012; NWT Cultural Places Program 2007). These activities support knowledge transmission and cultural continuity. Intergenerational transmission of knowledge encompasses people of all ages learning together and from one another, contributing to the preservation of culture and the development of social capital and cohesion (Generations Working Together n.d.).

For the Indigenous people in these communities, the ability to participate in such activities is a defining feature of their culture and identity; practicing the traditions of ancestors provides access to one's culture (ERFN and SVS 2022a; ERFN and SVS 2022b). The ability to speak ancestral languages allows for the continued ability to communicate with Elders and understand their culture (KML 2022).

12.1.1 Scope of the Assessment

The purpose of this subsection is to meet the Terms of Reference (EASB# 2019-005) requirements for the Project as issued by the Saskatchewan Ministry of Environment and Canadian Nuclear Safety Commission (CNSC). This subsection includes a detailed and comprehensive assessment of potential Project-specific effects and cumulative effects from the Project and other developments on the VC of Cultural Expression.

The assessment of Cultural Expression followed the overall approach and methods provided in Section 5 Approach and Methodology of the Assessment, which included the following primary steps:

Define the VC specific measurements: Sections 12.1.1.1 to 12.1.1.3 presents the specific approaches and methods used to measure and assess the effects of the Project on Cultural Expression as well as cumulative effects from the Project. This includes VC selection, identifying the Key Indicators (KIs) and Measurable Parameters (MPs), and defining the spatial and temporal boundaries for Cultural Expression.

Characterize existing conditions: Section 12.1.3 describes and characterizes existing conditions to provide context and a basis for evaluating potential changes to Cultural Expression caused by the Project.

Assessment of Project-related effects and mitigation measures: Sections 12.1.4 and 12.1.5 identify and summarize potential interactions between the Project and each VC and KI. The assessment then identifies and describes the potential Project-related effects and assesses the changes due to the Project (i.e., residual effects after mitigation) and their significance. Project VCs and/or activities with the potential to affect each VC are provided mitigation policies and actions committed to by the Denison Mines Corp. (Denison) to avoid or minimize potential adverse effects. A pathways analysis is used to focus further assessment on interactions between the Project and Cultural Expression by evaluating the different effect pathways to determine if, after incorporation of mitigation, there is still potential to cause residual adverse effects. Where potential adverse effects are adequately mitigated and are not forwarded for further analysis (i.e., where mitigation results in negligible effects or avoids the pathway altogether), the reasons for concluding the assessment at this stage are provided. Primary pathways anticipated to lead to residual adverse effects after incorporation of mitigation are carried forward to the next step for further analysis.

Residual effects evaluation and cumulative effects assessment (CEA): Sections 12.1.6 and 12.1.7 evaluate and describe the effects of the primary pathways from the Project on Cultural Expression. The residual effects analysis is presented as an integrated narrative that describes the effects of the Project over time and highlights predicted effects at the point when adverse effects of the Project are expected to be greatest. This section also completes an analysis of residual cumulative effects from the Project.

Monitoring and follow-up: Section 12.1.8 outlines the actions to verify predicted residual effects, evaluate effectiveness of planned mitigation designs, policies, and practices, and address key sources of uncertainty.

Figure 12.1-1 is a graphic representation of the assessment process used in this EIS.

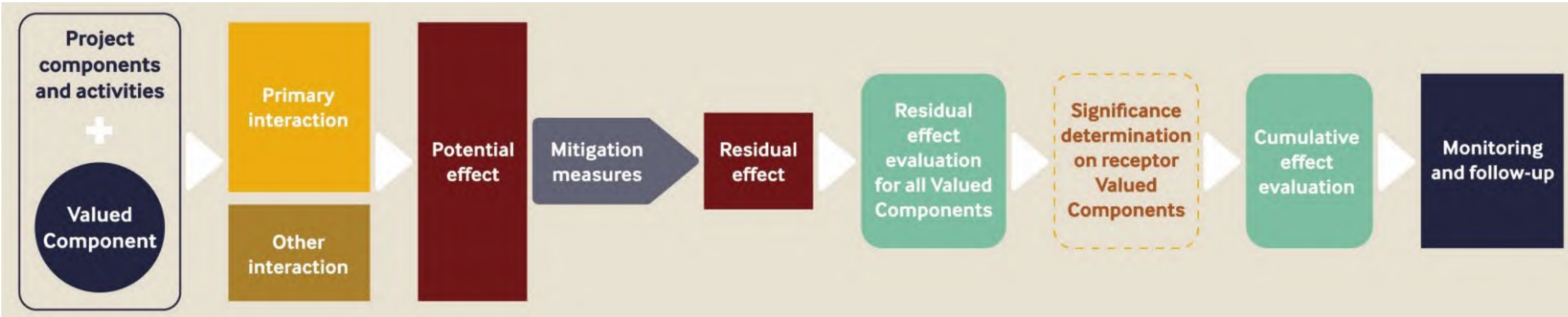

Figure 12.1-1: Environmental Assessment Process for the Wheeler River Project

12.1.1.1 Valued Component Selection

As per standard Environmental Assessment (EA) practice, this EA is organized by and focused on VCs. The VCs are aspects of the biophysical and socio-economic environments that will likely be affected (adversely or positively) by the Project. The VCs reflect identified scientific, Local Knowledge (LK) and Indigenous Knowledge (IK), and community interests regarding the Project and its potential effects. The VCs are typically identified early in the EA process as a result of questions and concerns raised through engagement with Indigenous and community groups, government departments and agencies, and the general public. Table 5-3.1 in Section 5 outlines the rationale for inclusion of Cultural Expression, including that Project activities may affect changes in culture and traditional ways of life. Cultural Expression is linked closely to Indigenous Land and Resource Use (ILRU), Community Well-being, and Economy (e.g., traditional economy). Figure 12.1-2 is a graphic representation of the main linkages among the Cultural Expression VC and other VCs, illustrating the flow of assessment information into and from the Cultural Expression VC.

Initial direction and input into VC selection were obtained through IK, LK, discussions with government agencies and the public, results of baseline studies, regional data from other EAs, results from engagement and consultation activity, and results from similar or recent projects in the region. To validate VC selection and as part of engagement activities, Denison sought feedback from the English River First Nation (ERFN)[1] and the Northern Village of Beauval, Northern Village of Pinehouse Lake, and Northern Hamlet of Patuanak (hereafter referred to as Beauval, Pinehouse, and Hamlet of Patuanak, respectively). As part of engagement activities for the Northern Village of Beauval and the Northern Village of Pinehouse Lake, Denison prepared and shared an online survey, which included information about Denison and the Project, and posed validation questions about the VCs being assessed as part of the EA process. Denison also met with the Métis Nation-Saskatchewan (MN-S) in early 2023 to share information about the Project, including discussion on VCs considered in the assessment; no new VCs were identified as part of that discussion.

[1] ERFN's Wapachewunak Reserve 192D is also referred to a Patuanak.

Figure 12.1-2: Integrated Assessment Approach - Key Connections between Cultural Expression and Other Valued Components

12.1.1.2 Key Indicators and Measurable Parameters

A KI, such as knowledge transmission, is an important aspect of a VC that may be affected by the Project and its activities. An MP is the metric associated with the KI that can be used to characterize changes to attributes of the environment that may change as a result of the Project and/or other human developments and natural factors. The changes in MPs are used to predict overall effects on the KIs, and in turn VCs. Two KIs and their associated MPs were identified for Cultural Expression (Table 12.1-1). The MN-S identified changes to Métis kinship ties and changes to Métis cultural practices as key indicators for consideration (MN-S and Two Worlds Consulting 2023).

Table 12.1-1: Key Indicators and Measurable Parameters for Cultural Expression

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Knowledge transmission	Project activities may affect opportunities for knowledge transmission on the land. This includes effects on language and land-based activities (such as hunting and gathering, travel, habitation, ceremonies, and cultural camps) where knowledge transmission occurs.	Changes to cultural practices that support knowledge transmission. Changes in the location of cultural practices that support knowledge transmission.
Traditional diet	Project activities may affect harvesting country foods (i.e., traditional foods), which support social bonds within families and communities and maintain cultural identities and traditional food systems.	Changes in availability of country foods included in a traditional diet. Changes in the perceived suitability and safety of country foods in a traditional diet.

12.1.1.3 Spatial and Temporal Boundaries

12.1.1.3.1 Spatial Boundaries

The spatial boundaries selected for Cultural Expression were chosen because they permit baseline characterization in sufficient detail to assess potential interactions between the Project and Cultural Expression. These boundaries were developed in consideration of where interactions are likely to occur. The spatial boundaries were derived based on the consideration of communities where Project recruitment is likely to be prioritized, consideration of previous EAs conducted in the region, and consideration of information shared through key persons during the Key Person Interview (KPI) program and the Traditional Land Use studies.

The Project Area is where all Project components/activities will be located. It is expected that all physical disturbances resulting from Construction, Operation, and Decommissioning will occur within this area or footprint. The Local Study Area (LSA) for Cultural Expression is based on documented land and resource use close to the Project site, and is reflective of uses by Indigenous communities in the LSA as described in Section 11.1. Consideration of pathways to Cultural Expression could change as a result of participation in the commuter rotation system. As such, the LSA is consistent with the LSA for Indigenous Land and Resource Use, which is described as the area established to assess the potential, largely direct effects of the Project on the environment. The LSA was delineated based on the area over which direct and indirect effects are most likely to occur on VCs. This includes the Project footprint plus the maximum combined extents of supporting VC RSAs, including Aquatic, Terrestrial, Noise, and Health, as changes in these components may affect the Indigenous resource use environment (see Table 11.1-2 for further detail). Community uses in the LSA include those documented by the ERFN (including Indian Reserves Wapachewunak 192D and La Plonge 192), the Métis Local #82 of Patuanak, and the Northern Hamlet of Patuanak (as described in *The Wheeler River Project: Métis Knowledge Study Report* [MN-S and Two Worlds Consulting 2023]); the Kineepik Métis Local (KML) #9 and the Northern Village of Pinehouse Lake; other Métis uses (as described in *The Wheeler River Project: Métis Knowledge Study Report* [MN-S and Two Worlds Consulting 2023]); and the Athabsasca Denesuline (as documented in *An Exploration of Recorded Athabasca Denesųłiné Traditional Knowledge, Land Use and Occupancy Information in the Vicinity of Denison Mines Wheeler River Project* [YNLR 2022]). As some pathways to Cultural Expression stem from participation in the commuter rotation system, the Regional Study Area (RSA) for Cultural Expression is the Northern Administrative District, Saskatchewan (Census Division 18), which would be considered as second priority for hiring after individuals from the Indigenous Communities of Interest. Figure 12.1-3 provides the location of the LSA and RSA.

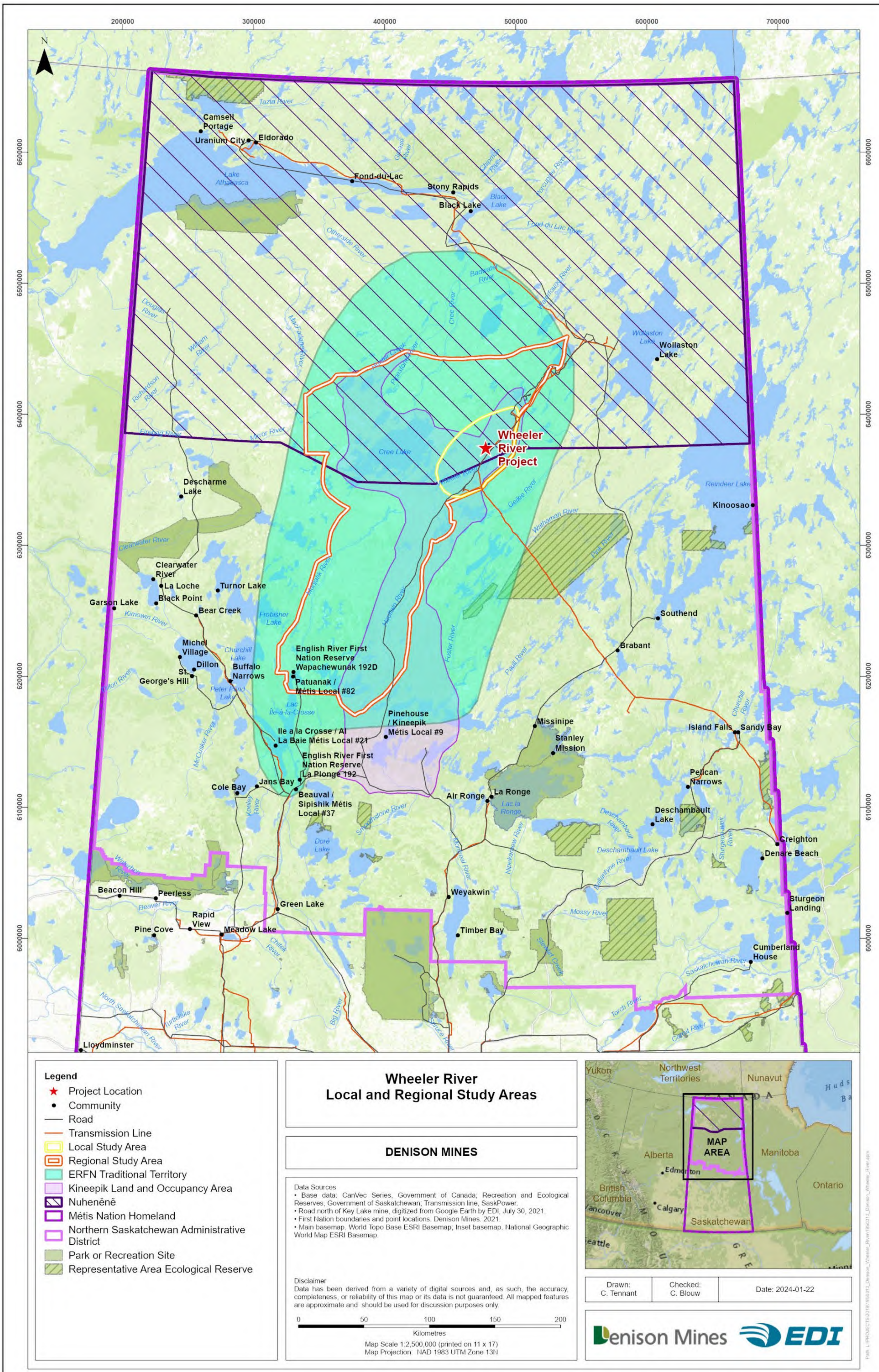

Figure 12.1-3: Location of the Project in Relation to the Communities in the Local Study Area

12.1.1.3.2 Temporal Boundaries

Temporal boundaries for characterizing the existing environment for Cultural Expression vary. The temporal scope of the assessment for all MPs of Cultural Expression are forward looking and include the period from initial Construction to the end of Decommissioning as defined by the following Project phases:

- Construction: includes site preparation; wellfield and freeze hole drilling; processing plant construction; other service infrastructure; and electrical infrastructure. The duration of Construction will be approximately two years.
- Operation: includes operation of the wellfield; operation of the processing plan and production; maintenance activities; water withdrawal from groundwater or surface water for potable use, fire suppression, and make-up water in the processing plant; water treatment; waste management; environmental monitoring; package and transport of nuclear substances; reporting to regulators; engagement; and site security. The duration of Operation will be approximately 15 years.
- Decommissioning: includes mining chamber remediation; decontamination; asset removal; demolition and disposal; and reclamation. The duration of Decommissioning will be approximately five years.

12.1.2 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

Indigenous Knowledge, LK, and engagement were collected documents supplied by Indigenous communities, through workshops, surveys, and KPIs identified in Section 3 Indigenous and Local Knowledge and Section 4 Engagement of the EIS. Indigenous Knowledge, LK, and engagement of the assessment are described in Section 3 and Section 4 of the EIS. Sources of information relevant to the influence on IK and LK include the *English River First Nation Wheeler River Project Summary of Health and Socio-Economy Study Results* (ERFN and SVS 2022a) and *Summary of Traditional Knowledge Study Results* (ERFN and SVS 2022b) and the *Kineepik Métis Local #9 and the Northern Village of Pinehouse Lake Kineepik Valued Ecosystem Components and Pre-statement for the Denison EIS* (KML 2022). Additional information relevant to IK and LK is provided in Section 11.

As part of engagement activities for the Northern Village of Beauval, and the Northern Village of Pinehouse Lake, Denison prepared and shared an online survey that included information about Denison and the Project, and posed validation questions about the VCs being assessed as part of the EA process. The survey is provided in Appendix 4-A in Section 4. The information related to the VCs was incorporated into the assessment and provided validation for inclusion of Cultural Expression through engagement processes. Comments provided through community engagement include:

- *"I always come from the Elders' perspective. Since 1906, the area where you're working has been Treaty 10 land. The first chief of English River was William Apesis. Those lands were the primary area of ERFN and contain burial sites and birth sites of ERFN members. The Dené name of the Wheeler River, Russell Lake and Cree Lake all come from the Denésuliné of English River. The Elders have always expressed that it's a primary area of ERFN. One of our late Elders was born north of there in 1922. Our traditional gathering place is there"* (18-EN-ERFN-5.1); and
- *"I chose those to emphasize how we value our eco system and to protect our traditional territory and please try to establish a resource management camp at KM 160 ON KEY LAKE ROAD, to have young teen agers get to know about wildlife and names and characteristics of each wildlife, forestry and know all the names and traditional use of each trees and all the plants, fish species and aquatic ... these are important for all young people to know... get ahold of integrated resource management to assist with how they teach resource management"* (21-EN-ERFNSUR-456.29).

12.1.2.1 English River First Nation

Indigenous Knowledge (referred to as Traditional Knowledge or TK by the ERFN) was provided by the ERFN for consideration in the EIS. This included several reports:

- *Wheeler River Project – Summary of Health and Socio-Economic Study Results,* which summarizes results from 16 interviews that were conducted for the health and socio-economic topics (ERFN and SVS 2022a).
- *Wheeler River Project - Summary of Traditional Knowledge Study Results*, which analyzed and presented results from 21 land use interviews that provided both IK and LK and included details on the ERFN's resource harvesting locations, species harvested, travel routes, cabins and special sites (ERFN and SVS 2022b).
- *The English River First Nation Country Foods Study Final Report* (CanNorth 2017), which was conducted in 2016 through funding secured from the First Nations Environmental Contaminants Program to complete a country foods study. The study involved three components: a dietary study, a sampling program, and a human health risk evaluation. The overall study objectives were to examine country food usage by ERFN community members and to assess if the country foods are safe to eat. The involvement of ERFN community members was one of the fundamental goals of the study, which relied heavily on TK to identify what and where to sample.
- *The English River First Nation Aboriginal Traditional Knowledge Summary Report* (ERFN 2011), which is a report compiled by Environment Canada on behalf of ERFN to summarize information for the purposes of recovery of the woodland boreal caribou population. Ten individuals (mostly Elders) were selected by ERFN to complete TK interviews to understand boreal caribou in the English River Traditional Territory.

Local Knowledge also was provided by an ERFN trapper, fisher, and resource harvester (ERFN Trapper) who resided in and conducted resource use in the Project Area. Unfortunately, prior to the filing of the EIS, the ERFN Trapper passed away.

12.1.2.2 Kineepik Métis Local #9 at the Northern Village of Pinehouse

The KML #9 at the Northern Village of Pinehouse submitted several documents to support the consideration of IK in the EIS.

- Kineepik Valued Ecosystem Components – KML Pre-statement for Denison EIS. While an overall consensus of support exists for the Project, two of the primary interests raised the need to have *"confidence in the continued success of the new mining application [in situ recovery or ISR] on [their] traditional territories*" and the potential cumulative effects to land use and land users due to the Highway 914 extension project (KML 2022). The KML have indicated that they are responsible for all proponent and industrial activity that occur in their land and occupancy area (KML 2022).
- The KML #9 (Pinehouse) hired Tobias and Associates to produce a Pinehouse land use and occupancy map survey in 2011 (Northern Village of Pinehouse 2011) and update it in 2018, which produced two ESRI geodatabase files containing that use.
- The KML #9 (Pinehouse) also prepared a "Response to the Environment Impact Assessment For the proposed Ministry of Highways 914 Extension Project", which specified ILRU use in the Project Area and identified concerns about ILRU in combination with the Highway 914 extension project (KML and Limnos Environmental 2022).

12.1.2.3 The Ya'thi Néné Lands and Resources Office on Behalf of Athabasca Communities

The YNLR submitted a report entitled *An Exploration of Recorded Athabasca Denesųłiné Traditional Knowledge, Land Use and Occupancy Information in the Vicinity of Denison Mines Wheeler River Project* in March 2022 (YNLR 2022). Denison requested the inclusion of this report into the EIS. The report focused primarily on the Athabasca Denesųłiné First Nations, including Hatchet Lake, Black Lake, and Fond du Lac. Indigenous Knowledge and LK within this report, as well as publicly available information, were integrated into the EIS with focus on the Athabasca Denesųłiné communities. This report is an amalgamation of known information from the YNLR and was not collected explicitly for the purposes of the Project. As such, it should be interpreted with caution. With approval from the YNLR, the March 2022 report is included as an appendix to the EIS (see Section 3 Indigenous and Local Knowledge, Appendix 3-A).

12.1.2.4 Métis Nation-Saskatchewan

The MN-S submitted *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) to Denison in October 2023. The Métis knowledge summarized therein included secondary literature approved for use by the MN-S and primary information collected during interviews with nine Métis citizens from Northern Region 1 (NR1) and Northern Region 3 (NR3), exclusive of information from the KML at Pinehouse Lake who formally revoked its delegated Duty to Consult from the MN-S.

12.1.2.5 Other Sources of Information and Local Knowledge

Engagement data, IK, and LK were also sourced from an Engagement Database, which is updated continuously. Engagement, LK, and IK comments are stored in the Engagement Database for integration into the existing environment and assessment sections. Within the database, records are given unique identification numbers (e.g., 18-EN-ERFN-5.1). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment. Appendix 12-A provides a summary of unique identification numbers referenced within Section 12.1.

Local Knowledge information was also sourced from the:

- Millennium Uranium Project EIS (Cameco 2013), which was completed prior to the project being put on hold in 2014 (CNSC 2019); and
- socio-economic baseline annex for the McArthur River Expansion Project (Cameco 2012).

Other secondary sources of information included land use studies, planning processes, other EIS, and community-based studies. For example, community profiles were prepared for ERFN at Patuanak (DPRA 2013a), and the Village of Pinehouse (DPRA 2013b) on behalf of the Nuclear Waste Management Organization.

12.1.3 Existing Environment

12.1.3.1 Methods

This subsection provides a description of cultural activities that Indigenous people in the LSA (the ERFN and the Métis Local #82 of Patuanak and the Northern Hamlet of Patuanak, and the KML #9 of Pinehouse Lake and the Northern Village of Pinehouse Lake) take part in and how these activities support Cultural Expression.

Understanding the current state of cultural activities and language in these communities can contribute to their longevity (FNIGC 2018). Cultural Expression in this context includes consideration of ILRU, travel routes, habitation patterns, languages, land-based programming and supports, and traditional diet. These activities also contribute to the physical, emotional, mental, and spiritual well-being of individuals and their community (FNIGC 2018). Without the ability to practice these activities, cultural continuity or cultural revitalization cannot exist (ERFN and SVS 2022a).

The characterization of the existing environment for Cultural Expression includes both primary and secondary data sources. Data collection began with a review of existing literature and databases from a variety of public sources. Primary data collection was undertaken in the form of KPIs. Online surveys, workshops, and other forms of engagement also assisted in identifying community interests and concerns relative to existing conditions.

Literature Review

The review of literature and databases included the following sources:

- regional level documents;
- community profiles; and
- publicly available profiles, reports, and EAs of past projects in the area.

The most recent data from these sources were used to characterize the existing environment.

12.1.3.2 Results

The KIs for Cultural Expression are described by community.

The KI, knowledge transmission, encompasses cultural activities and practices that provide an opportunity for knowledge sharing among family and community members. This includes Indigenous land based cultural practices, travel routes, language, and land-based programming and supports. The existing conditions of these activities and practices in ERFN are presented separately below.

The KI, traditional diet, summarizes country foods that are important to a traditional diet and the importance of a traditional diet to communities and their members.

12.1.3.2.1 English River First Nation

Key Indicator: Knowledge Transmission

Land-based Cultural Practices

The ERFN practices key cultural activities on the land throughout the year, include hunting, fishing, trapping, gathering food and medicine, smoking harvested meat and fish, and making birch bark baskets (ERFN and SVS 2022b). These activities are often a community event, such as sharing the harvests with the community. By practicing these activities, ERFN members can strengthen their spiritual health, as spiritual health is often determined by the tie one feels to their traditional culture (ERFN and SVS 2022a). Members of the ERFN have spoken about their cultural connection to the land and waters that surround them:

> *"The connection to the land, like the Elders have mentioned and I have mentioned, it's like our plate; it gives us everything. The land gives us the food that we need, it gives us the clothing that we need, it gives us the heartbeat that we need. The trees in the area also provide us with shelter and also provide us with medicines in the area. So that's really critical to us. The waters are also very important to us; without the waters, we're not alive, and that's one of the things. The forestry itself, it creates*

> *life, because the medicines we get from them is really important to us, the traditional medicines."* (ERFN and SVS 2022b)

Dene and Cree are orally-based knowledge systems that rely on connection to the land and are vital to cultural and social traditions within the community. Being on the Nuhtsiye-kwi Benéne ("Ancestral Lands" in Dene) of ERFN supports use by Dene and Cree, the main way through which knowledge is passed from generation to generation (ERFN and SVS 2022a).

> *"But my relation to the land is based on respect. I know that we're not the only ones on this earth, that was taught to us by our parents and our grandparents, and so because of that those kind of values kind of stick to your mind for the rest of your life."* (ERFN and SVS 2022b)

Before colonization, TK guided the ERFN lifestyle. English River First Nation members continue to work on growing and sharing TK while practicing land-based traditions, as TK remains foundational to their culture and the strengthening of their spiritual health (ERFN and SVS 2022a). In particular, harvesting, using, and sharing medicine for traditional ERFN treatments is an activity ERFN members emphasize as important to their spiritual and cultural connections (ERFN and SVS 2022b). Traditional medicines, such as rat root, spruce gum, sweet grass, and tree species including birch and tamarack, play a significant role in Denesųłiné and Cree ways of life, as the perceived purity and abundance of traditional medicines contribute to the vitality of ERFN culture and health (CanNorth 2017). Integrating key cultural practices such as the gathering and use of traditional medicines into the modern ERFN lifestyle supports cultural continuity.

> *"The lands and waters, we are definitely connected as peoples of English River. If we don't have the lands, we are not connected. If we don't have the water… Water is life to us*." (ERFN and SVS 2022b)

Travel Routes

Members of the ERFN access and use their land and resources via traditional travel routes and habitation sites. Travel routes and habitation sites/patterns (e.g., cabins and camps) provide understanding of the spiritual and cultural relationship Indigenous communities have with their landscape. This relationship helps to create a sense of place and shared sense of belonging (Section 11.1.3.2 in Section 11). Several ERFN members travel and use sites along the Churchill River system for trapping, and subsistence hunting and fishing; these river systems have been used for thousands of years (Cameco 2012, CanNorth 2017). Use of these waterways is important for practicing traditional activities, as they serve as traditional corridors that, at one point, established the boundaries of their territories (Cameco 2012). The community also uses Highway 914 to travel to parts of their territory that historically required access by waterway, float plane, or dog sled (Cameco 2012). Access beyond the Key Lake gate is currently restricted, although some members of ERFN are provided access to the Key Lake - McArthur River mine haul road if they are on the

Ministry of Environment list or have received a gate access pass. Some resource users are reported as using the decommissioned Fox Lake road to access northern areas of their Nuhtsiye-kwi Benéne. English River First Nation members drive trucks along the Fox Lake road to the Davis Creek bridge, where they need transfer to quad or snowmobiles (ERFN and SVS 2022b).

Language

The ERFN dialects, Denesųłiné and Cree, remain a part of the community's traditions and identity (ERFN and SVS 2022a). Although a decline has occurred in the number of traditional language speakers in ERFN, the community has a strong desire to revitalize its traditional languages (ERFN and SVS 2022a). The ERFN has been working on language revitalization through land-based cultural and language programs for youth, including an annual culture camp and culture conferences for students. Other methods for revitalization include hiring a culture teacher for St. Louis School in Patuanak and using a Denesųłiné language learning application from the Meadow Lake Tribal Council (ERFN and SVS 2022a).

Land-Based Programming and Supports

The ERFN's culture camp contributes to preserving the longevity of the Denesųłiné and Cree languages along with facilitating Elder-youth interactions that lead to storytelling, knowledge sharing, and land-based activities such as target practice, moose hunting, fishing, berry picking, and nature walks. The ERFN culture camp is located at Kilometre 160 of Highway 914 where it crosses the Haultain River. Each September during the community moose hunt, the St. Louis School hosts a camp for students at a Haultain River cabin (Cameco 2013). The autumn season also sees families gather in the area to camp along the Haultain River and the highway, as well as locations near the main camp with historic resource ties, for two weeks or more (Cameco 2012). More culture camps have also been reported to occur in July (one week for families and one week for Elders) and in the winter (DPRA 2013a). The camp remains a key gathering place for the cultural expression of ERFN members (CanNorth 2017).

Former ERFN Chief McIntyre expressed the importance of the cultural camp: "*For many years I've invited (the media) to come to our gathering on the Key Lake road, to showcase and impress on the world that we're still using those areas*" (18-EN-ERFN-5.3). The culture teacher and conference at St. Louis School is another program leading the revitalization of ERFN culture and language. The culture teacher organizes the annual conference where community Elders teach students land-based skills and activities (ERFN and SVS 2022a). The conference was still held even in the midst of the COVID-19 pandemic, where Elders were recorded teaching traditional activities.

Other community cultural activities in ERFN include: Treaty Days, Pilgrimage in the Grotto, Lac St. Anne Pilgrimage in Alberta, and the Youth Conference, where ERFN and other First Nations communities come together to promote the continued practice of traditional activities (NWMO 2013a).

Key Indicator: Traditional Diet

Moose is the most consumed mammal species by ERFN members throughout the year, with species such as snowshoe hare and woodland caribou being eaten somewhat less frequently (CanNorth 2017). Other important components of diet are fish, and traditional fruits including blueberries, raspberries, bog cranberries, and saskatoon berries, which are predominantly eaten during warmer months (CanNorth 2017). Access to the land where meat, fish, and berries can be harvested is critical to ERFN's consumption of country foods, and, therefore, the expression of their culture (CanNorth 2017). Some ERFN Elders and older adults perceive that living closer to the land, as they did in the past, was healthier due to relying on better quality foods and the need to work hard to acquire them (Cameco 2012).

12.1.3.2.2 Kineepik Métis Local #9 (Pinehouse)

The KML # 9 is closely tied with the Northern Village of Pinehouse. "*As of 2011, Kineepik Métis Local #9 (Pinehouse) has a population of 1,600 people, of which 1,500 live on the (Northern Village of Pinehouse) municipality and 200 living either in other jurisdictions or on the land surrounding the community*" (KML 2022).

Key Indicator: Knowledge Transmission

Land-based Cultural Practices

Land and resource use is increasingly important to the healing and social development of Pinehouse: "*this is where our cultural identity and values are nursed*" (Northern Village of Pinehouse 2011 p.52). The traditional land used by the people of Pinehouse is centred at Pinehouse Lake, but their uses extend to the lands surrounding the Churchill River watershed for shelter, materials, and gathering food (Cameco 2012). The people of Pinehouse have been accessing these resources on the land since time immemorial (KML 2022). Traditional activities carried in the land include hunting, fishing, berry picking, gathering medicinal plants, and canoeing (Cameco 2012).

Pinehouse's cultural heritage remains active and vital in the community today, through several means. For example, Pinehouse Lake is the centre of ceremonial and burial sites and has traditional canoe routes and trapping cabins used by the Village, all of which mark cultural heritage in the community (NWMO 2013b). Pinehouse residents continue to frequently use the surrounding land, cabins, and the lake to access camp sites (Cameco 2012).

Habitation Patterns

People of Pinehouse access and use their land and resources via traditional travel routes and habitation sites. The traditional lands of the residents of Pinehouse Lake extend beyond Cree Lake to the north, reach Besnard Lake to Black Bear Lake to Costigan Lake to Russell Lake in the east, stretch past Knee Lake (on the Churchill River) up to Haultain Lake and Mayson Lake to the west, and to Tippo and Emmeline Lake in the south (Northern Village of Pinehouse 2011). These lakes have been a centre for community activities for generations (Northern Village of Pinehouse 2011). Gordon Lake, in particular, was noted as a community gathering place for residents (Cameco 2012).

Habitation sites of the people of Pinehouse are largely found at Russell Lake; there are roughly 10 tents (2 with a stove and 8 without a stove), 2 shack-tents, and 2 other overnight sites surrounding the lake (Tobias and Associates 2018). Pinehouse has reported that "*all the lakes are accessible by trail, road, or canoe routes. There are traditional bush cabins dotted all over them*" (Northern Village of Pinehouse 2011). The cabins have served as locations where the intergenerational transfer of knowledge can take place, where people of Pinehouse have raised their children, teaching them to harvest moose, snare rabbits, and smoke fish.

Surrounding the cabins are sacred areas. The people of Pinehouse find being on the land and water in these areas peaceful and spiritual, connecting them to their ancestral past and contributing to cultural continuity (Northern Village of Pinehouse 2011).

Language

The proportion of the population speaking an Indigenous language in Pinehouse is greater than anywhere else in northern Saskatchewan or the province (NWMO 2013b). Pinehouse primarily speaks Cree and has identified maintenance of the Cree language as a community priority and key issue (NWMO 2013b). According to Pinehouse and the KML #9, loss of the Cree language can mean the loss of ability to communicate with Elders, a loss of cultural understanding, and a loss of connection to land (KML 2022). By putting initiatives in place to immerse youth into the language, Pinehouse may revitalize what has already been lost (KML 2022).

Land-Based Programming and Supports

Kineepik Métis Local #9 and Pinehouse are providing opportunities to reconnect with Indigenous identity through a Reclaiming Our Community model (KML 2022). The model has been in place for nearly 11 years. Pinehouse hosts week-long cultural camps for youth, Elders, and families, in both the winter and summer months (InterGroup 2011a). Two annual camps are held for Elders at Gordon Lake, one in the summer and one in the fall. Youth camps are held at Muskeg Lake and family camps are held further north on Highway 914 at km 67 (InterGroup 2011a). Camps held for Elders can be attended by up to 60 participants, while youth camp participation ranges anywhere from 20 to 60 individuals (InterGroup 2011a). Pinehouse's multi-generational culture camps help educate residents as they share food and stories, while preserving traditional practices, ways of knowing, and the cultural heritage of the community (Cameco 2012, NWMO 2013b). Kineepik Métis Local #9 and Pinehouse have also developed a cultural calendar, which is comprised of their current annual traditional activities (KML 2022). The cultural calendar includes the celebrations of cultural events that bring pride to community, including the Elders gathering and the km 67 gathering, among others (KML 2022).

Pinehouse has a Circle of Courage that works to improve community pride and self-esteem through the use of cultural teachings, such as how to hunt, fish, or prepare wild food (Cameco 2012). Pinehouse is also collaborating on a program with the school, where Elders teach TK and skills to students (Cameco 2012).

12.1.3.2.3 Métis Nation-Saskatchewan

Key Indicator: Knowledge Transmission

Central to the Métis way of life are the concepts of whakotowin, the responsibility to family, and kiyokewin, the practice of visiting, where social visits maintain kinship relations and facilitate knowledge transmission (Flaminio, Gaudet, and Dorion 2020; Raymond 2013). *The Wheeler River Project: Métis Knowledge Study Report* described the importance of knowledge transmission and Métis teachings (MN-S and Two Worlds Consulting 2023). For example, hunting is important for knowledge transmission and Métis teachings as it is linked to other land use activities, such as camping, which is an activity often done with grandparents, parents, and children. The practice of hunting and camping with children and the continued utilization of intergenerational campsites and trails reflects the shared value to keep Métis traditions and land and resource use practices alive (Joubert 2008).

Land-based Cultural Practices

For the Métis, kinship relationships and relationships to the land are paramount. Traditional activities are a crucial component to Métis cultural, spiritual, and community well-being. *The Wheeler River Project: Métis Knowledge Study Report* indicated that land-based cultural activities have included, and continue to include, traplines, fishing, ceremonial spaces, and gathering of medicinal and cultural plants. Métis land-based activities are deeply rooted in the cultural heritage and way of life of the Métis people (MN-S and Two Worlds Consulting 2023). These activities encompass a wide range of practices that connect Métis individuals and families to the land and foster a sense of belonging, sustainability, and cultural continuity (Flaminio, Gaudet, and Dorion 2020).

Fishing, hunting and trapping, gardening, and gathering were all activities that sustained physical needs and upheld spiritual and social dimensions crucial to Métis identity (MN-S and Two Worlds Consulting 2023). Historically, these activities reflected a reliance on the natural environment to sustain both family and the Métis economy, such as the fur trade (MN-S and Two Worlds Consulting 2023).

Habitation Patterns

The Northern Saskatchewan Administrative District includes MN-S NR1, Northern Region 2, NR3, and Eastern Region 1. The LSA communities are located within NR3 and the Project is located within NR1.

The Métis Homeland emerged during the fur trade in areas uniquely used by the Métis people for sustenance living and economic trade. The Métis Homeland is characterized by a deep attachment to specific regions, such as the Red River Valley in Manitoba or the South Saskatchewan River area. *The Wheeler River Project: Métis Knowledge Study Report* described that the Métis people have struggled to secure consistent legal recognition of their identities and rights, which are inherently community-based and reflect the land where they were born. The absence of comprehensive land treaties for the Métis has led to legal disputes over land ownership and resource management. Today, Métis claim their Homeland stretches from western Ontario to eastern British Columba, including southern Northwest Territories and the three prairie provinces. (MN-S and Two Worlds Consulting 2023).

Central to the Métis is the theme of landlessness, which may profoundly affect their social, economic, and cultural development. With the creation of the Canadian prairie provinces and the settlement of the prairies by Europeans, the Métis were dispersed from their communities (MN-S and Two Worlds Consulting 2023).

The Métis use cabins and camp sites in their travels across the Homeland.

> *"These activities are distinct from contemporary notions of camping and outdoor activities as they are inherently for land-based and cultural activities including hunting, gathering and fishing. Historically, Métis were understood as a 'highly mobile population' and the notions of mobility and kinship are integral parts of Métis Culture (McNab and Arlen 1992)"* (MN-S and Two Worlds Consulting 2023).

The Métis travelled from their cabins along Highway 914, accessing camps in areas south of the Key Lake gate, west of Key Lake on the Fox Lake Road, and on Russell Lake. Cabins are located near the McArthur River Road, near Foster Lake, and at km 160 near the Haultain River (MN-S and Two Worlds Consulting 2023). Many of these locations are consistent with camps and locations identified by the ERFN and KML# 9.

Language

Michif is a distinct language, combining French and Cree, and evolved from communication between Indigenous mothers and European fathers, although Métis spoke many Indigenous languages through intermarriage among regions (MN-S and Two Worlds Consulting 2023).

The Wheeler River Project: Métis Knowledge Study Report described the importance of storytelling as a time-honoured concept among Métis, wherein oral histories would be communicated to all and for any guests that might be present (Gabriel Dumont Institute 2022). The same stories would be repeated year after year, becoming living oral maps. With each telling, listeners would be provided the opportunity to understand things differently as they aged and gained experience (Gabriel Dumont Institute 2022).

Land-based Programming and Supports

Participants in *The Wheeler River Project: Métis Knowledge Study Report* noted overlap with cultural camps, such as those located near Patuanak or Kilometer 160 of the Key Lake Road (MN-S and Two Worlds Consulting 2023). This camp is understood to be that of the ERFN (Section 12.1.3.2.1), demonstrating the kinship ties the Métis maintain with their "extended First Nations relations" (MN-S and Two Worlds Consulting 2023).

Key Indicator: Traditional Diet

Among Métis in NR1 and NR3, there is a collective understanding that moose and caribou are an important cultural food source and are supplemented with smaller game, such as mallard ducks in the summer and geese in the fall. Hunting supports harvesters, their families, Elders, and sometimes whole communities. Quantity depends on the abundance of resources available, how challenging the resources are to harvest, and the need for additional food (MN-S and Two Worlds Consulting 2023). Métis harvesters hunt what is necessary (i.e., not for sport) and save resources for future need. Hunting and reciprocity are closely tied among Métis; Métis harvesters may share their game if another harvester is unsuccessful during a hunt. These practices reflect the foundational understanding of wahkotowin (kinship roles and responsibilities) and the importance of taking care of each other through food sharing and making sure enough resources are leftover to avoid overconsumption (Flaminio, Gaudet, and Dorion 2020). *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) notes that Métis Elders are now more reluctant to harvest proximal to uranium mines.

12.1.3.2.4 Athabasca Denesųłiné Communities

Key Indicator: Knowledge Transmission

Land-based Cultural Practices

Land and resource use is important to the Athabasca Denesųłiné communities. Traditional activities carried out on the land included hunting, fishing, berry picking, and others.

A careful review of the local map of recorded Athabasca Denesųłiné land use information in the vicinity of the Project (YNLR 2022) illustrated one harvest site of large game on the shore of Russell Lake, and one big harvest site proximal to Key Lake in the LSA. The timeframe of these harvests is not known; however, use was recorded over the last 20 years. No other harvests are recorded in the LSA, including harvests of small game, woodland caribou, fish, berries, or wood. Woodland caribou were sighted by Athabasca Denesųłiné members in the LSA and tracks have also been observed but no harvests were documented (YNLR 2022) (see Section 11.1.3.2.4 for further details).

Important sites were recorded on the YNLR (2022) local map of recorded Athabasca Denesųłiné land use information in the vicinity of the Project, including overnight (tent) sites near Holgar and McIntyre lakes located within the LSA and east of Cree Lake.

Habitation Patterns

The Project is in the Nuhenéné, the traditional territory of the Athabasca Denesųłiné, on land within Treaty 10. Hatchet Lake First Nation is a signatory to Treaty 10. Fond du Lac First Nation and Black Lake First Nation are signatories to Treaty 8.

> *"Athabasca Denesųłiné culture, history and way of life are interwoven with the movements and health of the Beverly, Ahiak, Bathurst and Qamanirjuaq barren-ground caribou herds. (They) are so intrinsically tied that it is often stated that Caribou are Dene; Dene are Caribou"* (YNLR 2022).

Residents of the Fond du Lac and Black Lake areas follow the Beverly herd, while residents of Hatchet Lake/Wollaston Lake tend to follow the Qamanirjuaq herd (Meyer 1981). Due to unpredictable patterns of caribou migration, residents of the Athabasca region must sometimes travel into the Northwest Territories and Nunavut to hunt; however, some years the herds travel as far south as Wollaston Lake (InterGroup 2011b). The Beverly and Qamanirjuaq herds do not typically travel far enough south to include the area of most uranium mining operations within their territories (InterGroup 2011b).

Current sites, such as cabins, were not documented in the LSA. Camping sites and navigation routes were documented based on historic use of the LSA by the Hatchet Lake First Nation. Trees and plants also have cultural significance, including medicinal, ceremonial, and spiritual uses (InterGroup 2011b).

Travel Routes

A network of traditional travel routes is documented in the LSA. As part of engagement activities undertaken by Denison with the YNLR and First Nation Chiefs, travel by a Hatchet Lake First Nation Elder from Hatchet Lake to the area near Russell Lake and the Highrock River was described as an area the nation has connections to. Also, the area towards Cree Lake and the Gieke River are areas where the Dene travelled.

<u>Key Indicator: Traditional Diet</u>

Barren-ground caribou is the most important resource for the people of the Athabasca region and residents continue to harvest caribou for domestic purposes. Residents also harvest moose, black bear, and waterfowl. Modern times have reduced dependency on the caribou herds for survival, but the animal remains an important part of the culture and lifestyle of the people in the Athabasca region. The high cost of transporting food and other goods to remote communities means that caribou meat, along with other wild foods, remains an important source of country food (BQCMB

2021) The Beverly and Qamanirjuaq herds do not typically travel far enough south to include the area of most uranium mining operations within their territories (InterGroup 2011b).

Fishing for domestic use occurs throughout the year for various species. Lake Whitefish is a preferred fish species because it is easily smoked (InterGroup 2011b). Other food species used include Lake Trout, Walleye, Northern Pike, Arctic Grayling, and suckers. Fish have been a vital part of traditional life in the Athabasca region and continue to be prepared for consumption based on local, social, and cultural practices (Marles et al. 2000; InterGroup 2011b).

Good berry picking spots are actively used around Athabasca Denesųłiné communities and on traplines (InterGroup 2011b). Berry picking is also done opportunistically while out on the land.

12.1.4 Assessment of Project-related Effects

12.1.4.1 Potential Project – Valued Component and Key Indicator Interactions

Potential interactions between Project components and activities and Cultural Expression and its associated KIs were considered for all phases of the Project in the LSA and RSA, with emphasis on changes in the LSA. The potential interactions between Project components and activities and the Cultural Expression VC are summarized in Table 12.1-2.

The identification of Project components and activities and their potential interactions with the Cultural Expression VC is based on IK, LK, discussions with Indigenous groups, government agencies and the public, KPIs for the Project, the professional judgment of members of the Project team, and consideration of existing conditions in the study areas for the VCs and KIs.

Potential interactions in Table 12.1-2 are ranked as:

- **Primary Interaction** (✓): Project activity is expected to interact with the VC/KI, which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- **Other Interaction (✓):** Project activity is expected to interact with the VC/KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- **No Interaction:** Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

Pathways to effects and potential effects prior to mitigation are described in Section 12.1.4.2.

Table 12.1-2: Potential Project Interactions for Cultural Expression

Project Phase/Activity	Cultural Expression	
	Key Indicator #1: Knowledge Transmission	Key Indicator #2: Traditional Diet
Construction Activities		
Development of access roads and air strip	✓	✓
Site preparation and earthworks; clearing, leveling and grading of the project area	✓	✓
Power generation – generators	✓	✓
Installation of main substation and distribution of power around site	✓	✓
Wellfield and freeze hole drilling; ground freezing	✓	✓
Ground freezing	✓	✓
Batch plant operation (concrete); crusher at borrow area		
Development of surface infrastructure (camp, operations centre, plants, ponds, pads, and support facilities)	✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)	✓	✓
Water management (including treatment and site runoff)	✓	✓
Groundwater supply	✓	✓
Surface water withdrawal	✓	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	✓	✓
On-site and off-site operation of vehicles and transport of materials	✓	✓
Air transportation for workers	✓	✓
Regulatory site inspections		
Engagement – site visit from Interested Parties		
Employment and Expenditures[1]		
Operation Activities		
Operation of the ISR wellfield	✓	✓
Wellfield and freeze wall drilling	✓	✓
Operation and expansion of freeze wall		
Batch plant operation (grout and cement); crusher in borrow area	✓	✓
Expansion of pond and pads	✓	✓
Operation of the processing plant and production of uranium concentrate	✓	✓
Water withdrawal from groundwater or surface water body	✓	✓
Management of surface water (including seepage and site run-off)	✓	✓
Water treatment, both domestic and industrial	✓	✓
Water release to surface water body	✓	✓

Project Phase/Activity	Cultural Expression	
	Key Indicator #1: Knowledge Transmission	Key Indicator #2: Traditional Diet
Waste management (composting, domestic and industrial landfill operation, recycling)	✓	✓
Hazardous waste management (temporary storage, handling, and off-site transportation)	✓	✓
Storage and disposal of drill waste rock, process precipitates and industrial wastewater treatment plant precipitates	✓	✓
On-site and off-site operation of vehicles and transport of materials	✓	✓
Power supply – primarily power from the grid, also generators and back-up generators	✓	✓
Package and transport of nuclear substances	✓	✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)	✓	✓
Air transportation for workers	✓	✓
Progressive Decommissioning and reclamation	✓	✓
Regulatory site inspections		
Engagement – site visit from Interested Parties		
Employment and Expenditures[1]		
Decommissioning Activities		
Site water management, treatment, and release	✓	✓
Mining horizon remediation and thawing of freeze wall	✓	✓
Process water treatment and release	✓	✓
Closure of ISR and freeze wells and infrastructure	✓	✓
Decontamination of surface facilities and injection, recovery, and monitoring wells	✓	✓
Asset removal (including site power transmission lines and electrical infrastructure)	✓	✓
Demolition and disposal of non-salvageable surface infrastructure and materials	✓	✓
Remediation of contaminated areas (wellfield, pads, ponds, domestic water treatment location, and process plant area)	✓	✓
Generators	✓	✓
Waste management (composting and landfill operation)	✓	✓
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)	✓	✓
On-site and off-site operation of vehicles and transportation of materials	✓	✓
Reclamation disturbed areas	✓	✓
Regulatory site inspections		

Project Phase/Activity	Cultural Expression	
	Key Indicator #1: Knowledge Transmission	Key Indicator #2: Traditional Diet
Engagement – site visit from Interested Parties		
Employment and Expenditures[1]		
Post-Decommissioning Activities		
Environmental monitoring	✓	✓
Regulatory site inspections		
Engagement - Site visit from Interested Parties		
Employment and Expenditures[1]		

Notes:

1 Project employment and expenditures are generated by most Project activities and components throughout the phases of the Project. Hence, Project employment and expenditures have been added into the table as a separate column for each Project phase instead of acknowledging these individually by component or activity.

12.1.4.2 Potential Project-related Effects

The phases of the Project affect Cultural Expression differently. The pathways to effects include:

- change in participation in cultural practices and subsequent knowledge transmission as a result of employment (e.g., time spent away from community because of the worker rotation schedule);
- change in location of cultural practices to support knowledge transmission because of restricted access or avoidance of areas;
- change in availability of country foods that support a traditional diet because of restricted access to or avoidance of hunting, fishing, trapping, and gathering areas; and
- change in perceived suitability of country foods that are part of a traditional diet.

The extent to which these potential interactions/pathways may affect communities would vary by community and individuals.

Two KIs were identified for Cultural Expression: change in knowledge transmission and change in traditional diet. As noted in Table 12.1-2, Project activities and components can result in changes to the KIs throughout the phases of the Project, although to varying degrees.

The pathway analysis identifies potential Project-related effects on Cultural Expression, identifies mitigation measures for these potential effects, and determines whether any of the potential effects can be sufficiently mitigated such that they are not expected to cause a residual adverse effect.

Additional information on potential effects prior to mitigation for each KI are outlined in subsequent subsections. Mitigation measures for each KI are outlined in Section 12.1.5 and residual effects following mitigation measures are presented in Section 12.1.6.

12.1.4.2.1 Potential Effect 1: Change in Knowledge Transmission

Knowledge transmission for cultural practices, including language, is experiential and often site-specific. Two pathways of effect could cause changes in knowledge transmission: employment on the Project limiting opportunities to engage in cultural practices with family and community members and share knowledge about them and changes in location of cultural practices through restricted access or avoidance of areas.

Effects of Participating in the Worker Rotation System

During Construction, Denison has estimated a workforce of approximately 300 people for two years. During Operation, Denison has estimated a workforce of approximately 180 people. Operation is expected to last approximately 15 years. Indigenous Communities of Interest (COI) are expected to be the focus in relation to employment for their members, which could increase the number of community members who participate in the worker rotation. Other Indigenous and northern communities in the Northern Administrative District of Saskatchewan would be considered as second priority for hiring. The worker rotation for the Project will involve two weeks on/two weeks off.

Being away from the community could inhibit community members from participating in cultural activities and sharing them with family and community members, resulting in a loss of knowledge and language. Taking care of day-to-day tasks that cannot be addressed while at the Project site could reduce the time spent engaging in cultural activities. For example, workers who participate in a rotation system sometimes need to spend their time off going to medical appointments, completing home maintenance, or spending time with friends and extended family to maintain relationships (CVMPP 2012).

The potential lack of time to spend out on the land with family and community members would reduce knowledge transmission because such a transmission is experiential. An ERFN member (ERFN and SVS 2022b) described how she and other children were taught different cultural practices by their parents by going out on the land with them:

> "*that's where we learned how to preserve food, gather berries, medicines. Those are some of the stuff that we were taught, us girls. And then the boys learned how to trap and hunt and fish. We were taught those survival skills. And how we were taught was also, when I think about it today, so amazing. I remember when my dad used to shoot a moose, like in the summer. My mom would be making the dry meat to preserve the meat—the jerky, as you guys call it. And my mom would just give us little pieces of meat, and that's how [we] learned. We had knives—today I wouldn't give my child a sharp knife, but we were taught this way. And it was like play. My dad would build us a little rack for smoking the meat. So that's how we learned to do all these things. Even with the fish, we learned how to prepare that. We went out in August for blueberries, and July would be raspberries and other berries—*

> *cloudberries, I think they're called. And other different types of berries. In the fall time it'd be cranberries. That's what we'd gather. In July, like now, we would also be helping my mother pick the medicines. Those are the fondest memories I have. They were the best times.*"

The Wheeler River Project: Métis Knowledge Study Report described the importance of knowledge transmission and Métis teachings (MN-S and Two Worlds Consulting 2023). For example, hunting is important for knowledge transmission and Métis teachings as it is linked to other land use activities, such as camping, which is an activity often done with grandparents, parents, and children. The practice of hunting and camping with children and the continued utilization of intergenerational campsites and trails reflects the shared value to keep Métis traditions and land and resource use practices alive.

Being away from their home communities could not only affect knowledge transmission through participating in cultural activities but also sharing language. Language loss can affect connection with the land where resource harvesting and ceremony occur. Language loss can also affect the ability for younger generations to talk to and learn from community Elders (KML 2022). English River First Nation members noted that many of the community's values and teachings do not translate well into English. Once language is lost, some teachings are lost (ERFN and SVS 2022a).

The Wheeler River Project: Métis Knowledge Study Report described the importance of storytelling as a time-honoured concept among Métis, wherein oral histories would be communicated to all and for any guests that might be present (MN-S and Two Worlds Consulting 2023. The same stories would be repeated year after year, becoming living oral maps. With each telling listeners would be provided the opportunity to understand things differently as they aged and gained experience.

Even if community members are away on working rotation, knowledge transmission is likely to continue because the entire family and community are involved. According to the *First Nations Regional Health Survey Phase 3* (FNIGC 2018), family members were reported as primarily helping First Nations understand their culture, but it was not limited to parents. Understanding of culture was supported by grandparents (72.6%), parents (66.0%), aunts and uncles (44.2%), and other relatives (33.5%). Within a community, almost half of educators were reported as helping First Nations children understand their culture.

Location Changes for Cultural Activities and Associated Knowledge Transmission

Knowledge transmission is often site-specific because it is based on the relationship between an Indigenous community and their traditional territory (FNIGC 2018). The Project may change where cultural activities and associated knowledge transmission occur by changing harvesting activities, restricting access, and altering the perceived suitability of lands and resources (Section 11.1.4 in Section 11). The changes could be experienced by individual members or families if their preferred areas are affected, or by the community if their culture camps are affected.

Based on the assessment of Project effects on ILRU, the Project is not expected to displace cultural activities, although some site-specific knowledge may be lost. Because the Project Area is small (1.69 km^2), and most community intensive uses are located south of the Key Lake gate, the presence of the Project is not expected to change the location of cultural activities, or important locations for knowledge transfer such as ERFN's and Pinehouse's respective cultural camps. Access north of the Key Lake gate is restricted, although some resource users use Fox Lake road to access areas close to the Project Area. Resources users will drive trucks along the road to the Davis Creek bridge, where they transfer to quads or snowmobiles. Even with the use of Fox Lake road, documented use near the Project Area was not intensive and was primarily done by the ERFN Trapper, which the ERFN considers as representative of continued and future community use of the area. Effects close to the Project, such as small changes to resource availability and abundance (Sections 11.1.4.3.2 and 11.1.4.3.3 in Section 11) are not expected to change the location of cultural activities.

It is difficult to predict with accuracy whether perceptions will result in a change in behaviour. Some community members may change the location of cultural activities because of perceived changes in the suitability and safety of lands and resources. Changes to the perceived suitability of lands through Project-related disturbances (e.g., noise, dust, traffic) are expected to have a negligible effect on resource harvesting activities and resource users (Section 11.1.4.5.5 in Section 11) and occur in areas with less intensive use and restricted access (i.e., the ILRU LSA).

The human health risk assessment concluded that no radiological exceedances are expected; however, an exceedance of selenium, a non-radionuclide constituent of potential concern (COPC) could arise. According to the human health risk assessment, the values for the Project hazard quotient was 0.93 for a fisher/trapper at Russell Lake. The traditional foods diet for the fisher/trapper is conservative as it assumes that all their annual fish consumption (183 kg of fish per year) would be obtained from Russell Lake. The exceedance in selenium from fish would only occur if fish were sourced from one location, which is unlikely. Despite the conservative nature of the assumption, the potential exceedance may change perceptions surrounding the quality and safety of the resource. As a result, some resource users may change their behaviour and alter ILRU activity.

The Project and its potential effects on the location of cultural practices are not expected to affect the culture camps for ERFN and KML #9 (Pinehouse). English River First Nation's culture camp is at kilometre 160 of Highway 914, where it crosses the Haultain River (Cameco 2012). Kineepik Métis Local #9 (Pinehouse)'s culture camps occur on Gordon Lake and Muskeg Lake at kilometre 67. Participants in *The Wheeler River Project: Métis Knowledge Study Report* noted overlap with cultural camps, such as those located near Patuanak or Kilometer 160 of the Key Lake Road (MN-S and Two Worlds Consulting 2023). These locations, which are south of the Key Lake gate and outside the ILRU LSA, should not be affected by the presence of the Project and Project activities. In addition, use of these camps has persisted with the presence of the Key Lake and McArthur River uranium operations. The Key Lake mill is closer to the cultural camps than the Project. The use of cultural camps for knowledge transmission is expected to continue.

12.1.4.2.2 Potential Effect 2: Change in Traditional Diet

Country foods are an important part of a traditional diet. The Project may change the traditional diet of Indigenous peoples living in the LSA by either reducing the availability of foods included in a traditional diet or by changing the perceived suitability of those foods in a traditional diet.

Availability of Traditional Diet Foods

The Project could potentially reduce the availability of country foods because of changes to the abundance of harvested resources, restricted access, and avoidance of areas where the Project is located, including areas where hunting, fishing, trapping, and gathering occur. Country foods consumed by Indigenous communities in the LSA include moose, snowshoe hare, woodland caribou, fish, and traditional fruits including blueberries, raspberries, bog cranberries, and saskatoon berries.

The assessment of Project effects on ILRU concluded that within the ILRU LSA (Fur Block N-18):

- Resource harvesting activities are not anticipated to be affected by the Project based on the availability and abundance of terrestrial wildlife, plant species, and fish (Walleye, Northern Pike, Lake Whitefish, and Arctic Grayling) (Sections 11.1.4.3.2 and 11.1.4.3.3 in Section 11). Therefore, country foods are still expected to be available for inclusion in a traditional diet.
- The lands available for resource harvesting in the ILRU LSA will be reduced by 169.6 ha (1.69 km^2) due to limiting access to the Project site for safety reasons, which amounts to less then 0.1% of the ILRU LSA's total area of 2,620 km^2 (Section 11.1.4.4.4 in Section 11). Access to Highway 914 north of the Key Lake Mine is currently restricted. The area around the Project was used primarily by the ERFN Trapper, which the ERFN considers as representative of current and future uses. Access restrictions are, therefore, not anticipated to affect the availability of traditional diet foods.
- Changes to the perceived suitability of lands through Project-related disturbances (e.g., noise, dust, traffic) are expected to have a negligible effect on resource harvesting activities and resource users (Section 11.1.4.5.5 in Section 11). Harvesting country foods is predicted to continue in the presence of the Project.

Based on these anticipated changes to ILRU, the availability of country foods for inclusion in a traditional diet is not expected to change. English River First Nation and KML #9 (Pinehouse) are expected to still have access to foods included in a traditional diet.

Perceived Suitability of Country Foods

For Indigenous peoples, the traditional diet is often preferred, and it is considered healthy. One ERFN member commented,

> "*Everything comes from the land. And it's very healthy, a healthy diet. Especially the fish, the omega-3 and all the other things. And back in the day, there was no diabetes of any kind in our ancestors, but just recently you see indication of a lot of the other stuff that's coming*" (ERFN and SVS 2022). Not only is a traditional diet considered healthy, it also reflects an Indigenous way of life. Another ERFN member noted, "*Like last year, I took my sister, she's 80 years old, she went on Mawdsley Lake, I knew where it was, we took her there, she picked cranberries, she was happy! You know, I set a net, we caught some fish, you know we had fish. And then some other young person got a moose, you know, they gave her some moose meat. You know that was just our lifestyle right there. You know eating wild food, berries*" (ERFN and SVS 2022b).

Project activities could change the perceived suitability of country foods. An ecological risk assessment (ERA) was conducted to consider both radiological and toxicological risks to ecological receptors such as terrestrial and aquatic invertebrates, terrestrial and aquatic vegetation, fish, and terrestrial and aquatic mammals and birds. Results for the radiological assessment predicted no exceedances of the radiation dose benchmark for the ecological receptors. For non-radiological COPCs, no exceedances were predicted except for selenium in fish from Russell Lake, based on a conversative dietary assumption for one resource user. The traditional foods diet for the fisher/trapper is conservative as it assumes that their annual fish consumption (183 kg of fish per year) would be obtained from Russell Lake, meaning the exceedance of the benchmark for selenium from fish would only occur if fish were only sourced from this one lake. This one exceedance could potentially change the perceived safety of country foods for community members and make country foods a less desirable part of a traditional diet.

Experience from other uranium operations in northern Saskatchewan suggests that resource use will continue despite the potential selenium exceedance. An examination of members of the Hatchet Lake Denesųłiné First Nation who live in Wollaston Lake near the Rabbit Lake operation found that over years of being active on the landscape both with and without the presence of the uranium industry, members had developed their own culturally appropriate practice of risk assessment and management based on their relationship with the land. Hatchet Lake Denesųłiné First Nation members appear to be more concerned with the direct effects of uranium mining on the local environment and less concerned about uranium mining's effects on their health through consumption of plants and animals. This is likely due to their high level of confidence in recognizing affected plants and wildlife and avoiding them (Elias et al. 1997).

The usage patterns of the ERFN Trapper have similarly allowed for continued use and access to areas proximal to other uranium operations. The ERFN Trapper had a positive relationship with other uranium operations in the ILRU LSA. He also continued to trap (i.e., used his trapline in Fur Block N-18), fish, and pick berries, and consumed those resources during operations (KPI Program 2021). Good relationships between Denison and a new trapper who eventually takes over the trapline from the ERFN Trapper would promote continued use.

In connection with the ERFN and KML #9 (Pinehouse) culture camps, these locations are not near Russell Lake. The ERFN culture camp is located at kilometre 160 on Highway 914, where the highway crosses the Haultain River (Cameco 2012), and is over 50 km south of Russell Lake. The Kineepik Métis Local #9 (Pinehouse) culture camps occur on Gordon Lake and Muskeg Lake at kilometre 67. The nearest KML #9 (Pinehouse) culture camp at Gordon Lake is over 150 km south of Russell Lake. The distance between the exceedance location and culture camps is expected to support continued consumption of country foods, although some individual users may change their habits.

12.1.5 Mitigation Measures

The Project may potentially affect Cultural Expression by limiting opportunities to engage in knowledge transmission through employment, changes in access, and changes in the perceived suitability of resources and lands. The Project may also affect Cultural Expression through changes to foods that support a traditional diet by changing their availability or desirability. Mitigation for each of these pathways is described in the following subsections.

Employment

To reduce the potential negative effects of Project employment, Denison will implement culturally sensitive employment policies that support the attraction and retention of an Indigenous workforce. Encouragement will be made to speak languages of choice while at the site, except during safety sensitive situations. Denison will work with the Indigenous COI to make sure understanding exists regarding the culturally important periods, including important harvest times and cultural camp schedules. Denison will facilitate Indigenous employees taking time off to participate in cultural activities with family or with the broader community, where appropriate.

Restricted Access

To minimize land that is disturbed by the Project, the Project Area has been reduced to the extent practicable. The proposed Project Area has been developed within previously disturbed areas, including roads currently used for exploration activities (see Section 2 Project Description). Therefore, no additional mitigation or follow-up measures are proposed for Cultural Expression.

Perceived Suitability

Mitigation measures for the perceived suitability of lands and resources are required to reduce the potential effects of traffic, noise, dust dispersion, air emissions, and the potential for COPCs to enter the environment. Mitigation measures for Project activities that could contribute to changes in perceived suitability of lands and resources are described in more detail in:

- Section 12.3 for traffic-related mitigation, including a requirement for Denison truck traffic to slow to 40 km/hr for a minimum of 2.5 km of either side of the culture camp(s), which are understood to occur in September and October (dates may be adjusted at the direction of each community);
- Section 6.1 in Section 6 Atmospheric and Acoustic Environment for air quality-related mitigation; and
- Section 6.2 in Section 6 for noise-related mitigation.

Human Health

Denison will implement an environmental monitoring program consistent with Canadian Standards Association for nuclear facilities and mines. Monitoring will focus on providing data to verify the predictions made in the ERA, to refine the models used in the ERA, and to reduce the uncertainty in the predictions made by the ERA (Section 10 Human Health). The environmental monitoring program will include collection of surface water, sediment, and soil samples as well as fish tissue samples, benthic invertebrate tissue samples, and country foods such as blueberries. Monitoring locations would be focused in the area of Whitefish Lake, McGowan Lake, and Russell Lake (Ecometrix 2022). Monitoring the resources, in turn, will inform predictions about any changes to human health.

Community / Company Relationships

The KML propose that working cooperatively with Denison is a path towards reconciliation (KML 2022). For each concern brought forward by KML, KML proposed that each concern will be reviewed by Denison for the best possible solution and that effects on land and resources be either nil or minimal (KML 2022). This approach is consistent with Denison's Indigenous Peoples Policy (Denison 2021).

As outlined in this Indigenous Peoples Policy, Denison recognizes the critical necessity of advancing reconciliation with Indigenous peoples in Canada and the important role of Canadian business in the reconciliation process. Denison is committed to providing Indigenous people and businesses with sustainable economic opportunities and benefits and sharing the economic benefits of Denison's business activities. Denison is currently working with the Indigenous COI to make sure the Project outcomes include the development of mutually beneficial relationships and minimized Project effects, and is focussed in the following areas: engagement, empowerment, environment, employment, and education.

12.1.6 Residual Effects Evaluation

12.1.6.1 Residual Effects Characterization

General definitions of the residual effects characteristics are provided in Table 5.8-1 in Section 5. Residual effects characteristics specific to Cultural Expression are defined in Table 12.1-3.

Table 12.1-3: Cultural Expression – Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Negative effect or effect is not desirable. **Positive** – Beneficial effect or effect is desirable.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Low** – Minimal amount of change relative to the range of existing variation. **Moderate** – Moderate amount of change relative to the range of existing variation. **High** – High amount of change relative to the range of existing variation.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Local** – Effect is limited to the LSA for the Cultural Expression VC. **Regional** – Effect extends beyond the LSA into the RSA for the Cultural Expression VC. **Beyond Regional** – Effect extends beyond the RSA for the Cultural Expression VC.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction Phase). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions. **Partially Reversible** – A residual effect that partially diminishes to baseline conditions. **Irreversible** – A residual effect that will not diminish to baseline conditions
Context	The extent to which the Cultural Expression VC or associated KIs have been affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its ability to recover from that effect (i.e., resilience)	**Low** – Cultural Expression VC/KIs have high resilience to stress or ecological change. **Moderate** – Cultural Expression VC/KIs have moderate resilience to stress or ecological change. **High** – Cultural Expression VC/KIs have weak resilience to stress or ecological change.

Residual Effect Characteristic	Definition	Rating
Likelihood	Likelihood that the residual effect will occur including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability that the residual effect will occur. **Unlikely** – A low probability that the residual effect will occur.

The characterization of residual effects is based on the review of the existing environment (Section 12.1.3), the assessment of Project-related effects and proposed mitigation measures, IK, KPIs, and professional judgment. All residual effects (independent of their significance rating) are carried forward to the CEA. In terms of confidence:

- a low level is assigned when the VC/KI and/or the Project interaction is not well understood, and/or the mitigation measures have not been proven effective;
- a moderate level is assigned where the VC/KI is understood and/or the mitigation measures have been proven effective elsewhere; and
- a high level is assigned when the VC/KI and Project interactions are well understood, and the mitigation measures have been proven effective.

A significant adverse residual effect on Cultural Expression is defined as an effect that is highly different from baseline conditions and trends and cannot be managed or mitigated through adjustments to existing programs, policies, or other mitigation. Because residual adverse effects on Cultural Expression are not expected to result in this level of change, effects are expected to be **not significant** for the Project.

12.1.6.2 Summary of Project-related Residual Adverse Effects on Cultural Expression

The Project may potentially adversely affect a traditional diet for residents of the LSA. With the implementation of Project mitigation measures, residual effects on traditional diet are expected to be adverse, of low magnitude, confined to the LSA, and medium-term in duration. Effects are expected to be frequent, reversible after Project completion, and low in context.

Knowledge transmission was not carried through to the residual effects evaluation for the following reasons:

- Participation in the worker rotation system is not expected to substantially change opportunities to participate in cultural activities and associated knowledge transmission. Having two weeks off should facilitate participation in activities out on the land because of the length of time off. The primary risk to being able to participate in cultural activities may be if an employee’s two weeks on coincide with a cultural event or key harvesting period. Culturally sensitive policies that account for harvesting activities and community celebrations should reduce but potentially not eliminate residual effects.

- The location of cultural practices is not expected to change as a result of the Project. The Project footprint is small (1.69 km^2), thus minimizing the extent of impacts to land and resource use. Areas south of the Key Lake gate are used more intensively, including for ERFN and KML culture camps. These areas are not expected to be affected by the Project's presence or activities. The most intensive resource user active in the area was the ERFN Trapper, who has passed away. The ERFN considers his use as representative of future uses of the community. When another individual takes over the trapline, Denison will similarly work with the new trapper to determine whether access to areas and/or compensation is appropriate. Other uranium sites in northern Saskatchewan provide access and maintain good relationships with resource users, and Denison will continue to pursue effective relationships with future users.

12.1.6.2.1 Change in Traditional Diet

A summary of residual environment effects on changes to traditional diet is found in Table 12.1-4. Potential effects of the Project on the availability and abundance of species that are important to a traditional diet (e.g., moose, Walleye) are expected to be low. The area where Project effects are anticipated for traditional diet species are not areas with intensive use by ERFN or KML #9 (Pinehouse). Those effects are anticipated in the ILRU LSA, which is north of the Key Lake gate. The perceived suitability of country foods may be adversely affected by the Project. The predicted exceedance of benchmark levels of selenium in fish from Russell Lake, although based on conservative assumptions and monitored throughout the life of the Project, may cause some residents of the LSA to avoid country foods harvested close to the Project Area. As noted, these areas are not intensively used now. Therefore, a change in perceived suitability and safety of country foods may change some behaviour but is not expected to cause a large reduction in the amount of country foods included in the traditional diet.

Table 12.1-4: Cultural Expression – Summary of the Characteristics Ratings for Change in Traditional Diet

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Changes in the perceived suitability of resources harvested by community members could reduce their desire to include country foods in their diet.
Magnitude	Low	Presently, few resource users practice land use in Project-affected areas; a sub-set may avoid including country foods harvested close to the Project in their diet.
Geographic Extent	Local	Effects are expected to be contained to the LSA communities.
Duration	Medium-term	Project Construction to Post-Decommissioning is 38 years. Effects on resource users will be most detectable during Construction and Operation and declining throughout the Decommissioning phase. If monitoring results are shared widely and well, the duration of changes to traditional diet may be shortened.
Frequency	Frequent	Project disturbances are expected to occur many times on a regular basis throughout the life of the Project.

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Reversibility	Fully Reversible	Project-related disturbances are expected to cease once Project infrastructure is removed, the site is remediated, and activity returns to baseline levels.
Context	Low	Resource users can adapt and change to new conditions and exhibit resiliency to changing conditions.
Likelihood	Likely	The Project will likely have some effect on Cultural Expression.

12.1.6.3 Significance and Confidence

A summary of the residual effects conclusions for traditional diet is provided in Table 12.1-5**.** Changes to traditional diet related to Cultural Expression are expected to be low in magnitude. The effect could diminish over time as monitoring results are shared with communities. The residual effect is expected to affect communities in the LSA because they are the primary users of the area closest the Project. The duration is medium-term because it starts during Construction and will end in Post-Decommissioning. The duration may be shortened if monitoring results are shared with communities. The effect is frequent while there are emissions from the Project and fully reversible once the Project ends. Social context is low as resource users can adapt and harvest country foods in a different location. Communities in the LSA are resilient as demonstrated by their continued efforts to express their Indigenous identity and reclaim their culture. While the effect will vary based on individual resource users and community members who eat traditional foods, to be conservative, changes to traditional diet are likely. The overall conclusion for changes to traditional diet is **not significant**.

Table 12.1-5: Summary of Residual Effects Characterization for Cultural Expression

Residual Effects Characteristic	Traditional Diet
	Ratings
Direction	Adverse
Magnitude	Low
Geographic Extent	Local Study Area
Duration	Medium-term
Frequency	Frequent
Reversibility	Fully Reversible
Context	Low
Likelihood	Likely

The overall confidence in the determination is moderate to high. This confidence level is based on the previous experience with the uranium industry in northern Saskatchewan, the prior experience of Indigenous COI with the industry, knowledge of other uranium mining operations, evidence gathered from processes such as the Community Vitality Monitoring Partnership and based on other relevant project experiences in Canada and beyond.

12.1.7 Cumulative Effects

Projects considered in the CEA (Section 5.9 in Section 5) were systematically examined for temporal and spatial overlap. Temporal overlap occurs when a project is a reasonably foreseeable development meaning that the project is fairly certain and the development will take place within the planning horizon and expected life cycle of the Project (i.e., 38 years) (IAA 2018). The only project carried through to the CEA relative to ILRU was the Highway 914 All Weather Road Extension Project, which informs the assessment of Cultural Expression and assesses Project effects on the activities that support cultural continuity.

The EIS for the Highway 914 extension project was filed on September 3, 2022. The project is described as follows (Stantec 2021):

> *"Saskatchewan Ministry of Highways (MOH or the Ministry) is proposing a highway extension project consisting of the construction of 50.7 kilometres (km) of all-weather highway that will extend the existing Highway 914 starting near the McArthur River mine site to an existing road near the Cigar Lake mine site… The purpose [of] the Project is to create an alternate travel route for residents of Saskatchewan's northernmost communities. Several communities have one road option to access the southern areas of the province (Provincial Highway 905). Development of the Project would provide a secondary route for vehicles travelling to and from the north."*

The first four years of the Highway 914 extension project, construction will consist of the construction of the roadway between the McArthur River and Cigar Lake mines. This portion of the roadway spatially overlaps with the Cultural Expression RSA but no cumulative effects are predicted. Assuming both projects will start their construction phases in the same year, no overlapping cumulative effects are anticipated during the construction phases of both projects. Both projects would become active during their operation phases when spatial overlap would occur because industrial, public, and recreational traffic will flow freely along the length of the road between the Key Lake Mill and the Cigar Lake Mine. Public access on the roadway will eliminate the need to check in at the access gate at the Key Lake Mill.

The residual effect for Cultural Expression is a decreased desire to include country foods in a traditional diet due to perceived changes in the quality and safety of resources proximal to the Project. The perceived change from the Project would potentially arise from the predicted exceedance of the selenium benchmark. While the EIS for the Highway 914 extension project documents expected changes to wildlife and fish, the changes occur through increased mortality risk from increased harvesting pressures, vehicle strikes, or predation as the area along

Highway 914 becomes more easily accessible. Unlike a mine, the road extension project will not have any discharges to the environment, and, as such, a human health risk assessment was not warranted. No anticipated change to wildlife or fish health through dust deposition or emissions are associated with the road extension, and emissions during construction are expected to be minor, transient, and occur over a short period of time (Stantec 2016).

As the effects of the Highway 914 extension project on harvested resources are not tied to perceived changes in the suitability of harvested resources, no overlap occurs between the effects of the projects on the traditional diet key indicator, specifically changes in the perceived suitability and safety of country foods in a traditional diet. Therefore, no cumulative effect is anticipated for Cultural Expression.

12.1.7.1 Climate Change Considerations

The Project must also be considered in the context of climate change. The sensitivities of the Project to severe weather (e.g., extreme temperatures and excessive precipitation) and forest fires have been examined as they have the potential to adversely affect the Project (Section 15). Events including flooding, tornadoes, and forest fires, which are likely to become more frequent and/or more severe under climate change have been considered in the Accidents and Malfunctions report (Ecometrix 2022; Appendix 14-A in Section 14). The Project will be designed, constructed, operated, and maintained relative to applicable regulations, codes, and standards. Detailed plans and procedures would be developed for the Project that are site specific including:

- process monitoring and operational procedures;
- mine development and control procedures;
- radiation protection plan;
- spill and emergency response plan;
- traffic and transportation plan;
- security procedures;
- travel management plan;
- environmental monitoring procedures;
- personnel training procedures;
- regular and preventive inspection and testing procedures;
- emergency and evacuation plans related to forest fires; and
- surface water and flood management procedures.

Based on a consideration of the mitigation strategies to be applied, past experience, and application of best management practices, the effects of a changing climate on the Project are expected to be **not significant**.

12.1.8 Monitoring and Follow-up

For the purposes of this EIS, monitoring and follow-up are defined as follows:

- Monitoring programs are designed to meet regulatory requirements (e.g., permit or licence conditions), and / or to demonstrate compliance with environmental commitments made in the EIS.
- Follow-up programs are those that are proposed to address any uncertainties identified during the EA process (e.g., to verify predictions made during the EA; determine the effectiveness of proposed and implemented mitigation measures) and to determine if and when to implement adaptive management measures.

No monitoring or follow-up activities are proposed for the Cultural Expression VC. Monitoring activities described for the aquatic environment and human health will be sufficient.

12.1.9 Cultural Expression Summary

Cultural Expression provides an understanding of the activities that Indigenous people in the LSA take part in and how these activities support their cultural continuity. Cultural Expression considers land-based cultural practices (such as hunting, fishing, trapping, gathering food and medicine, smoking harvested meat and fish, and making birch bark baskets), traditional travel routes and habitation sites, language, land-based programming and supports (such as cultural camps and Treaty Days), and traditional diet (such as moose, snowshoe hare, woodland caribou, fish, and traditional berries).

The KIs to assess changes to Cultural Expression include knowledge transmission (changes to cultural practices and changes in the location of cultural practices) and traditional diet (change in availability of country foods and change in the perceived suitability and safety of country foods).

Potential change to knowledge transmission due to the Project was determined to be manageable, can be eliminated, reduced, or controlled through mitigation measures, and was not carried through to the residual effects assessment because (1) participation in the worker rotation system is not expected to substantially change opportunities to participate in cultural activities and associated knowledge transmission; and (2) the location of cultural practices is not expected to change as a result of the Project because the Project footprint is small (1.69 km^2) and uses are more intensive in areas south of the Key Lake gate or along the Fox Lake Road towards Cree Lake.

For traditional diet, the Project may reduce the availability of country foods because of changes to the abundance of harvested resources, restricted access, and avoidance of areas where the Project is located, including areas where hunting, fishing, trapping, and gathering occur. For Indigenous peoples, the traditional diet is often preferred, and it is considered healthy. The Project's potential effects on the availability and abundance of species that are important to a traditional diet (e.g., moose, Walleye) are expected to be low. The area where Project effects are anticipated for traditional diet species are not areas with intensive use by any of the Indigenous communities considered, and the small Project footprint helps to minimize the extent to access to areas could be limited.

Project activities could also change the perceived suitability of country foods. The perceived suitability of resources harvested as they contribute to the traditional diet was carried forward to the residual effects assessment.

The perceived suitability of country foods may be adversely affected by the Project, although the extent of this will vary by resource user. A resulting change in consumption of traditional foods is not anticipated, due in part to the areas proximal to the Project not being intensively used for cultural practices, combined with sufficient resource availability to support for continued use in areas that are more frequently used. Therefore, a change in perceived suitability and safety of country foods may change some behaviour, but is not expected to cause a large reduction in the amount of country foods included in the traditional diet. The overall conclusion for changes to traditional diet is **not significant**.

To minimize residual effects of the Project on the traditional diet, mitigation measures associated with the Project include adopting culturally sensitive employment policies to reduce the potential effects of Project employment on cultural activities; working with communities to understand culturally important periods; reducing the Project footprint to the extent practicable; reducing risks associated to increased traffic, noise, air quality, and the potential for COPCs to enter the environment; and implementing an environmental monitoring program consistent with Canadian Standards Association for nuclear facilities and mines. As outlined in Denison's Indigenous Peoples Policy, Denison is committed to respecting Indigenous knowledge and values regarding environmental stewardship and Indigenous peoples' connection to the land, and to minimize potential effects, wherever possible.

The overall confidence in the determination is moderate to high. This is based on the previous experience with the uranium industry in northern Saskatchewan, the prior experience of Indigenous COI with the industry, knowledge of other uranium mining operations, evidence gathered from processes such as the Community Vitality Monitoring Partnership and based on other relevant project experiences in Canada and beyond.

The only project carried through to the CEA relative to Cultural Expression was the Highway 914 extension project. While the EIS for the Highway 914 extension project documents expected changes to wildlife and fish, the changes occur through increased mortality risk from increased harvesting pressures, vehicle strikes, or predation as the area along Highway 914 becomes more easily accessible. Unlike a mine, the road extension project will not have any discharges to the environment, and, as such, a human health risk assessment was not warranted. As the effects of the Highway 914 extension project on harvested resources are not tied to perceived changes in the suitability of harvested resources, no overlap is anticipated between the effects of the two projects on the traditional diet key indicator, specifically changes in the perceived suitability and safety of country foods in a traditional diet. Therefore, no cumulative effect is anticipated for Cultural Expression. No monitoring or follow-up activities are proposed specifically for Cultural Expression. Monitoring or follow-up activities proposed for Cultural Expression relate largely to those programs associated with biophysical environment.

12.1.10 References

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12.2 Community Well-being

12.2.1 Scope of the Assessment

Community well-being can be defined multiple ways depending on the community or group of people being considered. Academics, planners, health care providers, social service providers, community members, and others have different definitions of well-being. The Canadian Index of Well-being defines it as "*The presence of the highest possible quality of life in its full breadth of expression focused on but not necessarily exclusive to: good living standards, robust health, a sustainable environment, vital communities, an educated populace, balanced time use, high levels of democratic participation, and access to and participation in leisure and culture*" (Canadian Index of Wellbeing 2016). The US Center for Disease Control has found well-being to be associated with self-perceived health, longevity, healthy behaviors, mental and physical illness, social connectedness, productivity, and factors in the physical and social environment (CDC 2018).

The purpose of this section is to meet the Terms of Reference (EASB# 2019-005) requirements for the Project as issued by the Saskatchewan Ministry of Environment and CNSC. This section includes a detailed and comprehensive assessment of potential Project-related effects and cumulative effects from the Project and other developments on Community Well-being. This section provides an understanding of how the Project will affect Community Well-being, including:

- Will the Project create a change in population and demographics?
- Will the Project lead to a change in community cohesion?
- Will the Project change the income of local workers?

An understanding of the above questions will provide insight to the affects on Community Well-being. The assessment of Community Well-being followed the overall approach and methods provided in Section 5, which included the following primary steps:

Define the VC specific measurements: Sections 12.2.1.1 to 12.2.1.3 present the specific approaches and methods used to measure and assess the effects of the Project on Community Well-being as well as cumulative effects from the Project. This includes VC selection, identifying the KIs and MPs, and defining the spatial and temporal boundaries for Community Well-being.

Characterize existing conditions: Section 12.2.3 describes and characterizes existing conditions to provide context and a basis for evaluating potential changes to Community Well-being caused by the Project.

Assessment of Project-related effects and mitigation measures: Sections 12.2.4 and 12.2.5 identify and summarize potential interactions between the Project and each VC and KI. The assessment then identifies and describes the potential Project-related effects and assesses the changes due to the Project (i.e., residual effects after mitigation) and their significance. Project VCs, and/or activities with the potential to affect each VC, are provided mitigation policies and actions committed to by the proponent to avoid or minimize potential adverse effects. A pathways analysis is used to focus additional assessment on interactions between the Project and Community Well-being by evaluating the different effect pathways to determine if, after incorporation of mitigation, there is still potential to cause residual adverse effects. Where potential adverse effects are adequately mitigated and are not forwarded for additional analysis (i.e., where mitigation results in negligible effects or avoids the pathway altogether), the reasons for concluding the assessment at this stage are provided. Primary pathways anticipated to lead to residual adverse effects after incorporation of mitigation are carried forward to the next step for additional analysis.

Residual effects and CEA: Sections 12.2.6 and 12.2.7 evaluate and describe the effects of the primary pathways from the Project on Community Well-being. The residual effects analysis is presented as an integrated narrative that describes the effects of the Project over time and highlights predicted effects at the point when adverse effects of the Project are expected to be greatest. This section also completes an analysis of residual cumulative effects from the Project.

Monitoring and follow up: Section 12.2.8 outlines the actions to verify predicted residual effects, evaluate effectiveness of planned mitigation designs, policies, and practices, and address key sources of uncertainty.

Figure 12.2-1 is a graphic representation of the assessment process used in this EIS.

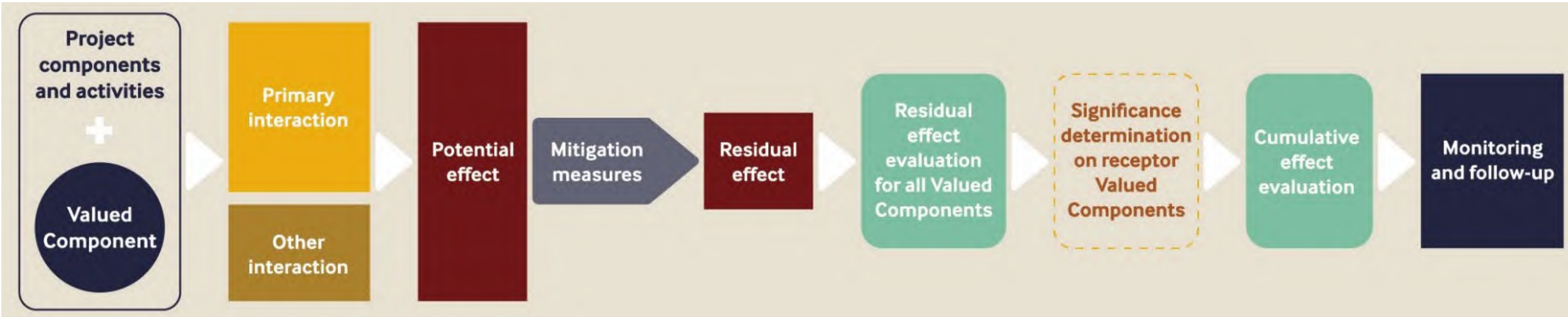

Figure 12.2-1: Environmental Assessment Process for the Wheeler River Project

12.2.1.1 Valued Component Selection

As per standard EA practice, this EA is organized by and focused on VCs. The VCs are aspects of the biophysical and socio-economic environments that will likely be affected (adversely or positively) by the Project. The VCs reflect identified scientific, LK, and IK, and community interests regarding the Project and its potential effects. The VCs are typically identified early in the EA process as a result of questions and concerns raised through engagement with Indigenous and community groups, government departments and agencies, and the general public. Table 5-3.1 in Section 5 provides the rational for inclusion of Community Well-being, including that Project activities may affect changes in community cohesion, population demographics, and income of local workers.

Initial direction and input into VC selection were obtained through IK, LK, discussions with government agencies and the public, results of baseline studies, regional data from other EAs, results from engagement and consultation activities, and results from similar or recent projects in the region. To validate VC selection and as part of engagement activities, Denison sought feedback from the English River First Nation (ERFN)[2] and the Northern Village of Beauval, Northern Village of Pinehouse Lake, and Northern Hamlet of Patuanak (hereafter Beauval, Pinehouse, and Hamlet of Patuanak, respectively). As part of engagement activities for Beauval and Pinehouse, Denison prepared and shared an online survey that included information about Denison and the Project, and posed validation questions about the VCs being assessed as part of the EA process. Denison also met with the Métis Nation-Saskatchewan (MN-S) in early 2023 to share information about the Project, including discussion on VCs considered in the assessment; no new VCs were identified as part of that discussion.

Figure 12.2-2 is a graphic representation of the main linkages among the Community Well-being VC and other VCs, illustrating the flow of assessment information into and from the Community Well-being VC.

[2] The ERFN's Wapachewunak Reserve 192D is also referred to a Patuanak.

Figure 12.2-2: Integrated Assessment Approach - Key Connections between Community Well-being and Other Valued Components

12.2.1.2 Key Indicators and Measurable Parameters

A KI is an important aspect of a VC that may be affected by the Project and its activities. A MP is the metric associated with the KI that can be used to characterize changes to attributes of the environment that may change as a result of the Project and/or other human developments and natural factors. The changes in MPs are used to predict overall effects on the KIs, and in turn on the VCs. Several KIs and MPs were identified for Community Well-being (Table 12.2-1). Measurable parameters for Community Well-being include that the Project may change population and demographics, income of local workers, and community cohesion.

Table 12.2-1: Key Indicators and Measurable Parameters for Community Well-being

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Population and demographics	Project activities may change population and demographics if in/out migration results from people seeking employment opportunities.	Change in population and demographics.
Income of local workers	Project activities may change income of local workers through participation in employment and/or contracting activities.	Change in income of local workers.
Community cohesion	Project activities may lead to a change in community cohesion through a change in income and participation in a worker rotation system.	Change in community cohesion as understood by community members through Key Person Interviews.

12.2.1.3 Spatial and Temporal Boundaries

12.2.1.3.1 Spatial Boundaries

The spatial boundaries selected for Community Well-being were chosen because they permit baseline characterization in sufficient detail to enable potential interactions between the Project and the well-being of the community. These boundaries were developed in consideration of where interactions are likely to occur. The spatial boundaries were derived based on the consideration of communities where Project recruitment is likely to be prioritized, consideration of previous EAs conducted in the region, and consideration of information shared through key persons in the interview program. The spatial boundaries may be refined during study implementation based on feedback from regulators, local and Indigenous communities, and the public. The LSA for the Community Well-being VC includes:

- ERFN (including Indian Reserves Wapachewunak 192D and La Plonge 192) and Patuanak, Northern Hamlet, and Métis Local #82 of Patuanak;
- Pinehouse Lake, Northern Village, and Kineepik Métis Local (KML) #9; and
- Beauval, Northern Village, and Métis Local #37.

Where applicable, the RSA for Community Well-being is the Northern Administrative District, Saskatchewan (Census Division 18). Figure 12.2-3 provides the location of the Project in relation to the communities in the LSA.

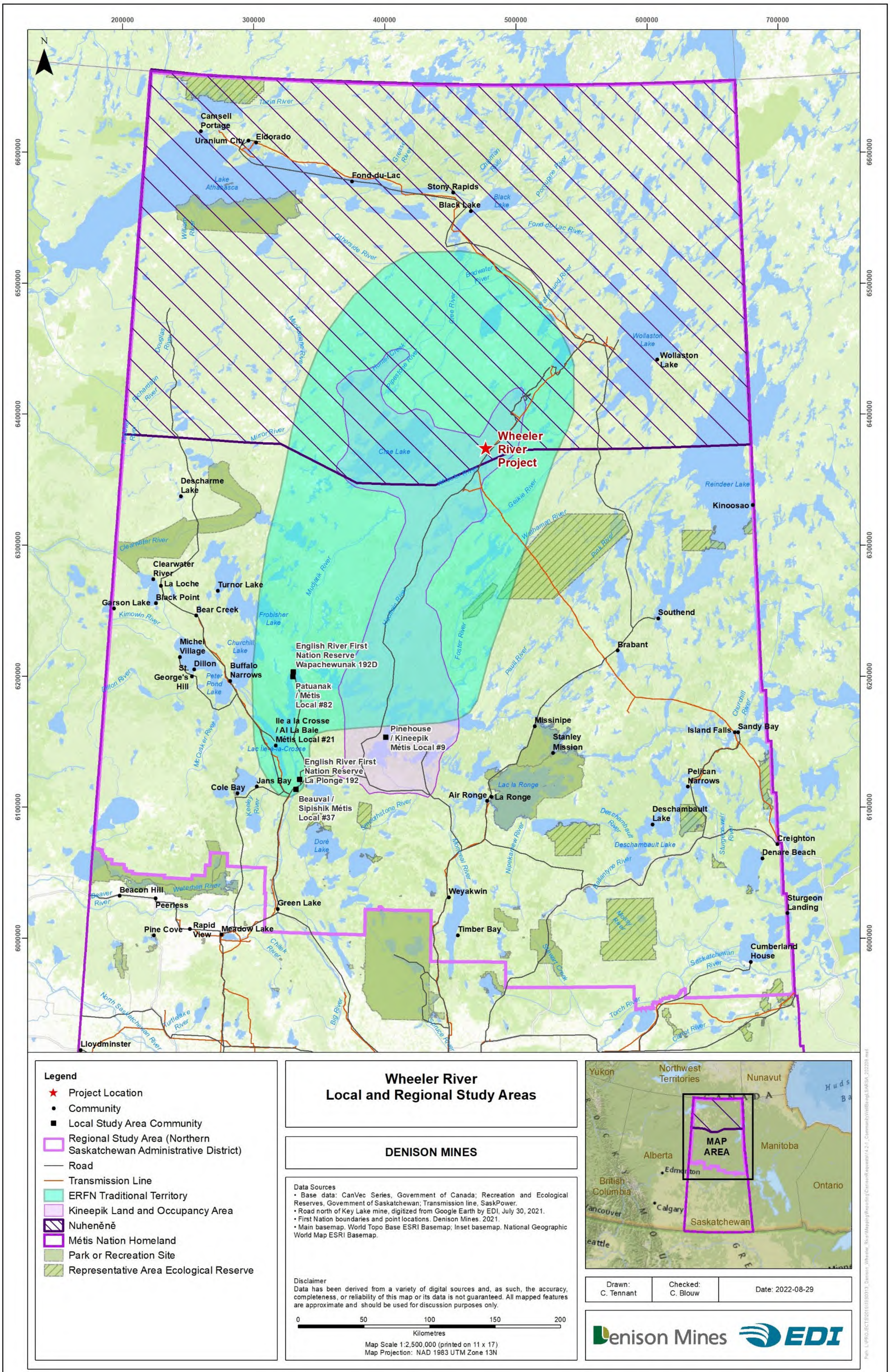

Figure 12.2-3: Location of the Project in Relation to Communities in the Local Study Area

12.2.1.3.2 Temporal Boundaries

Characterization of the existing environment for Community Well-being will be dependent on the MP. Change in population and demographics will go back to 1986 to understand trends (e.g., changes in population). Change in income of local workers and change in community cohesion will focus on the current status in the LSA and RSA.

The temporal scope of the assessment for all MPs of Community Well-being will be forward looking and will include the period from initial Construction to the end of Decommissioning as defined by the following Project phases:

- Construction: includes site preparation; wellfield and freeze hole drilling; processing plant construction; other service infrastructure; and electrical infrastructure. The duration of Construction will be approximately two years.
- Operation: includes operation of the wellfield; operation of the processing plant and production; maintenance activities; water withdrawal from groundwater or surface water for potable use, fire suppression, and make-up water in the processing plant; water treatment; waste management; environmental monitoring; package and transport of nuclear substances; reporting to regulators; engagement; and site security. The duration of Operation will be approximately 15 years.
- Decommissioning: includes mining chamber remediation; decontamination; asset removal; demolition and disposal; and reclamation. The duration of Decommissioning will be approximately five years.

12.2.2 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

Indigenous Knowledge, LK, and engagement were collected and incorporated into the assessment through workshops, surveys, and KPIs identified in Section 3 and Section 4 of the EIS. Indigenous Knowledge, LK, and engagement of the assessment are described in Section 3 and Section 4 of the EIS. Sources of information relevant to the influence on IK and LK include the *English River First Nation Wheeler River Project Summary of Health and Socio-Economy Study Results* (ERFN and SVS 2022a), *Summary of Traditional Knowledge Study Results* (ERFN and SVS 2022b), and the *Kineepik Métis Local and the Northern Village of Pinehouse Lake Kineepik Valued Ecosystem Components and Pre-statement for the Denison EIS* (KML 2022). Additional information relevant to IK and LK is provided in Section 11.

The MN-S submitted *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) to Denison in October 2023. The Métis knowledge summarized therein included secondary literature approved for use by the MN-S and primary information collected during interviews with nine Métis citizens from Northern Region 1 (NR1) and Northern Region 3 (NR3), exclusive of information from the KML at Pinehouse who formally revoked its delegated Duty to Consult from the MN-S.

As part of engagement activities for the Northern Village of Beauval and the Northern Village of Pinehouse Lake, Denison prepared and shared an online survey that included information about Denison and the Project and posed validation questions about the VCs being assessed as part of the EA process. The survey is provided in Appendix 4-A in Section 4. The information related to the VCs was incorporated into the assessment and provided validation for inclusion of Community Well-being through engagement processes. Comments provided through community engagement include the following:

- "*Ensure employment is available to my community including pick up points so that there is no undue hardship for workers*" (21-EN-SUR-446.61).
- "*Develop an agreement to acknowledge the importance of positive relationships with Indigenous communities who are directly impacted by the mining industry*" (21-EN-SUR-446.62).
- Engagement with community members of Pinehouse Lake indicated that residents routinely enjoy the employment and business opportunities that come with projects in the area due to their combined and collaborative efforts (KML 2022).
- "*Concern and interest for the well-being of people. Without adequate housing there are many people that cannot amount to their full potential*" (21-EN-SUR-446.78, 21-EN-SUR-446.80). *What are you doing for the community? Donations? Housing?* (22-EN-ERFN-621.11).
- "*A need for direct benefits and positive impacts to communities*" (21-EN-SUR-446.79).
- "*There will be jurisdictional challenges for communities to be able to work in a health partnership for the benefit of all community members, including dealing with opposing agencies, organizations, and parties. We need to educate our elementary and high school students about uranium and the good that comes from this type of industry in the north*" (21-EN-SUR-446.81).
- "*There may be depression that follows after the mines pack up and leave the area and a lack of employment when mines leave*" (21-EN-SUR-446.82, 21-EN-SUR-446.83, 21-EN-SUR-446.84).
- "*Concern for the mental health of people when the land is damaged from the Project*" (21-EN-SUR-446.85).

A KPI program was also undertaken to address gaps that could not be readily filled by secondary sources and to provide context and perspectives on community interests and concerns.

Denison has recorded and stored information regarding IK, LK and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 21-EN-SUR-446.82). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment. Appendix 12-A provides a summary of unique identification numbers referenced within Section 12.2.

12.2.3 Existing Environment

Characterization of the existing environment includes both primary and secondary data sources. Data collection began with a review of existing literature and databases from a variety of public sources. Primary data collection was undertaken in the form of KPIs. Online surveys, workshops, and other forms of engagement also assisted in identifying community interests and concerns relevant to existing conditions.

Literature Review

The review of literature and databases included the following sources:

- statistical data sources (e.g., Statistics Canada, Indigenous and Northern Affairs Canada, Saskatchewan Health Authority Population Health Unit);
- federal, provincial and municipal government reports and data;
- regional level documents;
- community profiles;
- publicly available profiles, reports, and EAs of past mines in the area; and
- online sources (e.g., community websites).

The most recent data from these sources were used to characterize the existing environment.

Limitations of Secondary Data Collection

Limitations of Statistics Canada Census of Population Data

Statistics Canada Census of Population data contribute to developing an understanding of the LSA and RSA population and demographics, and how they have changed over time. Data should be interpreted with caution because of issues of comparability across years, confidentiality, and data quality. Limitations relative to specific indicators are provided as notes to tables and figures. It is noted that in 2011 there was a shift in how the census was administered, with a National Household Survey replacing the long-form census. One of the key differences was a shift from a mandatory to an optional response requirement, resulting in a reduction in survey response rates and challenges associated with variability of response rates at lower geographic levels, sampling error, and non-response bias.

The Census of Population suppresses data for confidentiality or data quality. Data suppression for confidentiality reasons is meant to prevent the disclosure of data that could be used to identify individuals, particularly in small communities. Data suppression due to data quality is done for a variety of reasons, including incompletely enumerated reserve parcels or Indian settlements, or a global non-response rate of greater than or equal to 50%.

The 2021 Census disaggregates by gender. Census years prior to 2021 disaggregate by sex (male and female). Although sex and gender refer to two different concepts, the introduction of gender is not expected to have a significant impact on data analysis and historical comparability, given the small size of the transgender and non-binary populations. Given that the non-binary population is small, data aggregation to a two-category gender variable is sometimes necessary to protect the confidentiality of responses provided. In these cases, individuals in the category “non-binary persons” are distributed into the other two gender categories (men+ and women+) and are denoted by the “+” symbol (Statistics Canada 2022). When analyzing the 2021 Census data, the term gender is used, along with men+ and women+ in figures or men and women in the analysis. Footnotes expand on the explanation, where relevant.

Limitations of Statistics Canada Incident-Based Crime Statistics

Statistics Canada data on incident-based crime statistics (Statistics Canada 2019b) were used to contribute to an understanding of crime statistics for the Royal Canadian Mounted Police (RCMP) detachments in Beauval and Pinehouse Lake. The data should be used with caution for the following reasons:

- Crime statistics change over time as cases go in and out of court systems. For example, during the production of each year's crime statistics, data from the previous year are revised to reflect any updates or changes that have been received from police services (Statistics Canada 2019b).
- The RCMP-reported statistics may be affected by differences in the way police services deal with minor offences. For example, police or municipalities might chose to deal with some minor offences using municipal by-laws or provincial provisions rather than Criminal Code provisions (Statistics Canada 2019b).
- The Statistics Canada definition of incident-based crime includes all criminal code violations, including traffic (Statistics Canada 2018).

To address these limitations, triangulation was used where inconsistencies in data were apparent. Triangulation involves seeking multiple sources from different perspectives to corroborate data, such as through KPIs and other published reports and data (Pierce 2007).

<u>Key Person Interview Program</u>

A KPI program was undertaken to address gaps that could not be readily filled by secondary sources and to provide context and perspectives on community interests and concerns. Interview guides were developed to address gaps in information and provide local context. Key Person Interviews were conducted from June 2021 to May 2022. Interviews were conducted with the consent of individual interview participants.

The data retrieved from KPIs are not representative of the perspectives of all community members. Key persons were selected based on their knowledge and experience that could be relevant to characterizing the baseline of the community. Participants in the KPI program were identified by InterGroup based on a community member or organization that was anticipated to have expertise or knowledge on a specific topic (e.g., under community cohesion; to understand information on a community's crime trends and policing issues, the relevant RCMP detachment was contacted). During the interview, if it was determined that additional information or local context filling was required, participants were asked if they were aware of other knowledge holders locally or regionally that could serve as a resource on the topic. This sampling method is referred to as snowball sampling in which existing subjects and interviewees are asked to assist and provide referrals for additional potential subjects and research (whether local or regional residents, organizations, or reports and documentation) (OSE 2010). If the topic was of a sensitive or personal nature, care was taken to make sure that the potential subjects' privacy was not violated. For example, the interviewee may have been the one to reach out to the potential referral to ask for permission to share their contact information. Data presented from the KPIs are to the best of the interviewed community member's knowledge.

Other Sources of Information

Indigenous Knowledge was incorporated into the description of the existing environment as described in Section 12.2.2, including the results from the *English River First Nation Wheeler River Project Summary of Health and Socio-Economy Study Results* (ERFN and SVS 2022a), *Summary of Traditional Knowledge Study Results* (ERFN and SVS 2022b), and the *Kineepik Métis Local and the Northern Village of Pinehouse Lake Kineepik Valued Ecosystem Components and Pre-statement for the Denison EIS* (KML 2022). Additional information relevant to IK and LK is provided in Section 11. Information from engagement activities, workshops, and surveys was also used to inform the description of the existing environment.

12.2.3.1 Key Indicator: Population and Demographics

This section describes the historic, current, and potential future populations of the communities in the LSA. Information for northern Saskatchewan and the province of Saskatchewan are provided for comparison purposes. Population trends extend back to 1986. Community profiles for ERFN (Wapachewunak 192D and La Plonge 192), Patuanak, Pinehouse Lake, and Beauval are provided in Appendix 12-B**.**

Table 12.2-2 provides the 2021 population of the communities in the LSA as reported in the Census of Population (Statistics Canada 2022). English River First Nation's registered population (2021) is provided in Table 12.2-3. Figure 12.2-4 shows the population for each community in the LSA from 1986 through 2021 as reported in the Census of Population for each period. The LSA population increased at an average annual growth rate of 0.7% from 1986 (1,954 citizens) to 2021 (2,477 citizens), while the northern Saskatchewan population increased at an average annual growth rate of 1.0% from 1986 (25,340 citizens) to 2021 (35,986 citizens). Both the LSA and northern Saskatchewan had a higher average annual growth rate than the province of Saskatchewan (0.3%) from 1986 to 2021. However, this growth rate trend is not reflective of each community.

- Wapachewunak 192D saw a consistent population increase from 1986 (354 citizens) to 2021 (572 citizens).
- La Plonge 192 saw minimal change in population from 1986 to 2011, with a population increase in 2016. The population increased 16.1% from 1986 (124 citizens) to 2016 (144 citizens).
- Patuanak saw a consistent population decrease from 1986 (138 citizens) to 2021 (63 citizens). However, Patuanak's population has been relatively consistent from 1996 (89 citizens) to 2021 (63 citizens).
- Pinehouse Lake saw a consistent population increase from 1986 (682 citizens) to 2021 (1,013).
- Beauval saw a population increase from 1986 (656 citizens) to 2001 (843 citizens). The population peaked in 2001 (843 citizens) and then declined until 2016 (640 citizens). As of 2021, the population is 685 citizens.

As part of engagement activities for the Northern Villages of Beauval and Pinehouse Lake, Denison prepared and shared an online survey that included citizen feedback on overall concerns in their communities as it relates to population and demographics, which included concerns for a lack of employment, citizens losing jobs when mines close, and a lack of adequate housing that could influence population and people moving out of the area. A comment from community engagement includes that the population is growing, but jobs are depleting. People may leave for education and job [opportunities], particularly if there is a lack of employment when the mines eventually close and people lose jobs (21-EN-SUR-446.82, 21-EN-SUR-446.83, and 21-EN-SUR-446.84).

Table 12.2-2: Population of Communities in the Local Study Area, Northern Saskatchewan, and Saskatchewan, 2021[1,2,3,4]

Community	Population in 2021[1]
ERFN[2]	716 citizens on-reserve
Wapachewunak 192 D	*572 citizens on-reserve*
La Plonge 192	*144 citizens on-reserve*
Patuanak	63
Pinehouse Lake	1,013
Beauval	685
LSA[3]	**2,477**
Northern Saskatchewan[4]	**35,986**
Saskatchewan	**1,132,505**

Source: Statistics Canada 2022. See Appendix 12-C.

Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5 and in some cases 10.

2 English River First Nation includes Wapachewunak 192 D and La Plonge 192.

3 The LSA includes Wapachewunak 192 D, La Plonge 192, Patuanak, Pinehouse Lake, and Beauval.

4 Northern Saskatchewan is defined as Census Division No.18.

Table 12.2-3: Registered Population of English River First Nation, 2021[1,2]

Residency	Total[1]	Male[1]	Female[1]
Registered on-reserve	794 (47%)	390 (47%)	404 (47%)
Registered off-reserve[2]	887 (53%)	434 (53%)	453 (53%)
Total Registered Population	**1,681**	**824**	**857**

Source: Indigenous and Northern Affairs Canada 2021.

Notes:

1 Percentages are based on Total Registered Population.

2 Registered off-reserve includes on other reserves, on own crown land, on other band crown land, on no band crown land, and off-reserve.

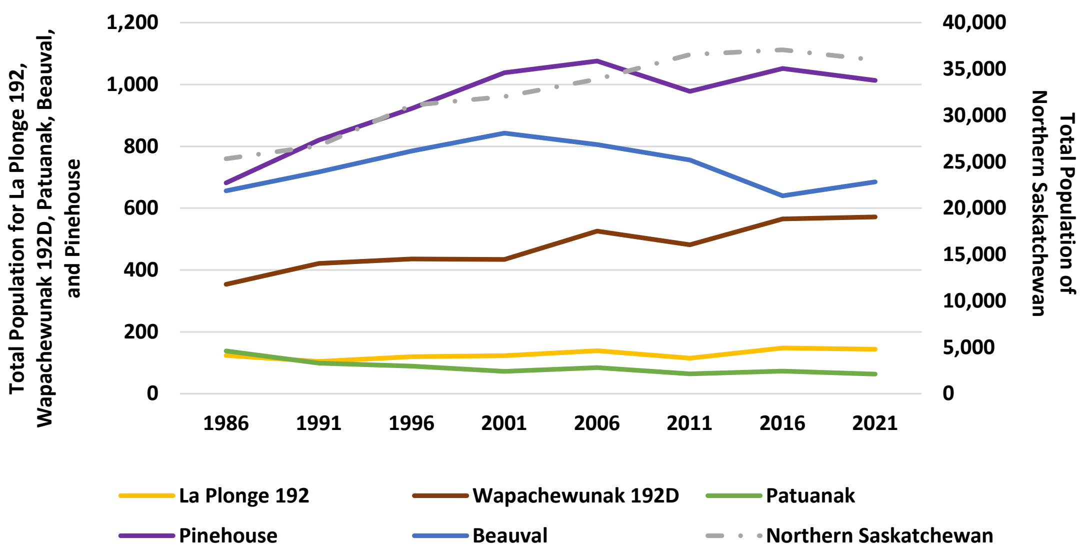

Figure 12.2-4: Population of Communities in the Local Study Area, 1986 to 2021[1,2,3]

Source: Statistics Canada 1992, 1998, 2002, 2008, 2012, 2017, and 2022. See Appendix 12-C.

Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5 and in some cases 10.

2 English River First Nation includes Indian reserves La Plonge 192 and Wapachewunak 192D. Beauval and Pinehouse Lake are Northern Villages, and Patuanak is a Northern Hamlet.

3 Northern Saskatchewan is defined as Census Division No.18.

English River First Nation has 19 different reserve parcels, although only Wapachewunak 192D and La Plonge 192 are populated. As of July 2021, ERFN had a total registered population of 1,681 citizens, including 824 males and 857 females (Table 12.2-3) (Indigenous and Northern Affairs Canada 2021). Of these, nearly half the population (794 citizens) lived on-reserve. The remaining members (887 citizens) did not live on an ERFN reserve parcel (Wapachewunak 192D and La Plonge 192); 38 lived on other First Nation reserves (17 males and 21 females) and 849 lived off-reserve (417 males and 432 females).

The KML and the Northern Village of Pinehouse Lake have reported that, as of 2011, the KML has a population of approximately 1,600 people, of which approximately 1,500 live in the Northern

Village of Pinehouse Lake municipality and 200 live either in other jurisdictions or on land surrounding the community (KML 2022).

Figure 12.2-5 shows the average annual population change for the LSA, northern Saskatchewan, and the province of Saskatchewan from 1986 to 2021 as reported in the Census of Population. Figure 12.2-6 shows the average annual population for each community within the LSA. Both the LSA and northern Saskatchewan experienced higher average annual population growth than the province of Saskatchewan from 1987 to 2006. From 2007 to 2011, the LSA experienced an average annual population decline of 1.9% compared to an average annual increase of 1.3% for the province of Saskatchewan. From 2017 to 2021, the LSA as a whole did not experience any measurable population change.

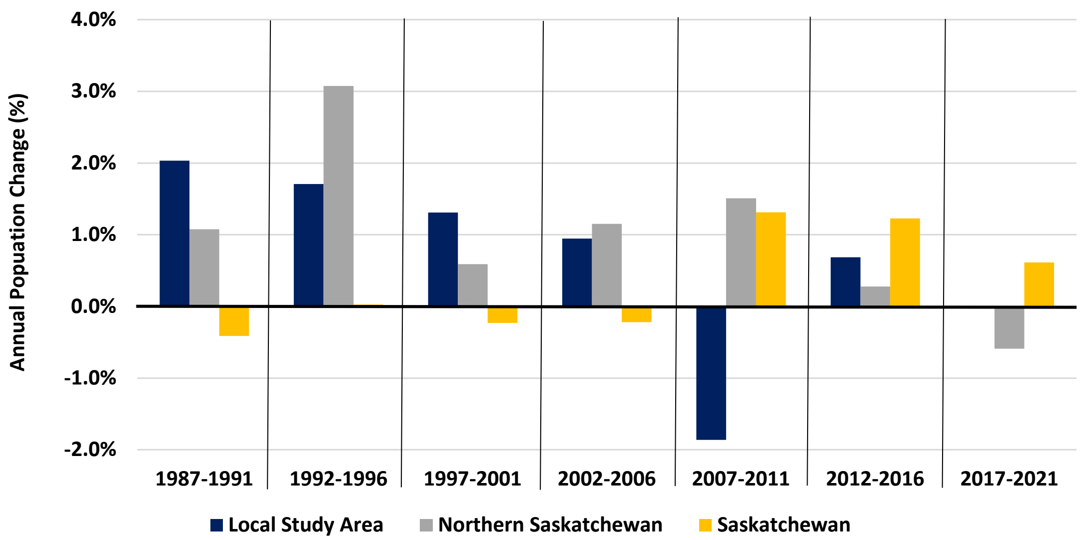

Figure 12.2-5: Average Population Change for the Local Study Area, Northern Saskatchewan, and Saskatchewan, 1986 to 2021[1,2,3]

Source: Statistics Canada 1992, 1998, 2002, 2008, 2012, 2017, and 2022. See Appendix 12-C.

Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5 and in some cases 10.

2 The LSA includes Wapachewunak 192 D, La Plonge 192, Patuanak, Pinehouse Lake, and Beauval.

3 Northern Saskatchewan is defined as Census Division No.18.

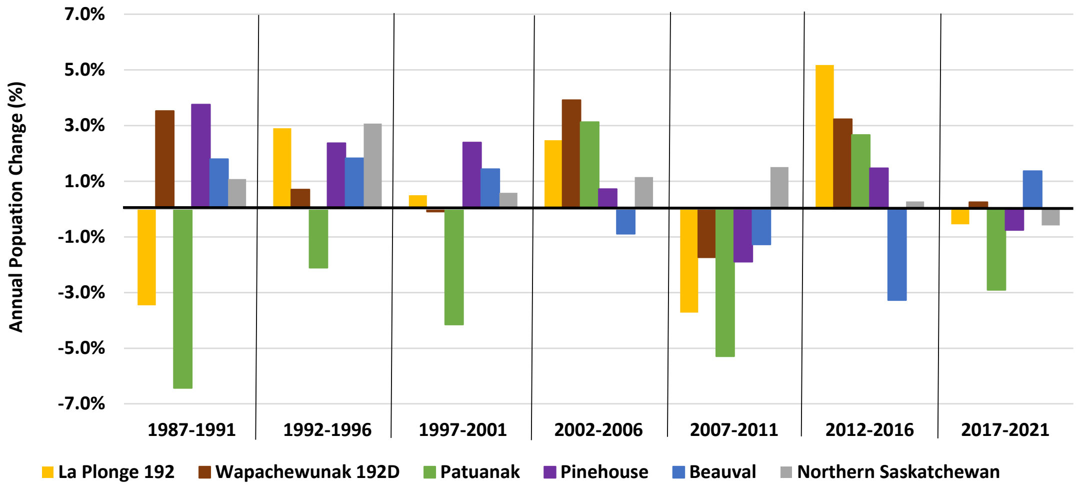

Figure 12.2-6: Average Population Change for Communities in the Local Study Area, 1986 to 2021[1,2]

Source: Statistics Canada 1992, 1998, 2002, 2008, 2012, 2017, and 2022. See Appendix 12-C.

Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5 and in some cases 10.

2 English River First Nation includes Indian reserves La Plonge 192 and Wapachewunak 192D. Beauval and Pinehouse Lake are Northern Villages, and Patuanak is a Northern Hamlet.

Figure 12.2-7 illustrates population distribution by age group for the LSA, northern Saskatchewan, and the province of Saskatchewan for 2021 as reported in the Census of Population. The population of the LSA and northern Saskatchewan is relatively young with a higher proportion of the population aged 25 years old or younger, and a lower proportion of the population aged 65 years or older. Population distributions by age groups are similar among the LSA communities and northern Saskatchewan. Figure 12.2-8 shows that communities tend to have a younger population base, with over 40% of each community's population aged 24 years or younger. The population in the LSA is slightly older than the population in northern Saskatchewan; however, the trend is similar. This trend is reflected in concerns raised by citizens of Beauval and Pinehouse Lake during an online survey: although the population continues to grow, there is a lack of or depleting employment opportunities that may lead to younger citizens leaving the area. Comments from community engagement include the following:

- Our population is growing, but the jobs are depleting. People may leave for education and job [opportunities], particularly if there is a lack of employment when the mines eventually close and people loose jobs (21-EN-SUR-446.82, 21-EN-SUR-446.83, and 21-EN-SUR-446.84). English River First Nation members commented that they would like to understand the plan to train young people (22-EN-ERFN-618.20).
- *"There are limited current employment opportunities for ERFN members, and many feel as though future opportunities are also limited due to the many barriers ERFN members face when*

seeking opportunities for post-secondary education and employment" (ERFN and SVS 2022a). Future education and employment opportunities for all ERFN youth is a key priority for ERFN (ERFN and SVS 2022a).

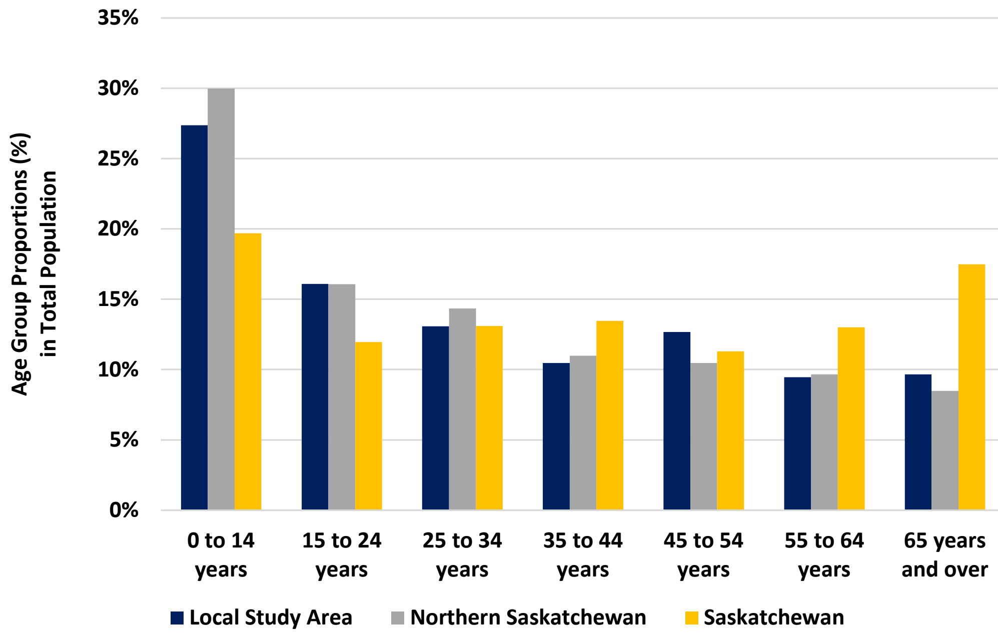

Figure 12.2-7: Population Distribution by Age Group in the Local Study Area, Northern Saskatchewan, and Saskatchewan, 2021[1,2,3,]

Source: Statistics Canada 2022. See Appendix 12-C.

Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5 and in some cases 10.

2 The LSA includes Wapachewunak 192 D, La Plonge 192, Patuanak, Pinehouse Lake, and Beauval.

3 Northern Saskatchewan is defined as Census Division No.18.

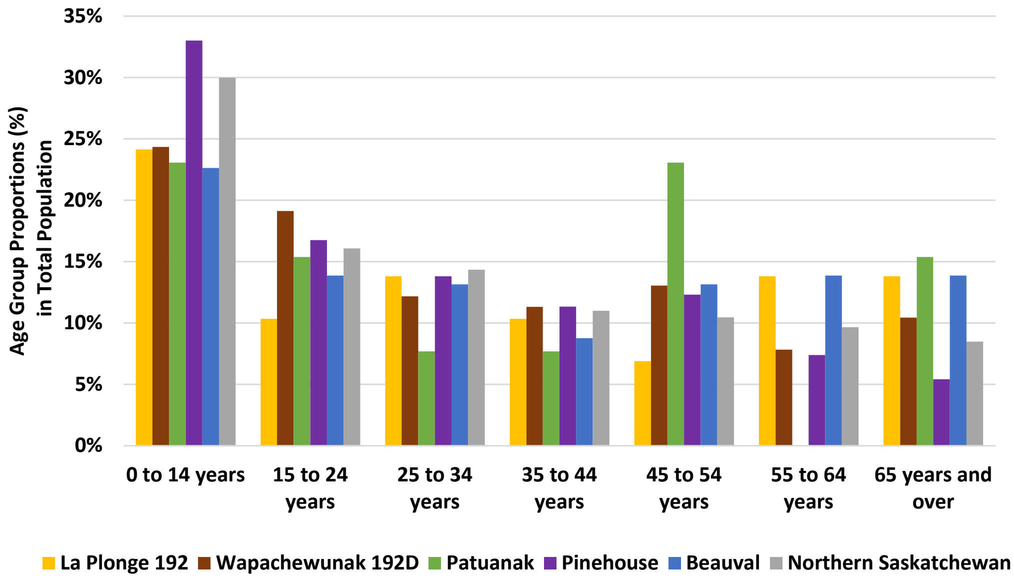

Figure 12.2-8: Population Distribution by Age Group in the Local Study Area, 2021[1,2,3]

Source: Statistics Canada 2022. See Appendix 12-C.

Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5 and in some cases, 10.

2 English River First Nation includes Indian reserves La Plonge 192 and Wapachewunak 192D. Beauval and Pinehouse Lake are Northern Villages, and Patuanak is a Northern Hamlet.

3 Northern Saskatchewan is defined as Census Division No.18.

Figure 12.2-9 shows the age structure by gender in the LSA compared to northern Saskatchewan and the province of Saskatchewan for 2021 as reported in the Census of Population. The population of men and women in the LSA communities in 2021 was similar to northern Saskatchewan but was younger than the population of Saskatchewan. Communities with higher proportions of younger citizens may experience increased economic pressures on the working-age population to support children and families. They may also place additional demands on health, education, and other social services (Irvine et al. 2011).

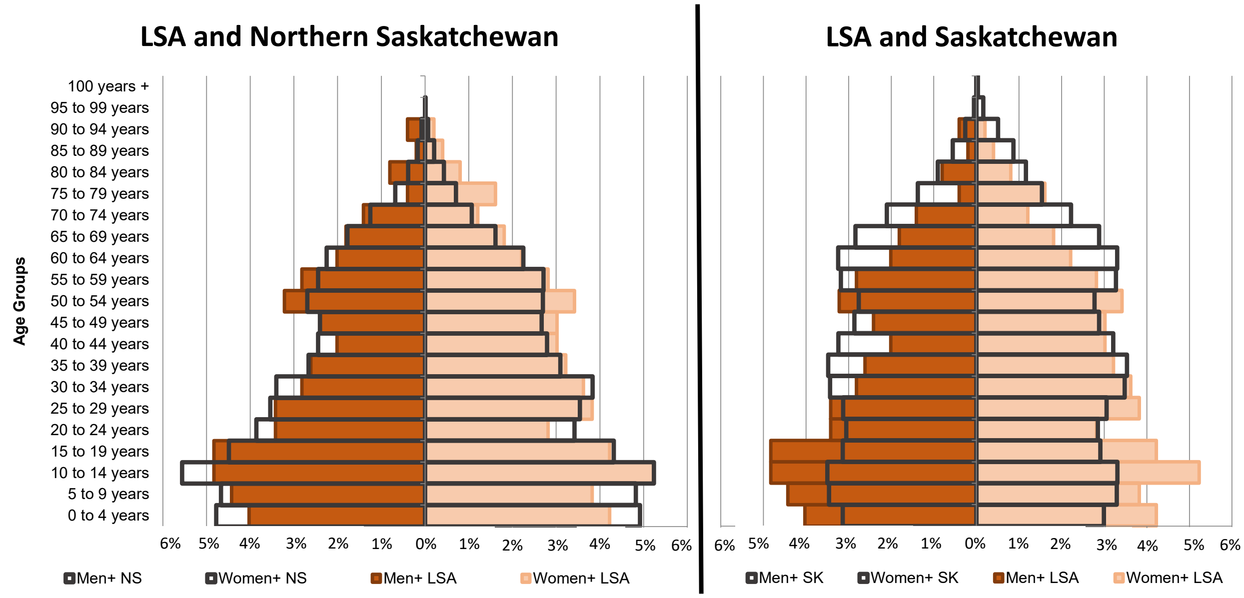

Figure 12.2-9: Population Age Structure by Gender in the Local Study Area, Northern Saskatchewan, and Saskatchewan, 2021[1,2,3,4]

Source: Statistics Canada 2022. See Appendix 12-C.

Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5 and in some cases 10.

2 The LSA includes Wapachewunak 192 D, La Plonge 192, Patuanak, Pinehouse Lake, and Beauval.

3 Northern Saskatchewan is defined as Census Division No.18.

4 Refer to Section 12.2.3 for limitations on the disaggregation gender and the 2021 Census.

Figure 12.2-10 shows the proportion of the 2021 population that identifies as Indigenous in LSA communities, northern Saskatchewan, and the province of Saskatchewan as reported in the Census of Population. Communities in the LSA are predominantly Indigenous (94.9%), which is higher than northern Saskatchewan (86.2%) and the province of Saskatchewan (17.0%). The Population Health Unit (2023) reported similar findings with approximately 87% of the northern Saskatchewan population self-identifying as Indigenous.

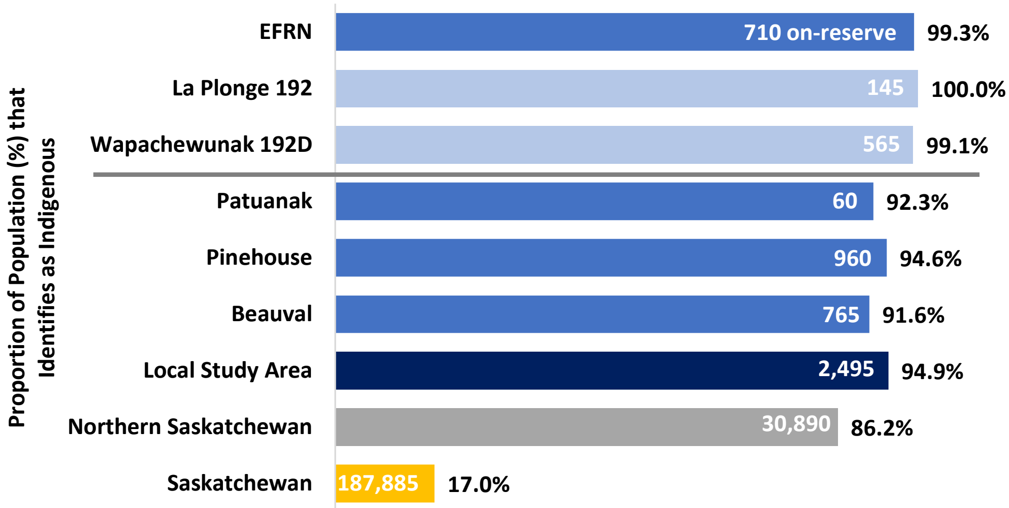

Figure 12.2-10: Proportion of the Population Identifying as Indigenous for the Local Study Area, Northern Saskatchewan, and Saskatchewan, 2021[1,2,3,4,5,6]

Source: Statistics Canada 2022. See Appendix 12-C.

Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5 and in some cases 10.

2 The LSA includes Wapachewunak 192 D, La Plonge 192, Patuanak, Pinehouse Lake, and Beauval.

3 Northern Saskatchewan is defined as Census Division No.18.

4 Statistics Canada defines 'Indigenous identity' as persons who are First Nations (North American Indian), Métis or Inuk (Inuit), and/or Registered or Treaty Indians (i.e., registered under the *Indian Act* of Canada), and/or persons who have membership in a First Nation or Indian band. Indigenous peoples of Canada are defined in the *Constitution Act* 1982 section 35 (2) as including the Indian, Inuit, and Métis peoples of Canada.

5 English River First Nation includes Indian reserves La Plonge 192 and Wapachewunak 192D. Beauval and Pinehouse Lake are Northern Villages, and Patuanak is a Northern Hamlet.

6 The 2021 Census identifies that the total population for Beauval is 685 (see Table 12.2-2) and the total Indigenous identity for the population in private households for Beauval is 835 (and the Indigenous identity population is 765) (Figure 12.2-10). Differences in total population, based on 100% sample data, and total Indigenous identity population, based on 25% sample data, exist due to the estimation and weighting involved in calculating data for the 25% sample population for the Indigenous identity population. The estimates are also affected by sampling variance.

Table 12.2-4 shows the Indigenous identity (First Nations, Métis, and Inuit) for the LSA communities in 2021 as reported in the Census of Population. The population of La Plonge 192, Patuanak, and Wapachewunak 192D are predominantly First Nations, while Beauval and Pinehouse Lake are predominantly Métis. Overall in the LSA, the ratio of individuals identifying as First Nation or Métis is 44.1% and 39.7%, respectively. In comparison, the northern Saskatchewan population is predominantly First Nations (70.1%). The Population Health Unit (2023) reported similar findings with approximately 71% of the northern Saskatchewan population self-identifying as First Nations and 15% as Métis.

Table 12.2-4: Proportion of the Population Identifying as First Nation, Métis, or Inuit for the Local Study Area, Northern Saskatchewan, and Saskatchewan, 2021

Location	Total Indigenous Identity Population [1,2,3,4]	First Nations [1,2]	Métis [1,2]
ERFN[5]	99.3%	95.1%	3.5%
La Plonge 192	*100.0%*	*86.2%*	*10.3%*
Wapachewunak 192D	*99.1%*	*97.4%*	*1.8%*
Patuanak	92.3%	76.9%	15.4%
Pinehouse Lake	94.6%	31.0%	62.6%
Beauval	91.6%	13.8%	44.9%
LSA[6]	**94.9%**	**44.1%**	**39.7%**
Northern Saskatchewan[7]	**86.2%**	**70.1%**	**15.1%**
Saskatchewan	**17.0%**	**11.0%**	**5.7%**

Source: Statistics Canada 2022. See Appendix 12-C.

Notes:

1 Rows may not add due to rounding.

2 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5 and in some cases 10.

3 Statistics Canada defines 'Indigenous identity' as persons who are First Nations (North American Indian), Métis or Inuk (Inuit), and/or Registered or Treaty Indians (i.e., registered under the *Indian Act* of Canada), and/or persons who have membership in a First Nation or Indian band. Indigenous peoples of Canada are defined in the *Constitution Act* 1982 section 35 (2) as including the Indian, Inuit, and Métis peoples of Canada.

4 No persons in the LSA identified as Inuk (Inuit). As a result, Inuk (Inuit) is not included in the above table.

5 English River First Nation includes Wapachewunak 192 D and La Plonge 192.

6 The LSA includes Wapachewunak 192 D, La Plonge 192, Patuanak, Pinehouse Lake, and Beauval.

7 Northern Saskatchewan is defined as Census Division No.18.

Statistics Canada surveys population mobility as part of the Census. Migrants include both internal migrants who moved to a different city, town, township, village, or Indian reserve within Canada and external migrants who lived outside Canada at the earlier reference date. Figure 12.2-11 shows the proportion of the population who migrated within the last year and last five years. A slightly smaller proportion of the LSA population are migrants within the last year and five years compared to northern Saskatchewan. A smaller proportion of the LSA population are migrants within the last year and five years compared to the province of Saskatchewan. An online survey conducted in Beauval and Pinehouse Lake collected citizens' feedback on overall concerns in their communities, such as a lack of employment, citizens losing jobs when mines close, and a lack of adequate housing that could influence community members decisions to migrate out of the area, as noted previously[3].

[3] 21-EN-SUR-446.78, 21-EN-SUR-446.80, 21-EN-SUR-446.82, 21-EN-SUR-446.83, and 21-EN-SUR-446.84

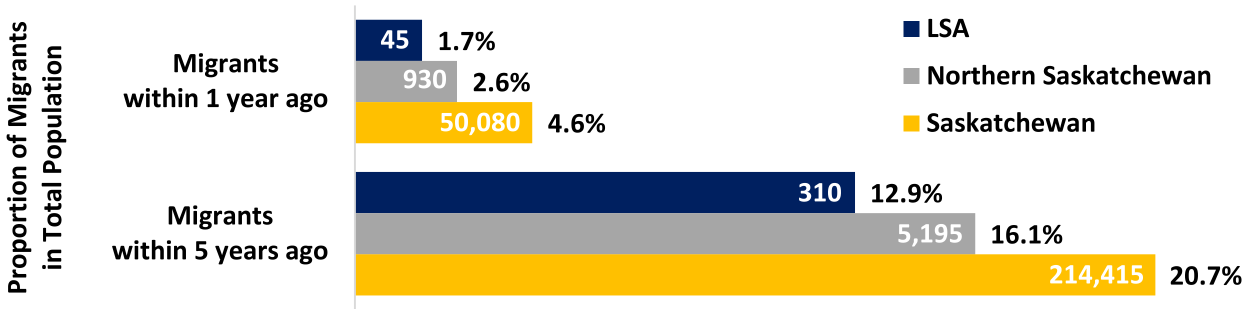

Figure 12.2-11: Proportion of the Population who Migrated within the Last Year and Last Five Years (2021)

Source: Statistics Canada 2021. See Appendix 12-C.

Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10.
2 The LSA includes Wapachewunak 192 D, La Plonge 192, Patuanak, Pinehouse Lake, and Beauval.
3 Northern Saskatchewan is defined as Census Division No.18.

Statistics Canada prepares population projection scenarios by health region (Figure 12.2-12 and Figure 12.2-13). The projections include low, medium, and high growth, as well as slow and fast aging scenarios. The Keewatin Yatthé Health Region (KYHR) includes Patuanak and Beauval, as well as other communities. The Mamawetan Churchill River Health Region (MCRHR) includes Pinehouse Lake. The KYHR had a population of 12,298 citizens in 2018, of which Patuanak (656 citizens) and Beauval (1,106 citizens) had a combined population of approximately 1,762 citizens, or 14% of the health region's population (eHealth Saskatchewan 2021). The MCRHR had a population of 25,061 citizens in 2018, of which Pinehouse Lake had a population of approximately 1,238 citizens, or 5% of the health region's population (eHealth Saskatchewan 2021).

Figure 12.2-12 shows a range of potential outcomes for the population of the KYHR between 2018 and 2049, from a cumulative increase of approximately 7% in the high growth scenario to a decrease of approximately 10% in the low growth scenario. This would result in a population range of 1,600 to 1,900 citizens for Patuanak and Beauval by 2049, and average annual population changes ranging from a decrease of 0.3% to an increase of 0.2%. By contrast, Statistics Canada (2019a) projects an average annual population increase of 0.8% to 1.7% for Saskatchewan between 2018 and 2043[4].

[4] Statistics Canada provided the population projections for the KYHR (2018 to 2049). Cumulative forecasted population percentage changes were calculated by InterGroup based on data from Statistics Canada available from: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710005701&pickMembers%5B0%5D=1.9&pickMembers%5B1%5D=3.1&pickMembers%5B2%5D=4.1&cubeTimeFrame.startYear=2018&cubeTimeFrame.endYear=2049&referencePeriods=20180101%2C20490101.

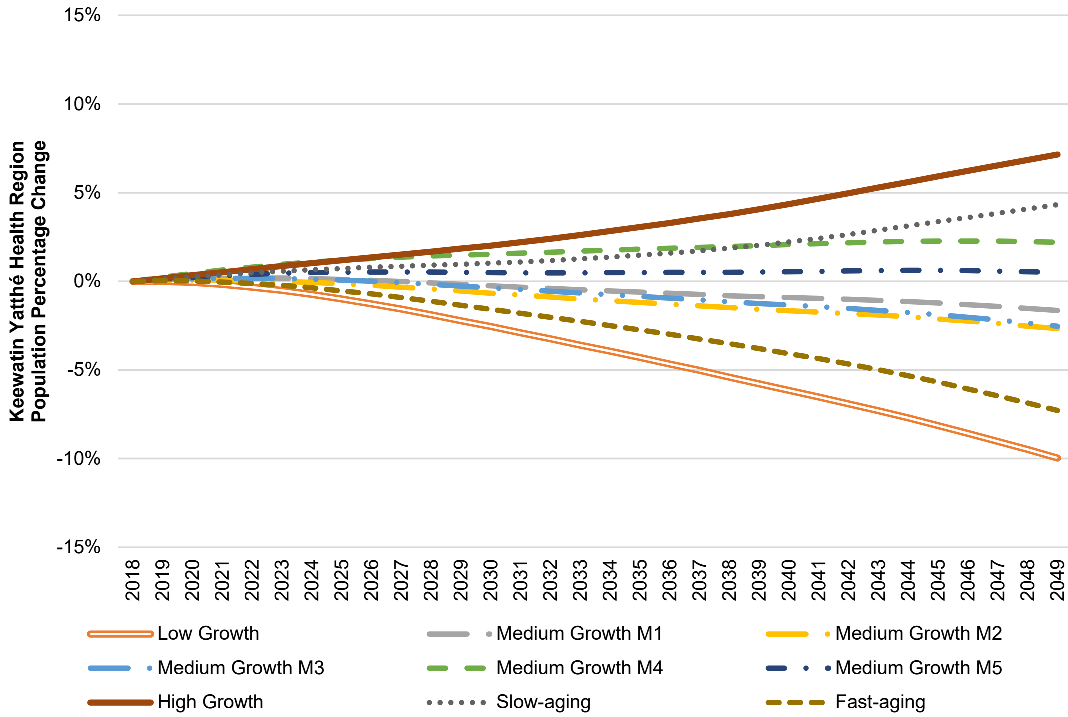

Figure 12.2-12: Cumulative Forecasted Population Change (%) by Scenario for Keewatin Yatthé Health Region (2018 to 2049)[1,2]

Source: Statistics Canada (2019a), Population Projections for the KYHR (2018 to 2049). Cumulative forecasted population percentage changes calculated by InterGroup Consultants Ltd. based on data from Statistics Canada. See Appendix 12-C.

Notes:

1 These projections use the same methodology, assumptions, and scenarios as in the Population Projections for Canada (2018 to 2068), provinces and territories (2018 to 2043), adapted to Health Regions (a description of the methodology and assumptions of these projections can be found here: https://www150.statcan.gc.ca/n1/pub/91-620-x/91-620-x2019001-eng.pdf. The methods combine the use of historical data and the opinion of experts for each component of growth to develop future trajectories specific to each Health Region. Generally, the same method has been used for all Health Regions. However, in Health Regions with small populations, where the counts of demographic events recorded annually are usually small, the past trends are often noisy as they are especially affected by random fluctuations. For this reason, some compromises were made in the less populated Health Regions (including KYHR), such as analyzing the trends for both sexes together instead of analyzing them separately or keeping the age structure constant over time (for the projected changes in a given component of growth).

2 Average annual population change and cumulative population change were calculated by InterGroup Consultants Ltd.

Figure 12.2-13 shows a range of potential outcomes for the population of the MCRHR between 2018 and 2049, from a cumulative increase of approximately 42% in the high growth scenario to an increase of approximately 17% in the low growth scenario. This would result in an average annual population change for the MCRHR ranging from an increase of 0.5% to 1.1%. By contrast, Statistics

Canada (2019a) projects an average annual population increase of 0.8% to 1.7% for Saskatchewan between 2018 and 2043[5].

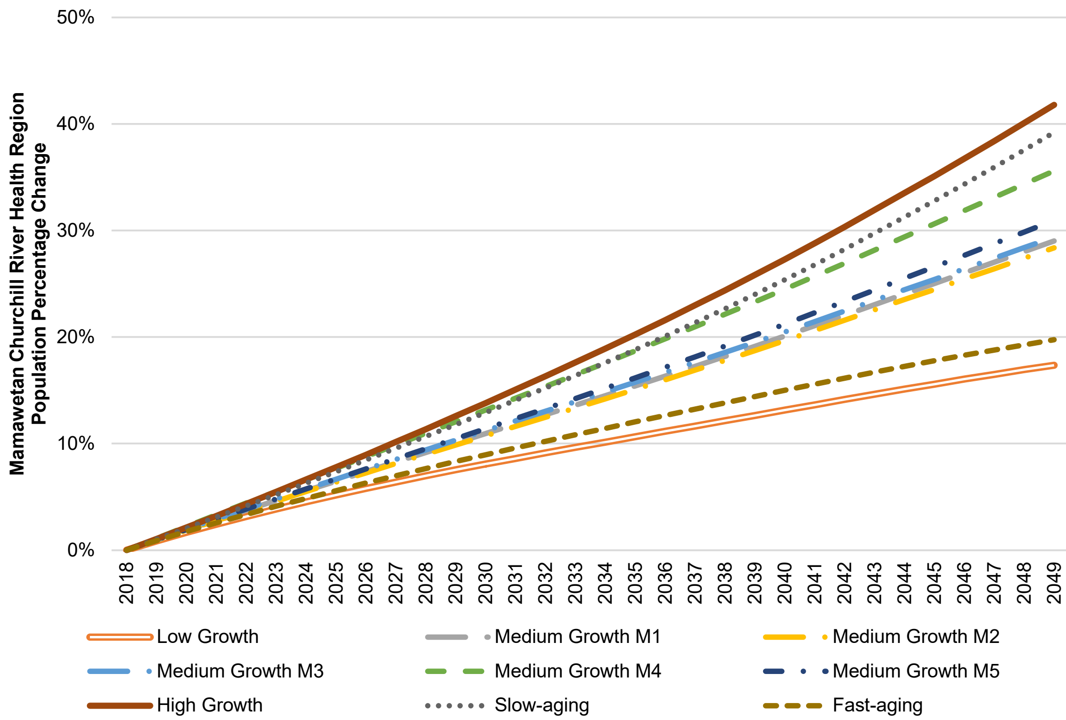

Figure 12.2-13: Cumulative Forecasted Population Change (%) by Scenario for Mamawetan Churchill River Health Region (2018 to 2049)[1,2]

Source: Statistics Canada (2019a), Population Projections for the MCRHR (2018 to 2049). Cumulative forecasted population percentage changes calculated by InterGroup Consultants Ltd. based on data from Statistics Canada. See Appendix 12-C.

Notes:

1 These projections use the same methodology, assumptions, and scenarios as in the Population Projections for Canada (2018 to 2068), provinces and territories (2018 to 2043), adapted to Health Regions (a description of the methodology and assumptions of these projections can be found here: https://www150.statcan.gc.ca/n1/pub/91-620-x/91-620-x2019001-eng.pdf. The methods combine the use of historical data and the opinion of experts for each component of growth to develop future trajectories specific to each Health Region. Generally, the same method has been used for all Health Regions. However, in Health Regions with small populations, where the counts of demographic events recorded annually are usually small, the past trends are often noisy as they are especially affected by random fluctuations. For this reason, some compromises were made in the less populated Health Regions (including MCRHR), such as analyzing the trends for both sexes together instead of analyzing them separately or keeping the age structure constant over time (for the projected changes in a given component of growth).

2 Average annual population change and cumulative population change were calculated by InterGroup Consultants Ltd.

[5] Statistics Canada provided the population projections for the MCRHR (2018 to 2049). Cumulative forecasted population percentage changes were calculated by InterGroup based on data from Statistics Canada available from: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710005701&pickMembers%5B0%5D=1.9&pickMembers%5B1%5D=3.1&pickMembers%5B2%5D=4.1&cubeTimeFrame.startYear=2018&cubeTimeFrame.endYear=2049&referencePeriods=20180101%2C20490101.

The difference in the population projections for the KYHR and MCRHR are a result of differences in natural increases (births minus deaths) and net intra-provincial migration (in-migrations coming from elsewhere in the province minus out-migrations going elsewhere) (KPI Program 2021 to 2022). The MCRHR has a higher natural increase rate (births minus deaths) than the KYHR. For both regions, the net intra-provincial migration rates are negative, meaning more people are leaving the region for another part of the province than there are people coming into the region from another part of the province. However, the KYHR has a lower net intra-provincial migration rate than the MCRHR (KPI Program 2021 to 2022). In summary, the higher natural increase rate and net intra-provincial migration rate in the MCRHR compared to the KYHR are the primary factors explaining the difference between the growth rates in the two regions (KPI Program 2021 to 2022). The natural increase rate in the KYHR is similar to the number of people leaving the region for other parts of the province, which explains why the growth rate is close to zero for the region. The natural increase rate in the MCRHR surpasses the net intra-provincial migration rate, which results in a growth in population (KPI Program 2021 to 2022).

12.2.3.2 Key Indicator: Income of Local Workers

Income is a social determinant of health. Social determinants of health contribute to overall health and well-being of people (World Health Organization 2017). Statistics Canada (2017) defines total income as the sum of certain incomes during a specified reference year (i.e., calendar year prior to the Census year) and includes market income (employment income, investment income, private retirement income, and market income not included elsewhere) and government transfers (old age security, Canada pension plan benefits, employment insurance benefits, child benefits, social assistance benefits, workers compensation benefits, Goods and Sales Tax or Harmonized Sales Tax credits, and government transfers not included elsewhere). Citizens in the LSA may also participate in the traditional economy. Income from an economic perspective, including the traditional economy, is provided in Section 13 Economics. The understanding of income in Section 13 includes an analysis of communities in the LSA: ERFN (Wapachewunak 192 D, La Plonge 192), Patuanak, Pinehouse Lake, and Beauval.

Income as a social determinant of health shapes living conditions such as housing quality, and influences health-related behaviours such as ability to buy sufficient good food (Mikkonen and Raphael 2010). Health Canada (2013) has found income to be the most important determinant of health. Having a higher income can lead to improved living conditions and increased ability to access resources while having a lower income can create stressors such as job strain, financial problems, and marital problems. Higher income generally results in more control and discretion for individuals and households. In 2020, the average personal and household income in the LSA was higher compared to northern Saskatchewan, but lower compared to the province of Saskatchewan (Figures 13.2-7 and 13.2-8 in Section 13). Additional information on personal and household income in the LSA is provided in Section 13.

Education is linked to income as a higher education presents a pathway to better employment opportunities, higher income potential, and improved well-being. In 2021, the education level (high school certificate and higher) for the population aged 15 years or older in the LSA was higher compared to northern Saskatchewan, but lower compared to the province of Saskatchewan (Figure 13.2-6 in Section 13). Indigenous people had a lower education level than their non-Indigenous counterparts. Insufficient education often equates to people having lower skill levels than are needed to enter the labour market (Canadian Institute for Health Information 2016). Community members identified the importance of educating elementary and high school students about the uranium industry, including its potential for opportunities for income and employment potential (21-EN-SUR-446.81). Community members identified that one of the best ways to prepare youth in the community for future employment was to encourage all high school students to complete their science and mathematics courses, as these courses would prepare the students for post-secondary training to access future employment, whether they went into trade or university degree programs (19-EN-PBN-135.5). The ERFN members have highlighted that enhancing future education and employment opportunities for all ERFN youth is a key priority (ERFN and SVS 2022a, 22-EN-ERFN-618.20, 22-EN-ERFN-621.10). Many careers now require certain education, training, and certification to be eligible for employment in certain roles. The ERFN has highlighted that it is important that the ERFN education department work with ERFN youth and students from an early age to begin identifying what career opportunities are best suited for and desired by each ERFN student (ERFN and SVS 2022a).

Employment combined with education is a pathway to higher income potential. Employment rates[6] vary among LSA communities. In 2021, the employment rate for the population aged 15 years or older in the LSA was higher compared to northern Saskatchewan, but lower compared to the province of Saskatchewan (Figure 13.2-2 in Section 13). Unemployment rates tend to be higher for Indigenous people compared to the general Canadian population (Canadian Institute for Health Information 2016). Community members in the LSA recognize the importance of employment for community well-being and as a pathway to higher earning potential. Engagement with community members of Pinehouse Lake indicated that residents routinely enjoy the employment and business opportunities that come with projects in the area due to their combined and collaborative efforts (KML 2022). However, community members are concerned that several people may lose their jobs and income when the mine eventually closes, and subsequently, how that may affect whether they and other community members leave the area. During community engagement, concern was raised for the well-being of people. Without adequate housing, many cannot reach their full potential if they cannot even safety rest their head at night (21-EN-SUR-446.78, 21-EN-SUR-446.80). Depression may follow after mines pack up and leave the area and there may be a lack of

[6] Statistics Canada (2017) defines employment rate as the number of employed persons aged 15 years or older expressed as a percentage of the total population.

employment when the mines eventually close and people lose jobs (21-EN-SUR-446.82, 21-EN-SUR-446.83, 21-EN-SUR-446.84, and 22-EN-SUR-652.68). Additionally, ERFN members indicated that the remote location of Patuanak and La Plonge often presents barriers to ERFN members trying to access economic opportunities and employment; as a result, they rely on accessing economic opportunities and employment outside of their communities (ERFN and SVS 2022a).

Indigenous status can also have an affect on income (Mikkonen and Raphael 2010). This is important as Figure 12.2-10 shows the communities in the LSA are predominantly Indigenous (94.9%). Indigenous people are more likely than other Canadians to experience inequalities and disadvantages that act as barriers to overall health and well-being largely due to negative socio-economic conditions and social conditions (Canadian Institute for Health Information 2016). In 2020, Indigenous people in the LSA had lower personal income compared to non-Indigenous people in the LSA (Figure 13.2-7 and Table 13.2-7 in Section 13). Annual earnings are typically lower for Indigenous people compared to other Canadians, irrespective of whether they are working full time or part time (Canadian Institute for Health Information 2016).

Community members commented that Indigenous land use should be integrated into the economic assessment and its importance to the traditional economy (21-EN-ERFN-474.5). The traditional economy in the LSA provides important non-cash income to citizens. People who do not have wage-paying jobs, but practice traditional activities, are not necessarily unemployed (Myers 1996). For many northern people, the mixed economy is important, and they prefer to have flexible jobs that provide an opportunity to practice their traditional activities, particularly when the activities are seasonal (Myers 1996).

The traditional economy provides a social safety net and supports a culture of reciprocity. For example, hunting and reciprocity are closely tied among Métis and a high value is placed on kinship and reciprocity, which encompasses all aspects of northern Métis life, including economy (MN-S and Two Worlds Consulting 2023). This is reflected in statements such as:

> "*Extra wild meat was always shared in the community and borrowing of staple food products was a common practice. It is often said that the communal lifestyle of the Métis was disrupted by the introduction of electricity and freezers into the Métis communities. Hoarding of food was unnatural, not practical, and virtually unheard of*" (Hourie et al. 2006)".

and,

> "*The insecurity of subsistence income tends to place a high value on sharing one's good fortune with the less fortunate…poverty was explained as a lack of friends and family rather than 'lacking in material things'*" (Raymond 2013).

The traditional economy includes activities such as hunting, fishing, trapping, and craft-making or carving, and can be an important aspect of well-being for individuals in communities. Northern

Indigenous communities have a mixed subsistence-based economy where the harvesting of local food for the purpose of their own consumption is important in their economy and culture (Usher et al., 2003). In northern communities, traditionally based activities play an important role in cultural and economic support where natural resources provide an opportunity for income. The traditional economy does not typically meet all employment and income needs but may hold cultural value and may assist with basic needs. For example, respondents to the Aboriginal Peoples Survey found Indigenous peoples across Canada participated in hunting, fishing, and trapping (35.4% of respondents), gathered wild plants (28.9% of respondents), made carvings, drawings, jewellery, or other kinds of artwork (24.3% of respondents), and made clothing or footwear (9.1% of respondents) (Statistics Canada 2017). These goods supply food and medicines for household consumption and reduce the need for cash income. Other goods such as artwork may be used for gifting, bartering, or sale.

The ERFN has a high use of country foods, which provide benefits culturally and physically as well as a healthy food source (CanNorth 2017). This is important as concern exists among ERFN members regarding a lack of affordable and healthy food available for purchase in Patuanak and La Plonge due to the remote location of these communities and high transportation costs (ERFN and SVS 2022a). Indigenous people may move between a subsistence and market-based economy depending on opportunities and preference (Usher et al., 2003). For example, Statistics Canada’s Aboriginal Peoples Survey (2017) found approximately 60% of respondents indicated they participated in traditional activities at least once in the past year. Traditional foods appeared in the diet of almost all (94%) First Nations adults in Saskatchewan (University of Ottawa et al. 2015). The Wheeler River is a culturally and economically important area for ERFN and a place where fishing, hunting, and trapping occur throughout the year (ERFN and SVS 2022b). Members of the ERFN have stressed the importance of protecting the area and are concerned that effects to the Project Area will expand beyond the immediate lands and waters (ERFN and SVS 2022b). Interviews with ERFN members have reported a growing desire for community members to re-engage and reconnect to these traditional activities, noting that this passion should be further supported by the band and by Denison (ERFN and SVS 2022a). Traditional activities for ERFN members are often a community affair, making the practice of hunting, fishing, trapping, and gathering important cultural activities (ERFN and SVS 2022b). Although culturally important, these traditional land-based activities are also an important economic activity for ERFN (ERFN and SVS 2022b). The ERFN members have noted that practicing traditional activities such as hunting, fishing, trapping, and gathering is a crucial component of ERFN spiritual and cultural health (ERFN and SVS 2022b). A strong consensus exists among ERFN members that participating in traditional land-based activities and maintaining a strong relationship with family are critical to mental health and well-being (ERFN and SVS 2022a).

Hunting and reciprocity are closely tied among Métis. Hunting supports harvesters, their families, Elders, and sometimes whole communities, though the quantity of resources harvested changes with each hunt. Métis harvesters hunt what is necessary and save resources for future needs (MN-S and Two Worlds Consulting 2023). Participants of *The Wheeler River Project: Métis Knowledge Study Report* shared that they would let other Métis harvesters share game if they came back unsuccessful from a hunt. These practices reflect the foundational understanding of wahkotowin, the importance of taking care of each other through food sharing, while ensuring enough resources are left over to avoid overconsumption (Flaminio, Gaudet, and Dorion 2020).

Despite the influx of the wage economy in Indigenous communities, customary social relationships of sharing and reciprocity continue (Natcher 2009). Wage earnings have allowed for the continuation of harvesting activities by enabling the purchase of hunting and trapping equipment (Natcher 2009). Rather than choosing to participate in only one activity, many households derive income from multiple sources, including the subsistence economy, giving and receiving food and medicines, selling or bartering goods produced from natural products, and by participation in the wage economy (Natcher 2009). Subsistence economies continue to demonstrate their resilience and remain integral to the health and well-being of northern Indigenous communities.

Additional information about the traditional economy is provided in Section 13. Participation in the traditional economy often occurs concurrently with activities related to ILRU and other land and resource use (Section 11).

12.2.3.3 Key Indicator: Community Cohesion

This section provides the current understanding of community cohesion as identified by community members in ERFN (Wapachewunak 192 D, La Plonge 192), Patuanak, Pinehouse Lake, and Beauval. Common to the definitions of community cohesion are the following characteristics:

- Community cohesion includes the mechanisms that strengthen the integration of societal values, solidarity, and togetherness to create consensus and sustain a stable and trusting society, which are crucial for the development of strong communities and relationships between individuals living in community (Ensign et al. 2014; Orenstein et al. 2013). Community cohesion includes a shared sense of belonging based on goals and values within a community, and relies on shared interactions and group experiences (Lev-Wiesel 2013). Important dimensions to community cohesion include social relations, identification with the geographical unit, and orientation towards the common good (Schiefer and van der Noll 2016).
- Ensign et al. (2014) identified important aspects of community cohesion, including social values, economic values, population shifts, community welfare (physical, mental, and cultural health), community, and the natural environment.
- Another aspect that is becoming increasingly important to social and community cohesion is the safety and security of a community and its residents. The United Nations Development Programme (UNDP 2009) created the Community Security and Social Cohesion programmatic approach to help ensure and operationalize security and safety at the local level. The programmatic approach focuses on ensuring communities and their members are ’free from

fear' while also acting on a range of social and economic issues that may affect the physical security of community members (UNDP 2009). Actions to improve safety and security at the local level include improving service delivery in communities, reducing social exclusion of community members, and enhancing relations between social groups (UNDP 2009).

Regardless of the definition used, community cohesion is based on a sense of belonging within a community. Engagement, including workshops, online surveys, and KPIs with community members in ERFN (Wapachewunak 192 D, La Plonge 192), Patuanak, Pinehouse Lake, and Beauval provide insight to the factors that communities feel contribute to their sense of cohesion. Looking at what makes life in communities cohesive based on the academic definitions, responses were organized by the categories of social values, economic values, population shifts, community welfare (mental, physical, and cultural health), the environment, and safety and security. Although responses from engagement are broadly organized into these categories, it is important to acknowledge that responses and categories are interrelated. Through engagement activities (online surveys and workshops by Denison), 62 complete responses have been received and incorporated into the assessment. Responses from community members about community cohesion relevant to all communities in the LSA include:

Social Values: Community members have noted that family, kinship, and community are important for community cohesion (KPI Program 2021 to 2022). Community members were asked about what contributes to a sense of community, and respondents shared that feelings of fellowship and shared common interactions, interests, and group experiences were contributing factors (KPI Program 2021 to 2022). For the Métis, kinship relationships and relationships to the land are paramount (MN-S and Two Worlds Consulting 2023). Central to the Métis way of life are the concepts of whakotowin, the responsibility to family, and kiyokewin, the practice of visiting, where social visits maintain kinship relations and facilitate knowledge transmission. The relationship-based understanding underpins how Métis gathered, shared, cared for relatives, saw the land, and enacted decision making across communities (Flaminio, Gaudet, and Dorion 2020). The MN-S identified Métis kinship ties and Métis cultural practices as important values to Métis (MN-S and Two Worlds Consulting 2023).

The social well-being of community members may depend on having adequate housing, which can be dependent on income as income can help shape healthy living conditions. Engagement found that community members may not be able to reach their full potential if they do not have adequate housing and a safe place to rest their head at night (21-EN-SUR-446.78). The Population Health Unit (2023) reported that northern Saskatchewan has elevated rates of household crowding. The ERFN members discussed how several houses in Patuanak and La Plonge have water leaking in, which can lead to mould and other problems. The prevalence of mould in houses can contribute to overall health challenges in the community, such as worsened respiratory health, weaker immune systems, and allergies (ERFN and SVS 2022a). Houses in need of major repair can have significant negative effects on the mental, physical, and emotional health of its occupants. Community members identified the benefits of the Project (e.g., employment and increased income) but had concerns about family and community members working for the Project and being taken out of the community for periods at a time, such as worker rotation or shift work (community members provided examples of seven-day on and seven-day off worker rotation or ten-day on and five-day off worker rotation) (KPI Program 2021 to 2022). Community members would like to know what the worker rotation schedule will be and how workers would get to site (22-EN-VPL/ML9-620.9 and 22-EN-VB-622.5). Being taken out of the community for long periods can affect an individual's or family's ability to participate and be active in the community. Community members identified that if you are going to work in the mining or extraction industries, you may need to put your social and community life aside until the job is done (18-EN-ERFN-5.58). Further, community members have raised concerns that as the population continues to grow, there is a lack of current meaningful employment opportunities to support the population growth, which may result in younger residents leaving the area to pursue employment opportunities[7]. Leaving a community to pursue employment opportunities elsewhere would further affect an individual's or family's social ties to their community.

Community members also identified themes of freedom, self-determination, and control as important aspects of community cohesion. Community members identified the jurisdictional challenges when dealing with opposing agencies, organizations, and political parties (21-EN-SUR-446.81).

Economic Values: Income is a social determinant of health, and social determinants of health contribute to the overall health and well-being of people (World Health Organization 2017). Income as a social determinant of health can shape healthy living conditions (i.e., housing quality), influence health-related behaviours (i.e., ability to buy sufficient good food), and influence access to resources (see Section 12.2.3.2 for additional information). Community members identified the benefits of mining and resource development on the local economy, including increased income and employment opportunities (KPI Program 2021 to 2022). Engagement with community members from Pinehouse Lake indicated that residents routinely enjoy the employment and business opportunities that come with projects in the area due to their combined and collaborative efforts (KML 2022). *The Wheeler River Project: Métis Knowledge Study Report* described that Métis citizens have worked on industrial development projects in northern Saskatchewan and, as a result, bring a range of knowledge on uranium mining processes (MN-S and Two Worlds Consulting 2023). However, community members have raised concerns that while the population continues to grow, there is a lack of meaningful employment opportunities locally. This may have a greater effect on younger citizens who may leave the area to pursue employment opportunities elsewhere[8]. There

[7] 21-EN-SUR-446.78, 21-EN-SUR-446.80, 21-EN-SUR-446.82, 21-EN-SUR-446.83, and 21-EN-SUR-446.84
[8] 21-EN-SUR-446.78, 21-EN-SUR-446.80, 21-EN-SUR-446.82, 21-EN-SUR-446.83, and 21-EN-SUR-446.84

are limited current employment opportunities for ERFN members, and many feel as though future opportunities are also limited due to the many barriers ERFN members face when seeking opportunities for post-secondary education and employment (ERFN and SVS 2022a). Future education and employment opportunities for all ERFN youth are key priorities for ERFN (ERFN and SVS 2022a). It was identified that to make sure employment opportunities are available to the communities, pick-up points[9] should be available so there is no undue hardship for workers (21-EN-SUR-446.61). However, community members had concerns about a lack of employment currently available in the area and whether local community members and companies will receive opportunities from the Project[10]. Additionally, communities who participate in mining employment are familiar with what occurs during a boom-and-bust cycle. Community members have expressed concerns that a lot of people are going to lose jobs when the mine closes, resulting in a lack of available local employment and affects to their mental health (21-EN-SUR-446.82 and 21-EN-SUR-446.84). The importance of educating elementary and high school students was identified, particularly about uranium mining and the good that could come from this type of industry in the north (21-EN-SUR-446.81).

Education is linked to income as a higher education presents a pathway to better employment opportunities, higher income potential, and improved well-being. Community members identified that one of the best ways to prepare youth in the community for future employment was to encourage all high school students to complete their science and mathematics courses, as these courses would prepare the students for post-secondary training to access future employment, whether they went into trade or university degree programs (19-EN-PBN-135.5). English River First Nation members have highlighted that enhancing future education and employment opportunities for all ERFN youth is a key priority (ERFN and SVS 2022a). Access to training and education is an obstacle for some Métis youth in Saskatchewan. Mine training courses are often not delivered in the north, creating economic challenges for students who must leave their communities to attend training in the south (MN-S and Two Worlds Consulting 2023; Gabriel Dumont Institute of Native Studies and Applied Research Inc 2021). Regardless, training programs have supported Métis ability to obtain employment in support of resource development projects (MN-S and Two Worlds Consulting 2023). Many careers now require specific education, training, and certification to be eligible for employment in certain roles. English River First Nation has highlighted that it is important that the ERFN education department work with ERFN youth and students from an early age to begin identifying what career opportunities are best suited for and desired by each ERFN student (ERFN and SVS 2022a).

[9] Pick-up points refer to airport locations associated with the worker rotation system utilized by the uranium industry in northern Saskatchewan. In some instances, these are located directly in a community. In other instances, community members must drive to a pick-up point in a different location.

[10] 21-EN-SUR-446.83, 21-EN-ERFN-447.4, and 21-EN-ERFN-447.12

Community members also identified the importance of setting aside a legacy fund to benefit the affected communities now and into the future (21-EN-SUR-446.61).

Population Shifts: Community members raised concerns over a lack of employment, citizens losing jobs when mines close, and a lack of adequate housing that could influence whether community members decide to migrate out of the area[11].

Community Welfare (mental, physical, and cultural health): Community members identified their spiritualty and ties to the land as important for community cohesion. For the Métis, kinship relationships and relationships to the land are paramount (MN-S and Two Worlds Consulting 2023). Community members raised concerns for their mental health when the land is being affected by industrial developments (21-EN-SUR-446.85). Community members identified developing an agreement to acknowledge the importance of positive relationships with Indigenous communities who are directly affected by the mining industry (21-EN-SUR-446.62). Community members are also concerned that Indigenous communities may get overlooked during the Project (21-EN-SUR-446.62). Housing was identified as an important contribution to mental and physical health of community members, and engagement found that access to housing and a safe place to rest their heads at night are important factors in people reaching their potential (21-EN-SUR-446.78). English River First Nation members discussed how many of the houses in Patuanak and La Plonge have water leaking in, which can lead to mould and other problems. The prevalence of mould in houses can contribute to overall health challenges in the community, such as worsened respiratory health, weaker immune systems, and allergies (ERFN and SVS 2022a). Houses in need of major repair can have significant negative effects on the mental, physical, and emotional health of its occupants. Concern also exists that community members may fall into depression after the mines pack up and leave, taking jobs and income with them (21-EN-SUR-446.82 and 22-EN-SUR-652.68). English River First Nation members have described how a factor leading to anxiety, depression, and other mental health concerns is the perceived lack of overall employment opportunities for ERFN members, including that there may be limited options for personal advancement, a lack of ability to provide for families, and a lack of opportunities to contribute to their communities (ERFN and SVS 2022a). To encourage positive emotional health, the ERFN Health Department encourages ERFN members to follow key Dene laws and teachings, which include the following (ERFN and SVS 2022a):

1. Share what you have.
2. Help each other.
3. Love each other as much as possible.
4. Be respectful of Elders and everything around you.
5. Sleep at night and work during the day.

[11] 21-EN-SUR-446.78, 21-EN-SUR-446.80, 21-EN-SUR-446.82, 21-EN-SUR-446.83, and 21-EN-SUR-446.84

6. Be polite and don't argue with anyone.
7. Young girls and boys should behave respectfully.
8. Pass on teachings.
9. Be happy at all times.

English River First Nation members have noted that practicing traditional activities such as hunting, fishing, trapping, and gathering is a crucial component of ERFN spiritual and cultural health (ERFN and SVS 2022b). Traditional activities are similarly a crucial component to Métis cultural, spiritual, and community well-being (MN-S and Two Worlds Consulting 2023).

Environment: Community members identified the environment as a direct benefit and positive effect on the community and its identity, including citizens' spirituality and ties to the land. English River First Nation members commented that the land is not only important because it is the physical space in which community activities and cultural events occur, but because humans are in an active relationship with their environment (ERFN and SVS 2022a). English River First Nation members are passionate about their land, water, and medicines (22-EN-ERFN-621.13). Maintaining the health of both the ecological world and the human world is a guiding principle in many ERFN teachings (ERFN and SVS 2022a). The Métis have a deep connection to the land, viewing it not merely as a resource but as a living entity with which they share a reciprocal relationship (MN-S and Two Worlds Consulting 2023). The Métis ways of knowing, doing, and living encompass the ecological, social, and spiritual understandings of the environment and are passed down through generations (Vizina 2010; Métis National Council n.d.).

Concerns were raised about the contamination of resources, most importantly the quality of water (21-EN-SUR-446.89). Working with Indigenous communities who are directly affected by the mining industry, including agreements to acknowledge the importance of positive relationships with Indigenous communities, could help preserve the environment (21-EN-SUR-446.62). Community members have identified the importance of water to their community, and mentioned that waterbodies have changed in recent years, resulting in flooding in one year to drought the next year (18-EN-VB-4.39). Climate change is also resulting in changes to the local environment (e.g., permafrost is occurring further down in the ground; 16-EN-ERFN-100.17). Hunting, gathering, and trapping are important to community identity. Questions have been raised about the effects on, and access to, wildlife (e.g., moose, caribou, deer, spawning grounds) due to the Project (18-EN-ERFN-5.35). This is important as community members identified that ancestors have lived off the land since the 1800s and early 1900s (18-EN-ERFN-5.64). There was a strong consensus among ERFN interview participants that participating in traditional land-based activities and maintaining a strong relationship with family are critical to mental health and well-being (ERFN and SVS 2022a).

Safety and Security: KPIs have identified the importance of ensuring the safety and security of their communities [in the LSA] (KPI Program 2021 to 2022). The safety and security of communities in the LSA can be understood through the status of crime (total incident-based crime) in LSA communities. Beauval and ERFN policing services are provided by the RCMP detachment located in Beauval, and Pinehouse Lake policing services are provided by the RCMP detachment located within that community (RCMP 2015, FNMR – Northern Affairs Division 2012). The Pinehouse Lake Police Management Board acts as a liaison between the RCMP and Pinehouse Lake citizens and is made up of volunteers that assist with coordinating the concerns of the community and the RCMP (InterGroup Consultants Ltd. 2011). Statistics Canada prepares incident-based crime statistics (Statistics Canada 2019b) for police services in Saskatchewan, including for the RCMP detachments in Beauval and Pinehouse Lake. Incident-based crime statistics include all criminal code violations, including traffic violations (Statistics Canada 2019b).[12]

Figure 12.2-14 provides the total incident-based crime for the Beauval[13] and Pinehouse Lake RCMP detachments from 2016 to 2020. Each RCMP detachment saw an increase in crime over this period. Although Beauval saw a decrease in incident-based crime in 2019, Beauval's overall incident-based crime saw a slight increase from 2016 to 2020. Pinehouse Lake's incident-based crime increased from 2016 to 2020, with a peak in 2019. Key Person Interviews with the RCMP detachment in Pinehouse Lake found that the main policing issues for the community were drug and alcohol-related offences (KPI Program 2021 to 2022). Key Person Interviews with the RCMP detachment in Pinehouse Lake indicated that an increase in drug and alcohol-related offences is one reason for the increase in incident-based crimes in 2019 and 2020 (KPI Program 2021 to 2022).

[12] Caution must be used with Statistics Canada incident-based crime statistics as crime statistics change over time as cases go in and out of court systems, and they may be affected by differences in the way police services deal with minor offenses (e.g., RCMP detachments may chose to deal with minor offences using municipal by-laws or provincial provisions rather than the Criminal Code provisions). Limitations associated with Statistics Canada crime statistics are provided in Section 12.2.3.

[13] The Beauval RCMP detachment serves Patuanak and La Plonge (KPI Program 2021 to 2022). Patuanak has an RCMP detachment that is provided under the Beauval RCMP detachment and service area (KPI Program 2021 to 2022). La Plonge does not have an RCMP detachment.

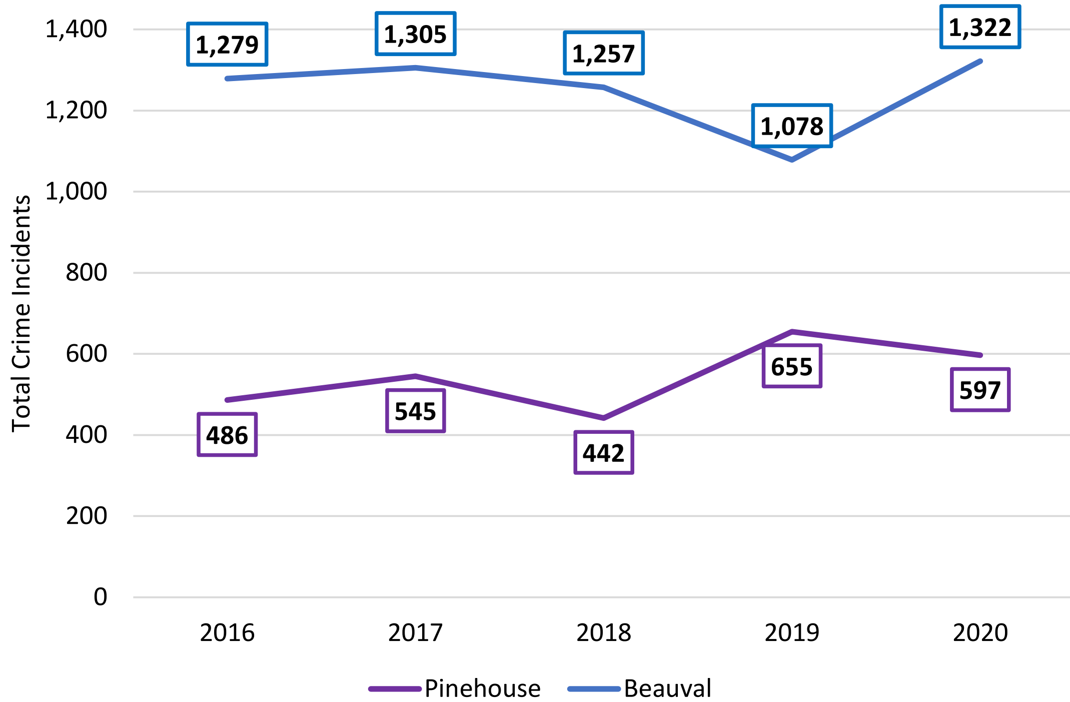

Figure 12.2-14: Total Incident-Based Crime for the Beauval and Pinehouse Lake RCMP Detachments (2016 to 2020)[1,2]

Source: Statistics Canada (2019b). Table 35-10-0182-01. See Appendix 12-D.

Notes:

1 The Statistics Canada definition of incident-based crime includes all criminal code violations, including traffic (Statistics Canada 2018).

2 Statistics Canada Uniform Crime Reporting does not match to the Census geographic measures as RCMP boundaries are not determined by Census boundaries. Data for northern Saskatchewan (Census Division No.18) are not available as a comparison.

Figure 12.2-15 provides the crime-incident rate per 100,000 population for the Beauval and Pinehouse Lake RCMP detachments. The figure shows that Beauval and Pinehouse Lake have crime-incident rates per 100,000 population greater than the province of Saskatchewan. Statistics Canada reported in 2017 that northern Saskatchewan had the highest crime and violent crime incidents compared to all provinces and territories in Canada (Eneas 2019). Statistics Canada also reported in 2017 that young women and girls in northern Saskatchewan were disproportionately victims of violent crimes (Rotenberg 2019). Violent crime rates against young women and girls in Canada were the highest in northern Saskatchewan compared to all other provinces and territories in Canada (Rotenberg 2019). Rural areas in northern Canada typically have higher rates of violent crime against young women and girls compared to urban areas (Rotenberg 2019). Section 12.2.3 provides a description of the health care and social facilities and services available within each community in the LSA, inclusive of programming to support victims of crime, including violent crime.

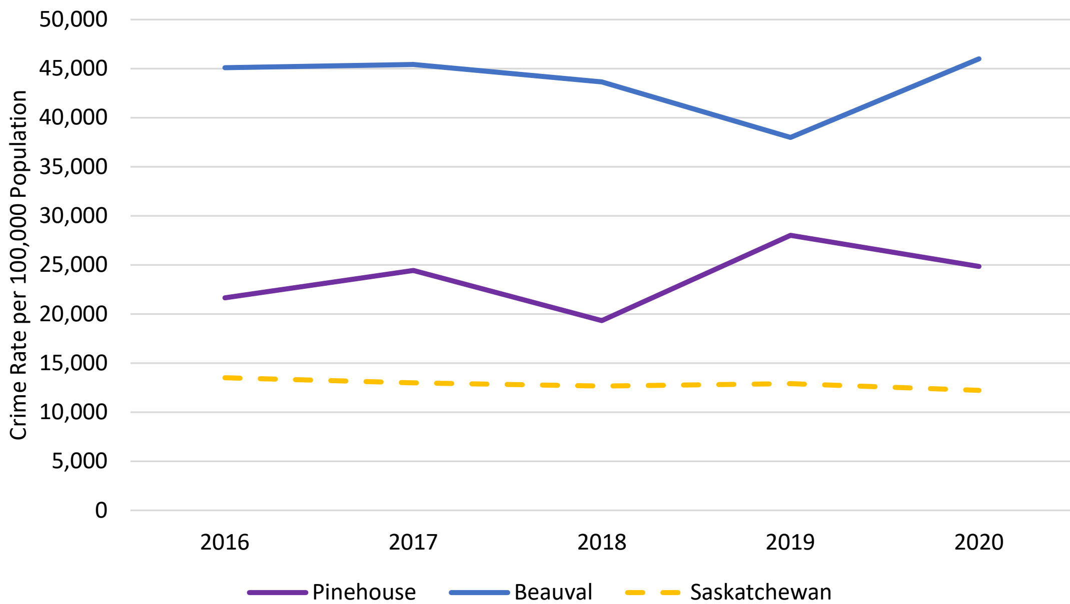

Figure 12.2-15: Crime-Incident Rate per 100,000 Population for the Beauval and Pinehouse Lake RCMP Detachments (2016 to 2020) [1,2]

Source: Statistics Canada (2019b). Table 35-10-0182-01. See Appendix 12-D.

Notes:

1 The Statistics Canada definition of incident-based crime includes all criminal code violations, including traffic (Statistics Canada 2018).

2 Statistics Canada Uniform Crime Reporting does not match to the Census geographic measures as RCMP boundaries are not determined by Census boundaries. Data for northern Saskatchewan (Census Division No.18) are not available as a comparison.

12.2.4 Assessment of Project-related Effects

12.2.4.1 Potential Interactions Between the Project and Valued Component / Key Indicators

Potential interactions between Project components and activities and the Community Well-being VC and its associated KIs were considered for the Construction and Operation phases of the Project in the LSA and RSA, with emphasis on changes in the LSA. The potential interactions between Project components and activities and the Community Well-being VC are summarized in Table 12.2-5.

The identification of Project components and activities and their potential interactions with the Community Well-being VC is based on IK, LK, discussions with Indigenous groups, government agencies, and the public, KPIs for the Project, the professional judgment of members of the Project team, and consideration of existing conditions in the study areas for the VCs and KIs. Potential interactions in Table 12.2-5 are ranked as:

- **Primary Interaction** (✓): Project activity is expected to interact with the VC/KI, which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.

- **Other Interaction (✓):** Project activity is expected to interact with the VC/KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- **No Interaction:** Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

Pathways to effects and potential effects prior to mitigation are described in Section 12.2.4.2. As noted in Table 12.2-5, Project employment and expenditures are generated by most Project activities and components throughout the phases of the Project, although to varying degrees.

Table 12.2-5: Potential Project Interactions for Community Well-being

Project Phase/Activity	Community Well-being		
	Key Indicator #1 – Change in Population and Demographics	Key Indicator #2 – Change in Income	Key Indicator #3 – Change in Community Cohesion
Construction Activities			
Development of access roads and air strip			
Site preparation and earthworks; clearing, levelling, and grading of the Project Area			
Power generation – generators			
Installation of main substation and distribution of power around site			
Wellfield and freeze hole drilling			
Ground freezing			
Batch plant operation (concrete); crusher at borrow area			
Development of surface infrastructure (camp, operations centre plants, ponds, pads and support facilitates)			
Waste management (composting, domestic and industrial landfill operation, recycling)			
Water management (including treatment and site runoff)			
Groundwater supply			
Surface water withdrawal			
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)			
On-site and off-site operation of vehicles and transport of materials			
Air transportation for workers			

Project Phase/Activity	Community Well-being		
	Key Indicator #1 – Change in Population and Demographics	Key Indicator #2 – Change in Income	Key Indicator #3 – Change in Community Cohesion
Regulatory site inspections			
Engagement - Site visit from Interested Parties			
Employment and Expenditures[1]	✓	✓	✓
Operation Activities			
Operation of the in situ recovery (ISR) wellfield			
Wellfield and freeze wall drilling			
Operation and expansion of freeze wall			
Batch plant operation (grout and cement); crusher at borrow area			
Expansion of pond and pads			
Operation of the processing plant and production of uranium concentrate			
Water withdrawal from groundwater or surface water body			
Management of surface water (including seepage and site runoff)			
Water treatment, both domestic and industrial			
Water release to surface water body			
Waste management (composting, domestic and industrial landfill operation, recycling)			
Hazardous waste management (temporary storage, handling, and off-site transportation)			
Storage and disposal of drill waste rock, process precipitates, and industrial wastewater treatment plant precipitates			
On-site and off-site operation of vehicles and transportation of materials			
Power supply – primarily power from the grid, also generators and back-up generators			
Package and transport of nuclear substances			
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)			
Air transportation for workers			
Progressive decommissioning and reclamation			
Regulatory site inspections			

Project Phase/Activity	Community Well-being		
	Key Indicator #1 – Change in Population and Demographics	Key Indicator #2 – Change in Income	Key Indicator #3 – Change in Community Cohesion
Engagement – site visit from Interested Parties			
Employment and Expenditures[1]	✓	✓	✓
Decommissioning Activities			
Site water management, treatment, and release			
Mining horizon remediation and thawing of freeze wall			
Process water treatment and release			
Closure of ISR and freeze wells and related infrastructure			
Decontamination of surface facilities and injection, recovery and monitoring wells			
Asset removal (including site power transmission lines and electrical infrastructure)			
Demolition and disposal of non-salvageable surface infrastructure and materials			
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)			
Generators			
Waste management (composting and landfill operation)			
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)			
On-site and off-site operation of vehicles and transport of materials			
Reclamation of disturbed areas			
Regulatory site inspections			
Engagement – site visit from Interested Parties			
Employment and Expenditures[1]	✓	✓	✓
Post-Decommissioning Activities			
Environmental monitoring			
Regulatory site inspections			
Engagement – Site visit from Interested Parties			

Project Phase/Activity	Community Well-being		
	Key Indicator #1 – Change in Population and Demographics	Key Indicator #2 – Change in Income	Key Indicator #3 – Change in Community Cohesion
Employment and Expenditures[1]	✓	✓	✓

Notes:

1 Project employment and expenditures are generated by most Project activities and components throughout the phases of the Project. Hence, Project employment and expenditures have been added into the table as a separate column for each Project phase instead of acknowledging these individually by component or activity.

12.2.4.2 Potential Project-related Effects

The phases of the Project would each have different effects on Community Well-being. The pathways to effects include:

- potential in-migration of workers to the region for employment opportunities, which could change population and demographics;
- change in income for local workers; and
- change in community cohesion as a result of change in income and employment (e.g., work rotation schedule, time spent away from family).

In terms of Community Well-being, the experience of the Project will vary for individuals and families, depending on their specific experience with respect to the Project. There may be positive and negative effects from the Project. In-migration may change the population and demographics of a community and community cohesion. Project employment and business opportunities may result in additional income to individuals and households that may be beneficial (e.g., increased money to participate in activities, ability to purchase healthier foods). Additional income may also result in negative behaviours (e.g., smoking, excessive drinking, illicit drug use), which could be exacerbated through factors such as time away from family due to work rotations. This may also result in negative effects on community cohesion and increased crime and violence crime rates. These are discussed in the following sub-sections.

Three KIs were identified for the Community Well-being VC: change in population and demographics, change in income, and change in community cohesion. As noted in Table 12.2-5, Project activities and components may result in changes to the KIs throughout the phases of the Project, although to varying degrees.

The pathway analysis identifies potential Project-related effects on Community Well-being, identifies mitigation measures for these potential Project-related effects, and determines whether any of the potential Project-related effects can be sufficiently mitigated such that they are not expected to cause a residual adverse effect. In the instances of beneficial pathways, the potential outcomes are described but an analysis of residual effects and significance are not undertaken.

12.2.4.2.1 Potential Effect 1 – Change in Population and Demographics

An increased availability of Project-related employment, with opportunities prioritized for residents in the LSA, could provide incentive for people to move to the area. This could include both former residents, who move home when employment opportunities increase, and newcomers to the LSA. Previous research has indicated many northern Saskatchewan residents have a strong sense of home and connection to the northern region and return if they can find employment (Anderson Fast & Associates 2000).

An increase in income may enable residents of the LSA to move, either within or outside the LSA/RSA, to pursue other opportunities and amenities. Project-related in- and out-migration have the potential to change the population and demographics in the LSA and/or RSA.

Overall, the population in the LSA increased at an average annual growth rate of 0.7% from 1986 (1,954 citizens) to 2021 (2,477 citizens), although there were differences in each community (Statistics Canada 2017, 2022). Population projections have been provided for the KYHR, which includes Patuanak and Beauval, the MCRHR, which includes Pinehouse Lake, and other communities (Statistics Canada 2019a) and suggest that communities in the LSA are not expected to see substantial growth in population relative to historic ranges.

Local Study Area residents have noted that several factors influence migration decisions, including access to employment, income, education, and other amenities (KPI Program 2021 to 2022). However, LSA residents have noted that younger residents may leave to pursue employment and education opportunities. During community engagement, concern was raised for the well-being of people, including that without adequate housing many cannot reach their full potential if they cannot even safety rest their heads at night (21-EN-SUR-446.78, 21-EN-SUR-446.80), depression may follow after mines pack up and leave the area, and there may be a lack of employment when the mines eventually close and people lose jobs (21-EN-SUR-446.82, 21-EN-SUR-446.83, and 21-EN-SUR-446.84). Additionally, ERFN members have included that the remote location of Patuanak and La Plonge often results in barriers to ERFN members' access to economic opportunities and employment; as a result, they rely on accessing employment opportunities outside of their communities (ERFN and SVS 2022a). Local Study Area residents who obtain employment on the Project may choose to relocate to southern centres to access education and other amenities and may commute to the Project site depending on the availability of commuter transportation. Local Study Area residents have noted concerns about potential future population growth in the LSA and related issues (e.g., employment concerns, adequate housing), as noted above. Overall, migration decisions reflect highly personal consideration of several factors.

With previous and current uranium operations, in-/out-migration related to the Project is difficult to discern from overall migration trends. A slightly lower proportion of the population within the LSA were migrants within the last five years compared to northern Saskatchewan (12.9% and 16.1%, respectively). In comparison, the proportion of the population that were migrants within the last five years was higher (20.7%) for the province of Saskatchewan. Residents of the COI identified concerns such as a lack of employment, citizens losing jobs when mines close, and a lack of adequate housing that could influence community members' decisions to migrate out of the area as provided above[14]. Additionally, ERFN members have indicated that the remote location of Patuanak and La Plonge often results in barriers to ERFN members' access to economic opportunities and employment; as a result, they rely on accessing employment opportunities outside of their communities (ERFN and SVS 2022a).

How communities are prioritized for employment at other uranium operations has been defined, in the past, through mineral surface lease agreements and human resource development agreements with the province of Saskatchewan. The definition of a "Resident of Saskatchewan's North", which has been central to previous hiring objectives across the industry, has been a factor in how this has historically been managed. This has served to minimize an influx of non-local residents to the area. For recruitment purposes, a Resident of Saskatchewan's North is defined as (Government of Saskatchewan 2018):

"A person who has resided in Saskatchewan's North for a period of 10 years or one half his or her age, whichever is less. A person retains "northern status" if he or she:

- "*Needed to relocate outside of Saskatchewan's north for education;*
- "*Resided outside of Saskatchewan's North for less than five years; or*
- "*Moved back to the North*.

  "*Or*
- "*A northerner who is transferred to another northern mine or re-employed by a mine within the year and met the above criteria at the time of recruitment*."

Between a narrow definition of who gets prioritized for employment and providing a variety of pick-up points for fly-in/fly-out workers throughout Saskatchewan, there has been success in limiting Project-related in-migration to communities such as those in the LSA. Multiple pick-up points for workers will be determined as part of Project design, including a minimum of two pick-up points in the LSA and one in Saskatoon, with additional locations to be determined relative to eligible labour force supply. In addition, working with LSA communities to develop hiring policies and commuter transportation options that provide flexibility for workers to maintain employment, specifically if they choose to relocate south to larger communities (e.g., Saskatoon) to access education or other amenities for themselves and/or family members, can help with the planning and management of any in-migration and out-migration pressures.

[14] 21-EN-SUR-446.78, 21-EN-SUR-446.80, 21-EN-SUR-446.82, 21-EN-SUR-446.83, and 21-EN-SUR-446.84

Based on these considerations, increases in employment may affect either in-migration or out-migration decisions based on individual circumstances. Other actions to minimize the extent the Project contributes to in- and out-migration in the LSA include the following:

- Denison will initially prioritize the COI in terms of employment opportunities and will work with the leadership of these communities to assist in determining hiring practices during all phases of the Project. Priority for hiring will then focus on Indigenous and non-Indigenous residents of the RSA and then beyond the RSA.
- Employees will not be permitted to commute to the site by any means other than the fly-in/fly-out worker rotation systems (i.e., they cannot drive to the site).
- Pick-up and drop-off points are being planned at two locally central points in communities within the LSA, at one additional site in Saskatchewan (i.e., Saskatoon), and potentially at other locations.
- Housing for workers will be provided at the camps with free accommodations and meals.

Although difficult to predict, communities in the LSA are not expected to experience any substantial population growth or change in demographics as a result of the Project, particularly with mitigation measures identified. Although the potential exists for some individuals to return to the COI, it is anticipated that this would be difficult to discern from existing in-/out-migration rates. As population and demographics are not expected to experience any change as a result of the Project, this pathway will not be carried forward to the residual effects assessment.

12.2.4.2.2 Potential Effect 2 – Change in Income

The Project will provide opportunities for increased personal income for residents of the LSA through employment on the Project. Best efforts will be made to make sure employment is maximized, including within the LSA communities and to encourage business participation within the LSA. Engagement with community members of Pinehouse Lake has indicated that residents routinely enjoy the employment and business opportunities that come with projects in the area due to their combined and collaborative efforts (KML 2022). In 2020, the average personal and household income in the LSA was higher than in northern Saskatchewan, but lower than in the province of Saskatchewan (Figures 13.2-7 and 13.2-8 in Section 13). The average hourly wage by sector in 2020 showed that the forestry, fishing, mining, quarrying, oil, and gas sectors had the highest wage ($42.47/hour) compared to all other industries (average of $29.13/hour across all industries). Additional information on personal and household income and wages in the LSA is provided in Section 13. Table 13.2-10 in Section 13 provides additional information on average hourly wage by sector. In February 2022, the Mining Industry Human Resources Council reported that the estimated median weekly wage within the Canadian mining sector was approximately $1,800 compared to $1,000 for all Canadian industries, while the median weekly income in Saskatchewan was approximately $1,900 (MIHRC 2022). Mining is a well-paid industry, and when compared to the minimum wage across Canada, even the lowest paid mine labourers tend to receive 58% to 87% more in base wages (Canadian Mining Journal 2021). This is exclusive of additional employment benefits such as insurance, vacation, sick leave, disability, and health benefits (Canadian Mining Journal 2021).

Income has the potential to affect community well-being in multiple ways depending on how income is spent. Both potential positive outcomes and potential adverse outcomes are described.

Increased income for local community members through employment opportunities may enhance quality of life.

Income is a social determinant of health and can contribute to the overall health and well-being of people (World Health Organization 2017). For example, quality of life could increase for residents of the LSA if employment income is saved or spent on items like housing or education. Income as a social determinant of health can shape healthy living conditions (i.e., housing quality), influence health-related behaviours (i.e., ability to buy sufficient good food), and access to resources (for additional information see Section 12.2.3.2). Higher income generally results in more control and discretion for individuals and households (World Health Organization 2017).

Community members identified the benefits of mining and resource development on the local economy, including increased income and employment opportunities (KPI Program 2021 to 2022). As noted above, the average hourly wage by sector in 2020 showed that the forestry, fishing, mining, quarrying, oil, and gas sectors had the highest wage when compared to all other industries.

Research shows the positive relationship between higher incomes and improved health from those who have higher incomes over a longer period of time. This relates to a ‘higher socio-economic status,’ not necessarily those who experience sudden increases in income for limited timeframes, which may not change long term socio-economic status. Research shows that, after a year or two, communities and individuals may adjust to increased income levels through an increase in social stability and improved services (NAHO 2008). This may suggest that income earned during Operation employment (15 years) has a greater likelihood to contribute to positive health outcomes than the shorter opportunities offered during Construction (2 years) or Decommissioning (5 years) employment. Communities have also expressed concerns about the loss of employment following Decommissioning as the loss of income can be difficult for individuals and their families (21-EN-SUR-446.82 and 21-EN-SUR-446.84). English River First Nation members have also commented that the remote location of Patuanak and La Plonge results in barriers to ERFN members’ access to economic opportunities and employment (ERFN and SVS 2022a). As a result, ERFN members rely on accessing employment opportunities outside of their communities (ERFN and SVS 2022a). Similarly, *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) noted that attaining meaningful employment can be challenging, and that access to training is an obstacle for Métis youth as training is not delivered in northern communities.

Increased income as a result of the Project for local community members may result in spending that could have a negative effect on quality of life.

While increased income for LSA community members may be beneficial if income is spent well or invested, a potential exists to spend increased disposable income inappropriately. Change in income can affect workers, their families, and social cohesion, including undermining the social and behavioural patterns of a community (e.g., drugs and alcohol). The COI have expressed concern about the potential adverse effects from increased income on workers, their families, and communities, such as the potential for drug and alcohol use, along with financial mismanagement due to lack of experience with high levels of income (KPI Program 2021 to 2022). KPIs with the RCMP detachment in Pinehouse Lake found that the main policing issues for their community included drug and alcohol-related offences, and that an increase in drug and alcohol-related offences is one reason for the increase in incident-based crimes in 2019 and 2020 (KPI Program 2021 to 2022). Increased violence and crime rates could be attributable to changes in income and patterns of work life (e.g., drugs and alcohol, work rotations, adapting to camp life, increased stress on workers) as a result of the Project. Residents of the LSA employed by the Project may or may not be prepared for the intense work schedule (e.g., long daily routines, minimal time off during work rotations), the separation of living in a work camp away from their family and home community, and the sudden increase in income. These conditions may result in stress for some workers employed by the Project. Increased income as a result of the Project may result in an implicit trade-off with job satisfaction and compromise worker and family well-being (Gardner et al. 2018), particularly if increased income is experienced suddenly and for limited timeframes (e.g., during the Project Construction phase). As employees become accustomed to a higher income, they may feel trapped in a worker rotation system, geographically distant from their home community, and unable to take a lower paying alternative (Gardner et al. 2018, Centre for Transformative Work Design 2018). Substance abuse is a known coping factor for stress, with alcohol identified as a coping mechanism for a range of issues (Gallo et al. 2001, Ofrord et al. 2001). Employment and associated increased income as a result of the Project may exacerbate issues with addictions.

Communities in the LSA will see increased income through employment, training, and business opportunities from the Project, particularly with measures identified to enhance these opportunities. Increased income for local community members may result in inappropriate spending and have a negative effect on quality of life. Mitigation measures to reduce adverse effects are outlined in Section 12.2.5.

12.2.4.2.3 Potential Effect 3 – Change in Community Cohesion

The Project has the potential to affect community cohesion within LSA communities, and the factors that contribute to the sense of belonging within a community as described in Section 12.2.3.3. Factors contributing to community cohesion identified in engagement with communities include social values such as family and kinship, economic values such as the ability to secure employment and income (which in turn provides resources for things such as housing), environmental values such as important ties to the land, and overall welfare values that support individual mental, physical, and cultural health. Mining is understood as having the potential to affect multiple factors, and community cohesion could be affected by things such as changes associated with demography (Section 12.2.4.2.1), income (Section 12.2.4.2.2), and participation in the worker rotation system.

Changes in demography, like in-migration to take advantage of Project-related employment, can change the local demographic structure of a community. This can undermine social cohesion in a community (Mancini and Sala 2018), particularly when migrants are not northerners who may not hold the same social or cultural values as the communities in which they are moving to. In-migration was assessed in Section 12.2.4.2.1.

Time spent by LSA residents employed by the Project away from their communities and families during work rotation may result in negative effects on quality of life and community cohesion.

Participation in the worker rotation system, which involves being taken out of community and on the job site for weeks at a time, can affect community cohesion by limiting participation in community and cultural activities that bring community together (Gibson and Klink 2007). For the Métis, kinship relationships and relationships to the land are paramount (MN-S and Two Worlds Consulting 2023). Central to the Métis way of life are the concepts of whakotowin, the responsibility to family, and kiyokewin, the practice of visiting, where social visits maintain kinship relations and facilitate knowledge transmission (Flaminio, Gaudet, and Dorion 2020; Raymond 2013), which may be affected if cultural practices are disrupted. English River First Nation members similarly noted that practicing traditional activities is a crucial component of ERFN spiritual and cultural health (ERFN and SVS 2022b).

Community members identified the benefits of the Project (e.g., employment and increased income), but had concerns for family members and community members working for the Project being taken out of the community for long periods at a time. Participation in the worker rotation system may affect family dynamics by having an adverse effect on the worker and their immediate families.

Effects on individuals may include challenges adjusting to work and home life, feelings of isolation and loneliness, increased rates of substance abuse as a coping mechanism, and challenges adjusting to shift work (Villeneuve 2019, Gardner et al. 2018, CVMPP 2005, Bowers et al. 2018). Key Person Interviews with the RCMP detachment in Pinehouse Lake found that the main policing issues for their community included drug and alcohol-related offences, and that an increase in drug and alcohol-related offences is one reason for the increase in incident-based crimes in 2019 and 2020 (KPI Program 2021 to 2022). Although difficult to attribute directly to a specific project, any increase in substance use and violence could have a negative effect on community cohesion by disrupting social and cultural norms and harming relationships among individual community members.

A recent study on fly-in/fly-out workers in Australia (Gardener et al. 2018) found that workers reported difficulty in balancing the demands of a worker rotation system with domestic commitments, and many reported being unable to achieve a work-life balance, which led to distrust and tension among families. Many participants stated the geographical distance and regular and prolonged absences led to psychological detachment of workers from their families (Gardener et al. 2018). Community members identified the benefits of the Project (e.g., employment and increased income) but had concerns for family members and community members working for the Project and being taken out of the community for periods at a time, such as worker rotation or shift work (KPI Program 2021 to 2022). Being taken out of the community for long periods can affect an individual's or family's ability to participate and be active in community.

Modern advances in communication (e.g., video calls and social media) can help reduce, but not fully alleviate, concerns of geographical distance. Preparing and educating fly-in/fly-out workers and their families prior to employment can help them make informed choices on a worker rotation lifestyle. Preparation could include strategies to plan and manage a fly-in/fly-out lifestyle, and education on common issues, coping strategies, management of transition between worker rotation and home life, skills for effective communication, tips and ideas from other successful worker rotation families, and financial literacy (Centre for Transformative Work Design 2018).

For household members, including partners and spouses, effects of a worker rotation system could include increased stress from managing a household and assuming all household roles while their partner is away. This includes assuming additional household roles and responsibilities for the duration of a rotation, which can be especially stressful when decisions need to be made or in a crisis (CVMPP 2005). In some instances, there can be increased rates of domestic violence from family strain and fragmentation, and emotional distress from children while the partner is away depending on the temperament of the child and age (Gibson and Klink 2007, Gardener et al. 2018). Further, violence could have a negative effect on community cohesion by disrupting social and cultural norms and harming relationships among individual community members.

English River First Nation interview participants have indicated that Elders should continue to play a role as knowledge holders and connection to family life and cultural traditions within resource development projects (ERFN and SVS 2022a). English River First Nation interview participants suggested several opportunities for Elder engagement in the Project. These include having an Elder present at the site to monitor the Project and provide support to ERFN members, create a liaison role between Chief and Council and Denison, and having Elders conduct cultural programming to support Indigenous employees at the site (ERFN and SVS 2022a). As a result, culturally sensitive employment policies to support the Indigenous workforce have been developed (Section 12.2.5).

Previous studies (CVMPP 2005) on the effects of worker rotation systems on workers, families, and communities in northern Saskatchewan found that the effects are primarily experienced by workers and their immediate families; they are not expected to affect communities more broadly.

Mitigation measures to reduce potential adverse effects on community cohesion are outlined in Section 12.2.5.

12.2.5 Mitigation Measures

The suite of tools used to address the issues that may arise from increased income and changes to community cohesion are often interrelated and focus on providing education and supports to the individual workers, and in some instances their families.

This will include the establishment of health and wellness programming on-site, which will be accessible to all workers. A primary care paramedic will be contracted to provide care on site through all phases of the Project. Denison will provide the appropriate level of First Aid and CPR training to employees to ensure adequate coverage. Health promotion and on-site health care programming will be designed to reflect the needs/interests of the workforce and may include topics such as tobacco cessation, health and stroke awareness, diabetes awareness, mental health and addictions support, cancer awareness, and nutrition awareness. Immunization programs may be administered through the on-site health team. Programming may include the development of life skills programming to address topics such as managing personal finances and coping with stressful situations. Recreation options will be offered on site to promote health and wellness. Denison will provide space for an on-site Elder counsellor to provide culturally relevant programing and support.

An Employee and Family Assistance Program (EFAP) will also be part of each worker’s benefits package and will provide supports to individuals and their families that may not be readily available in their communities. Employee and family assistance programs typically provide free assessments, short-term counselling, referrals, and follow-ups to employees and their family members who are having personal or work-related problems. Generally, these programs can be accessed remotely by workers and their immediate family. Denison will aim to educate their staff on the offerings of their EFAP, as well as making information shareable with each worker’s family.

Denison is also committed to offering life skills and financial literacy training to staff (either mandatory or as an optional offering to employees on site, to be determined cooperatively with the communities in the LSA).

Other mitigation measures will be implemented to reduce adverse effects on Community Well-being, including the following:

- Pick-up points will be located at two locally central points in communities within the LSA, one additional site in northern Saskatchewan, and potentially other locations to minimize time spent away from families.
- First aid facilities will be supplied during Construction. A primary care paramedic will be contracted to provide care on site through all phases of the Project. Denison will provide the appropriate level of First Aid and CPR training to employees to ensure adequate coverage.
- A no alcohol and drug policy will be established at the Project site.
- Denison's Environment, Health, Safety, and Sustainability Policy will be enforced.
- Liaison with LSA communities and relevant authorities (e.g., RCMP, health and service providers) will continue.
- Denison will plan a workforce transition plan prior to decommissioning of the mine.
- Culturally sensitive employment policies that support the Indigenous workforce will be implemented (e.g., having an Elder representative at the Project site to provide cultural programming)

12.2.6 Residual Effects Evaluation

12.2.6.1 Residual Effects Characterization

General definitions of the residual effects characteristics are provided in Table 5.8-1 in Section 5. Residual effects characteristics specific to Community Well-being are defined in Table 12.2-6.

Table 12.2-6: Community Well-being – Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Negative effect or effect is not desirable. **Positive** – Beneficial effect or effect is desirable.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Negligible -** no measurable change from the existing conditions. **Low** – the Project will have a measurable effect on Community Well-being, but within the range of normal variation in baseline conditions. **Moderate** – the Project will have a measurable effect on Community Well-being that exceeds the normal variation in baseline conditions, but which can be managed using existing resources. **High** – the Project will have a measurable effect on Community Well-being that will exceed the management capacity of existing resources.

Residual Effect Characteristic	Definition	Rating
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the LSA for the Community Well-being VC. **Regional** – Effect extends beyond the LSA into the RSA for the Community Well-being VC. **Beyond Regional** – Effect extends beyond the RSA for the Community Well-being VC.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions. **Partially Reversible** – A residual effect that partially diminishes to baseline conditions. **Irreversible** – A residual effect that will not diminish to baseline conditions.
Context	The extent to which the Community Well-being VC and associated KIs have been affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its ability to recover from that effect (i.e., resilience).	**Low** – Community Well-being VC/KIs have high resilience to stress and are able to accommodate change. **Moderate** – Community Well-being VC/KIs have moderate resilience to stress and are able to accommodate some change. **High** – Community Well-being VC/KIs have weak resilience to stress and are unable to accommodate change.
Likelihood	Likelihood that the residual effect will occur, including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability that the residual effect will occur. **Unlikely** – A low probability that the residual effect will occur.

The characterization of residual effects is based on the review of the existing environment (Section 12.2.3), the assessment of Project-related effects and proposed mitigation measures, IK, KPIs, and professional judgment. All residual effects (independent of their significance rating) are carried forward to the CEA. In terms of confidence:

- a low level is assigned when the VC/KI and/or the Project interaction is not well understood, and/or the mitigation measures have not been proven effective;
- a moderate level is assigned where the VC/KI is understood and/or the mitigation measures have been proven effective elsewhere; and

- a high level is assigned when the VC/KI and Project interactions are well understood, and the mitigation measures have been proven effective.

A significant adverse residual effect on Community Well-being is defined as an effect that is highly different from baseline conditions and trends and cannot be managed or mitigated through adjustments to existing programs, policies, or other mitigation. Because residual adverse effects on Community Well-being are not expected to result in this, effects are expected to be **not significant** for the Project.

Table 12.2-7 provides a summary of the KIs that were or were not carried through to the residual effects assessment, along with a summary of mitigations. Table 12.2-5 provides the potential Project interactions (primary interactions and secondary interactions) for Community Well-Being.

Table 12.2-7: Summary of Key Indicators Considered in the Residual Effects Assessment

Key Indicator	Measurable Parameter	Consideration in the Residual Effects Assessment	Mitigations
Population and demographics	Change in population and demographics	Communities in the LSA are not expected to experience any substantial population growth or change in demographics as a result of the Project. Change in population and demographics is not carried through to the residual effects assessment.	Refer to Section 12.2.5 for mitigations. Actions to minimize the extent to which the Project may contribute to in- and out-migration in the LSA include that Denison will initially prioritize the COI in terms of employment opportunities and will work with the leadership of these communities to assist in determining hiring practices during Project phases. Priority for hiring will then focus on Indigenous and non-Indigenous residents of the RSA and then beyond the RSA. Employees will not be permitted to commute to the site by any means other than the fly-in/fly-out worker rotation systems (i.e., they cannot drive to the site). Pick-up and drop-off points are being planned at two locally central points in communities within the LSA, at one additional site in Saskatchewan (i.e., Saskatoon), and potentially at other locations. Housing for workers will be provided at the camps with free accommodations and meals.
Income of local workers	Change in income of local workers	Communities in the LSA will see increased income through employment, training, and business opportunities from the Project, particularly with measures identified to enhance these opportunities. Increased income for local community members may result in inappropriate spending and have a negative effect on quality of life. Change in income of local workers is carried through to the residual effects assessment.	Mitigations (Section 12.2.5) to support worker increase in income include: health and wellness programming on-site; an Employee and Family Assistance Program; life skills and financial literacy training; and a workforce transition plan prior to decommissioning.
Community cohesion	Change in community	Changes in demography (e.g., in-migration to take advantage of Project-related	Mitigations (Section 12.2.5) for community cohesion include: pick-up points at two

Key Indicator	Measurable Parameter	Consideration in the Residual Effects Assessment	Mitigations
	cohesion as understood by community members through Key Person Interviews.	employment) can change the local demographic structure of a community. This may undermine social cohesion in a community (Mancini and Sala 2018), particularly when migrants are not northerners who may not hold the same social or cultural values as the communities in which they are moving to. Previous studies (CVMPP 2005) on the effects of worker rotation systems on workers, families, and communities in northern Saskatchewan found that the effects are primarily experienced by workers and their immediate families. Effects are not expected to affect communities more broadly. Change in community cohesion is carried through to the residual effects assessment.	locally central points in communities within the LSA, one additional site in northern Saskatchewan, and potentially other locations to minimize time spent away from families; a no drug and alcohol policy established at the Project site; enforcement of Denison's Environment, Health, Safety, and Sustainability Policy; continued liaison with LSA communities and relevant authorities; and culturally sensitive employment policies to support an Indigenous workforce.

12.2.6.2 Summary of Project-related Residual Adverse Effects on Community Well-being

The Project could affect income and community cohesion of residents primarily in the LSA in both positive and adverse ways, and the characterization of residual effects considers these potential outcomes. As noted earlier, Project-related changes to population and demographics will not be material enough to measure and are not carried through to the discussion of residual effects.

12.2.6.2.1 Income

A summary of residual effects on change in income is found in Table 12.2-8. In terms of change in income, the Project is expected to result in additional income for workers and their families, particularly in the LSA, as a result of Denison's focus on COI in terms of employment and business opportunities. This may result in increased cash income, while also potentially reducing the ability of some individuals to contribute to non-cash income through participation in the traditional economy (traditional economy is assessed in Section 13). Adverse effects could result from misspending of income. Upon Decommissioning of the mine, loss of income could contribute to individual stress. Denison will have a workforce transition plan prior to decommissioning of the mine and employee and family assistant programs to assist workers and their families.

The residual effects on change in income are anticipated to be positive/adverse, low in magnitude, local and regional in geographic extent, and medium-term in duration. The residual effects are also expected to be continuous in frequency, moderate in context, and fully reversible following Decommissioning.

Table 12.2-8: Community Well-being – Summary of the Characteristics Ratings for Change in Income

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Positive/Adverse	Increased income as a result of the Project can be beneficial to households in communities in the LSA and RSA. Adverse effects can also result (e.g., work rotations can limit the amount of time families have together).
Magnitude	Low (for adverse effects)	The Project will have a measurable effect on Community Well-being; however, the extent of effects in some instances will be based on individual decisions and actions.
Geographic Extent	Local and Regional	Effects of income relative to quality of life may occur for anyone employed on the Project, and may be discernable in the LSA and RSA as more individuals gain Project employment.
Duration	Medium-term	The period of time from Project Construction to end of Post-Decommissioning is 38 years, although effects on community income will be highest during Construction and Operation.
Frequency	Continuous	Any change in income to households in the LSA and RSA will occur throughout the during of the Project, especially during Construction and Operation.
Reversibility	Fully Reversible	Effects on income are fully reversible after Decommissioning.
Context	Moderate	Communities will be able to adapt to the Project as they have on previous developments. Mitigation measures are designed to support health promotion broadly.
Likelihood	Likely	The Project will result in increased income.

12.2.6.2.2 *Community Cohesion*

A summary of residual effects on changes in community cohesion is found in Table 12.2-9. The Project will likely result in some effects on community cohesion, mainly through participation in the worker rotation system (other pathways through changes in demographics and income are assessed separately in Section 12.2.4.2.1 and Section 12.2.4.2.2). Stress associated with participation in the worker rotation system, along with family tensions, may result in use of alcohol/substances as a coping mechanism. In some instances, evidence exists that these factors may result in an increase in violence and crimes, although this would be difficult to attribute directly to the Project. It is anticipated that the effects could be reduced over time as individuals and communities adjust to their participation in the worker rotation system.

With the application of mitigation measures, including the inclusion of a robust EFAP as part of employee benefits, health promotion activities on site, and the use of culturally sensitive employment policies, the residual effects on change in community cohesion are expected to be adverse, low in magnitude, local in geographic extent, and medium-term in duration. The residual effects are also expected to be continuous in frequency, moderate in context, and fully reversible following Decommissioning.

Table 12.2-9: Community Well-being – Summary of the Characteristics Ratings for Change in Community Cohesion

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	Employment and business opportunities, and in-migration of workers to the LSA, have the potential to change population and demographics in communities in the area and change community cohesion.
Magnitude	Low	Communities in the LSA are not expected to see any substantial in-migration as a result of the Project. The Project will also have positive inputs to communities in the LSA in terms of employment and business opportunities.
Geographic Extent	Local	Project Construction, Operation, and Decommissioning have the potential to affect communities in the LSA.
Duration	Medium-term	The period of time from Project Construction to end of Post-Decommissioning is 38 years, although effects may become less pronounced over time as individuals and communities adjust to the worker rotation system.
Frequency	Continuous	Any changes to community cohesion in the LSA communities will occur throughout the duration of the Project, especially during Construction, Operation, and Decommissioning.
Reversibility	Fully Reversible	Effects on community cohesion are fully reversible after Decommissioning.
Context	Moderate	Communities in the LSA will be able to adapt to the Project as they have on previous developments. The Project will also have positive effect on communities in the LSA.
Likelihood	Likely	The Project will likely result in some effects on community cohesion.

12.2.6.3 Significance and Confidence

A summary of the residual effects conclusions for change in income and change in community cohesion relative to the Community Well-being VC are provided in Table 12.2-10.

Table 12.2-10: Summary of Residual Effects Characterization for Community Well-being

Residual Effects Characteristic	Income	Community Cohesion
	Ratings	
Direction	Positive/Adverse	Adverse
Magnitude	Low (for adverse effects)	Low
Geographic Extent	Local and Regional Study Areas	Local Study Area
Duration	Medium-term	Medium-term
Frequency	Continuous	Continuous
Reversibility	Fully Reversible	Fully Reversible
Context	Moderate	Moderate
Likelihood	Likely	Likely

Although the outcomes of the Project for change in income and change in community cohesion relative to the Community Well-being VC may include a combination of adverse and positive residual effects, only adverse residual effects are considered in the context of significance. Changes to income and community cohesion relative to Community Well-being are expected to be negligible to low in magnitude, with the magnitude of effects potentially diminishing in some instances as participation in the worker rotation system becomes normalized for individuals, families, and communities. The residual effects are likely and will occur through the duration of Construction, Operation, and Decommissioning and will vary in frequency. Upon Decommissioning, it is expected that the residual effects will be reversed. The communities overall are resilient and are expected to accommodate the anticipated changes as there is already considerable experience with other similar uranium operations in the region. The overall conclusion for changes to income and community cohesion relative to Community Well-being is that the residual effects are expected to be **not significant**.

The overall confidence in the significance determination is moderate to high. This is based on the previous experience of the COI in the uranium industry in northern Saskatchewan, knowledge of other uranium mining operations, evidence gathered from processes such as the Community Vitality Monitoring Partnership, and other relevant project experiences in Canada and beyond.

12.2.7 Cumulative Effects

Consideration of cumulative effects is based only on residual adverse effects. Projects considered in the CEA (Section 5.9 in Section 5) were systematically examined for temporal and spatial overlap. Temporal overlap occurs when a project is a reasonably foreseeable development, meaning that the project is fairly certain and the development will take place within the planning horizon and expected life cycle of the Project (i.e., 38 years). The only project carried through to the CEA relative to Community Well-being was the Highway 914 All Weather Road Extension Project. Although some uncertainty exists as to when construction of the road will occur, it is reasonable to assume that it could overlap with Construction, Operation, and/or Decommissioning of the Project.

The planned Wollaston Lake all-season road and Highway 914 all weather road do not overlap with the Project Area or Community Well-being LSA; however, these roads fall within the boundary of the Community Well-being RSA. Construction of these all-weather roads will create an equivalent of 300 full-time employees, along with 6 to 10 long-term, full-time employment positions associated with maintenance, snow clearing, highway grading, and other repairs. An on-site camp(s) will provide accommodations and services for workers for the duration the construction of the road. Although this all-weather road project indicated a commitment towards Indigenous employment in the procurement process, commitments towards individual First Nations or Métis communities have not been specified. The list of Indigenous communities the Saskatchewan Ministry of Highways and Infrastructure (MOHI) consulted is broader than Denison’s Indigenous COI and is inclusive of numerous communities in the Northern Administrative District. This means some uncertainty exists as to whether this all-weather road project would draw upon the same labour pool as the Project, although it is possible that some positions may be available to those from

Denison's Indigenous COI. The opportunities associated with this all-weather road project would be of shorter duration, with construction occurring over a three-to-five-year period depending on the final design, and it is anticipated that some of the employment would be seasonal.

Given the understanding of this all-weather road project, the overlap in effects stemming from employment, such as those associated with income and community cohesion, is unlikely to result in any discernable changes, particularly as the opportunities associated with the all-weather road may involve a broader labour pool. As such, the assessment of cumulative effects and determination of significance for Community Well-being does not change with consideration of the all-weather road project.

With application of mitigation measures, cumulative effects on Community Well-being are expected to be adverse, low in magnitude, medium-term in duration, continuous in frequency, and fully reversible, and are anticipated to occur in a resilient socio-economic context. No additional mitigation measures are required.

12.2.7.1 Climate Change Considerations

The Project must also be considered in the context of climate change. The sensitivities of the Project to severe weather (e.g., extreme temperatures and excessive precipitation) and forest fires have been examined as they have the potential to adversely affect the Project. Events including flooding, tornadoes, and forest fires, which are likely to become more frequent and/or more severe under climate change, have been considered in the Accidents and Malfunctions report, although the risk of these events occurring has been determined as low, very low, or not expected (Ecometrix 2022). Beauval community members have identified the importance of water to community cohesion and have indicated that waterbodies have changed in recent years, resulting in flooding in one year to drought the next year (18-EN-VB-4.39). English River First Nation community members have commented that climate change has resulted in changes to the local environment (e.g., permafrost occurring further down in the ground; 16-EN-ERFN-100.17). Maintaining the health of both the ecological world and the human world is a guiding principle in many ERFN teachings (ERFN and SVS 2022a). Community members identified the environment as a direct benefit and positive effect on the community and its identity, including citizen spirituality and ties to the land. English River First Nation community members have indicated that the land is not only important because it is the physical space in which community activities and cultural events occur, but because humans are in an active relationship with their environment (ERFN and SVS 2022a). Working with Indigenous communities who are directly affected by the mining industry, including agreements to acknowledge the importance of positive relationships with Indigenous communities, could help preserve the environment (21-EN-SUR-446.62).

Detailed plans and procedures would be developed for the Project that are site specific, including:

- process monitoring and operational procedures;
- mine development and control procedures;
- radiation protection plan;
- spill and emergency response plan;
- traffic and transportation plan;
- security procedures;
- travel management plan;
- environmental monitoring procedures;
- personnel training procedures;
- regular and preventive inspection and testing procedures; and
- surface water and flood management procedures.

Based on a consideration of the mitigation strategies to be applied, past experience, and application of best management practices, the effects of a changing climate on the Project are expected to be **not significant**.

12.2.8 Monitoring and Follow-up

No monitoring or follow-up is anticipated for Community Well-being. Government departments and private-sector companies that provide community services will continue to monitor the ongoing demand. Denison will also continue to liaise with local communities and service providers for the duration of the Project.

12.2.9 Community Well-being Summary

The KIs for Community Well-being include population and demographics, income of local workers, and community cohesion. The rationale for the KIs include the following:

- Project activities may change population and demographics if in-/out- migration results from people seeking employment opportunities.
- Project activities may change income of local workers through participation in employment and/or contracting activities.
- Project activities may lead to a change in community cohesion through a change in income and participation in a worker rotation system.

The various phases of the Project could have different effects on Community Well-being and its KIs: population and demographics (no discernable changes anticipated); changes associated with participation in employment and the worker rotation system, including income for local workers;

and changes in community cohesion. In terms of Community Well-being, the experience of the Project will vary for individuals and families, which may be negative or positive.

Project employment and business opportunities could result in additional income for individuals and households that could be beneficial, such as increased money to participate in activities and ability to purchase healthier foods. Increased income could also result in negative behaviours, such as smoking, excessive drinking, and illicit drug use, which could be further exacerbated by factors such as time away from family due to worker rotations. This could also result in negative effects on community cohesion, including increased crime rates.

Effects on Community Well-being could be mitigated through prioritizing employment for LSA communities, working with LSA communities to develop hiring practices, and providing supports to individual workers and, in some cases, their families. Supports could include providing multiple, centrally located pick-up points for fly-in/fly-out workers; providing commuter transportation options to pick-up points that provide flexibility for workers to maintain employment; establishing health and wellness programming; establishing life skills programming; offering an EFAP; implementing a no drug and alcohol policy on site; and offering culturally sensitive employment policies (e.g., providing a space for an on-site Elder counsellor for culturally relevant programming).

The Project could affect local worker income and community cohesion of residents, primarily in the LSA in both positive and adverse ways. With the implementation of Project mitigation measures, residual effects on change in income and change in community cohesion are expected to be adverse/positive, low to moderate in magnitude, primarily local (i.e., LSA) in geographic extent, and medium-term in duration. Residual effects on change in income and change in community cohesion are also expected to be continuous in frequency, moderate in context, and fully reversible following Decommissioning.

The communities overall are resilient and expected to accommodate the anticipated changes as there is already considerable experience with other similar uranium operations in the region. Overall, the conclusion for changes to income and community cohesion relative to Community Well-being is that the residual effects are expected to be **not significant**, with confidence in the determination ranging from moderate to high. Further, with the application of mitigation measures, cumulative effects on Community Well-being are expected to be adverse, medium in magnitude, medium-term in duration, continuous in frequency, and fully reversible, and are anticipated to occur in a resilient socio-economic context. No additional mitigation measures, monitoring, or follow-up are required.

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12.3 Infrastructure and Services

12.3.1 Scope of the Assessment

The purpose of this section is to meet the Terms of Reference (EASB# 2019-005) requirements for the Project as issued by the Saskatchewan Ministry of Environment and CNSC. This section includes a detailed and comprehensive assessment of potential Project-related effects and cumulative effects from the Project and other developments on Infrastructure and Services. This section provides an understanding of how the Project will affect Infrastructure and Services, including:

- Will the Project increase the volume and types of traffic in the LSA?
- Will Project activities affect demands on local infrastructure and services, including changes to access, capacity, and quality of Infrastructure and Services?
- Will Project activities affect demands specifically on health and emergency services capacity?

The assessment of Infrastructure and Services followed the overall approach and methods provided in Section 5, which included the following primary steps:

Define the VC specific measurements: Sections 12.3.1.1 to 12.3.1.3 present the specific approaches and methods used to measure and assess the effects of the Project on Infrastructure and Services as well as the cumulative effects from the Project. This includes VC selection, identifying the KIs and MPs, and defining the spatial and temporal boundaries for Infrastructure and Services.

Characterize existing conditions: Section 12.3.3 describes and characterizes existing conditions to provide context and a basis for evaluating potential changes to Infrastructure and Services caused by the Project.

Assessment of Project-related effects and mitigation measures: Sections 12.3.4 and 12.3.5 identify and summarize potential interactions between the Project and each VC and KI. The assessment then identifies and describes the potential Project-related effects and assesses the changes due to the Project (i.e., residual effects after mitigation) and their significance. Project activities with the potential to affect each VC are provided mitigation policies and actions committed to by Denison to avoid or minimize potential adverse effects. A pathways analysis is used to focus further assessment on interactions between the Project and Infrastructure and Services by evaluating the different effect pathways to determine if, after incorporation of mitigation, there is still potential to cause residual adverse effects. Where potential adverse effects are adequately mitigated and are not forwarded for further analysis (i.e., where mitigation results in negligible effects or avoids the pathway altogether), the reasons for concluding the assessment at this stage are provided. Primary pathways anticipated to lead to residual adverse effects after incorporation of mitigation are carried forward to the next step for further analysis.

Residual effects evaluation and CEA: Sections 12.3.6 and 12.3.7 evaluate and describe the effects of the primary pathways from the Project on Infrastructure and Services. The residual effects analysis is presented as an integrated narrative that describes the effects of the Project over time and highlights predicted effects at the point when adverse effects of the Project are expected to be greatest. This section also completes an analysis of residual cumulative effects from the Project.

Monitoring and follow-up: Section 12.3.8 outlines the actions to verify predicted residual effects, evaluate effectiveness of planned mitigation designs, policies, and practices, and address key sources of uncertainty.

Figure 12.3-1 is a graphic representation of the assessment process used in this EIS.

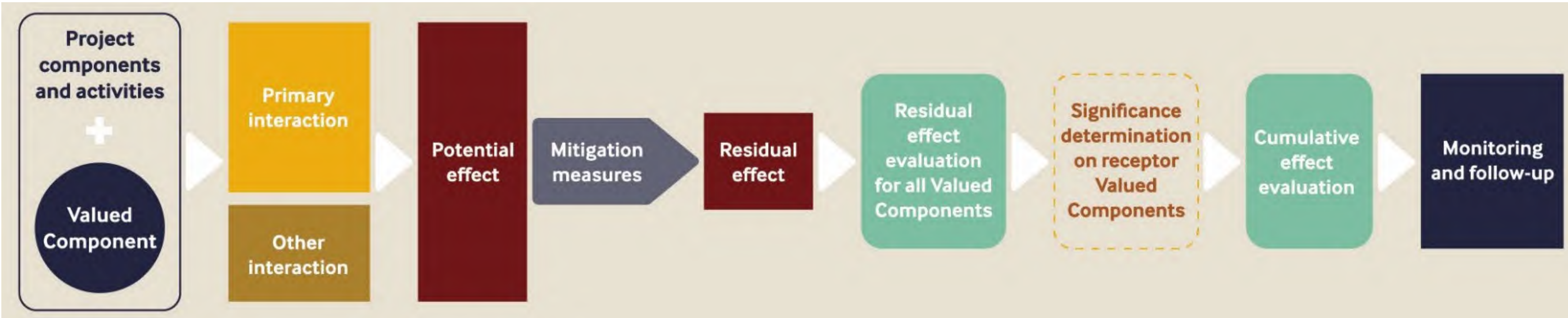

Figure 12.3-1: Environmental Assessment Process for the Wheeler River Project

12.3.1.1 Valued Component Selection

As per accepted EA practice, this EA is organized by and focused on VCs. The VCs are aspects of the biophysical and socio-economic environments that will likely be affected (adversely or positively) by the Project. The VCs reflect identified scientific, LK, and IK, and community interests regarding the Project and its potential effects. The VCs are typically identified early in the EA process as a result of questions and concerns raised through engagement with government departments and agencies, Indigenous and community groups, and the general public. Potential changes in traffic volumes and community infrastructure and services as a result of the Project were identified during engagement as interests and concerns regarding the Project. Comments through community engagement identified 'changes in traffic' as an interest and concern regarding the Project[15]. Community engagement with Pinehouse Lake raised the concern for increased traffic on the road from the Project (including increased risk of truck traffic vehicle incidents with land users) and a need for better information on transportation safety processes (KML 2022).

Initial direction and input into VC selection were obtained through IK, LK, discussions with government agencies and the public, results of baseline studies, regional data from other EAs, results from engagement and consultation activities, and results from similar or recent projects in the region. To validate VC selection and as part of engagement activities, Denison sought feedback from the English River First Nation (ERFN)[16] and the Northern Village of Beauval, Northern Village of Pinehouse Lake, and Northern Hamlet of Patuanak (hereafter Beauval, Pinehouse, and Hamlet of Patuanak, respectively). As part of engagement activities for Beauval and Pinehouse, Denison prepared and shared an online survey that included information about Denison and the Project and posed validation questions about the VCs being assessed as part of the EA process. Denison also met with the Métis Nation-Saskatchewan (MN-S) in early 2023 to share information about the Project, including discussion on VCs considered in the assessment; no new VCs were identified as part of that discussion.

Table 5-3.1 in Section 5 outlines the rationale for inclusion of Infrastructure and Services, which includes Project activities (e.g., increased traffic) that may affect demands on local infrastructure (e.g., roads and highways) and services. Initial direction and input into VC selection were obtained through:

- discussions with Indigenous groups;
- discussions with LK holders;
- discussions with government agencies and the public;

[15] 20-LK-LEASESUR-267.104, 20-LK-LEASESUR-267.105, 20-LK-LEASESUR-267.106, 20-LK-LODGESUR-267.107, and 20-LK-LODGESUR-267.108.

[16] The ERFN's Wapachewunak Reserve 192D is also referred to a Patuanak.

- results of baseline studies;
- regional data from other EAs;
- results from engagement and consultation activity; and
- results from similar or recent projects in the region.

Figure 12.3-2 is a graphic representation of the main linkages among the Infrastructure and Services VC and other VCs, illustrating the flow of assessment information into and from the Infrastructure and Services VC.

Figure 12.3-2: Integrated Assessment Approach - Key Connections between Infrastructure and Services and Other Valued Components

12.3.1.2 Key Indicators and Measurable Parameters

A KI, such as traffic, is an important aspect of a VC that may be affected by the Project and its activities. A MP is the metric associated with the KI that can be used to characterize changes to attributes of the environment that may change as a result of the Project and/or other human developments and natural factors. The changes in MPs are used to predict overall effects on the KIs, and in turn on the VCs. Two KIs (i.e., traffic and community infrastructure and services) were identified, along with associated MPs for Infrastructure and Services (Table 12.3-1). The MP for the traffic KI is change in traffic volumes and types and risk of accident due to Project activities. Measurable parameters for the community infrastructure and services KI are change in access to and capacity of community infrastructure and services and change in emergency services capacity due to Project activities.

Table 12.3-1: Key Indicators and Measurable Parameters for Infrastructure and Services

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Traffic	Project activities may increase traffic	Change in traffic volumes and types and risk of accident
Community infrastructure and services	Project activities may affect demands on local infrastructure and services	Change in access to and capacity of community infrastructure and services
	Project activities may affect demands on emergency services	Change in emergency services capacity

12.3.1.3 Spatial and Temporal Boundaries

12.3.1.3.1 Spatial Boundaries

The spatial boundaries selected for Infrastructure and Services were chosen because they permit baseline characterization in sufficient detail to assess potential interactions between the Project and Infrastructure and Services. These boundaries were developed in consideration of where interactions are likely to occur and where residents in the area are likely to access services. The spatial boundaries were derived based on the consideration of communities where Project recruitment is likely to be prioritized, consideration of previous EAs conducted in the region, and consideration of information shared through key persons during the KPI program. The spatial boundaries may be further refined during study implementation based on feedback from regulators, local and Indigenous communities, and the public. The spatial boundaries for Infrastructure and Services include:

- the traffic study area;
- the LSA for community infrastructure and services; and
- the RSA for community infrastructure and services.

Traffic Study Area

The traffic study area includes the highways anticipated to be used throughout the Project phases, which include Highway 914 and Highway 165. Additional highways near the communities in the LSA, including Highway 918 to Patuanak, Highway 155, and Highway 2, are not likely to be affected by Project-related truck traffic since traffic during the Construction and Operation phases is not expected to intersect with those areas, or would be indistinguishable from existing traffic volumes. Figure 12.3-3 shows the location of the Project in relation to the communities in the LSA, including the locations of Highway 914 and Highway 165.

Local Study Area for Community Infrastructure and Services

The LSA for community infrastructure and services includes the communities where Project activities may affect demands on local infrastructure and services or health and emergency services. The LSA includes:

- ERFN (including Indian Reserves Wapachewunak 192D and La Plonge 192) and Patuanak, Northern Hamlet;
- Pinehouse Lake, Northern Village; and
- Beauval, Northern Village.

Regional Study Area for Community Infrastructure and Services

The RSA for community infrastructure and services is the Northern Saskatchewan Administrative District (Census Division 18), which is defined in *The Northern Municipalities Act, 2010* (Government of Saskatchewan 2021a).

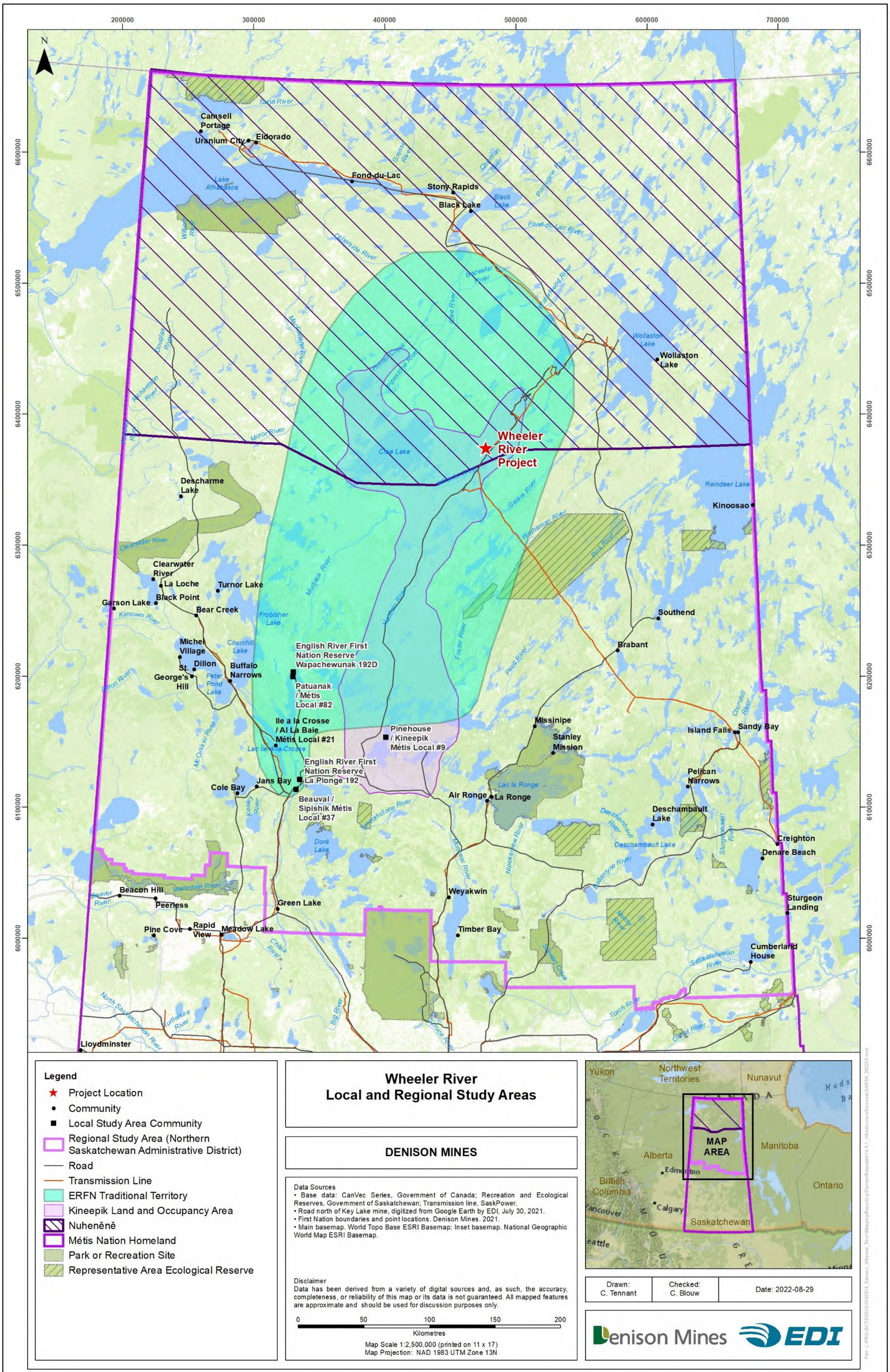

Figure 12.3-3: Location of the Project in Relation to the Communities in the Local Study Area

12.3.1.3.2 Temporal Boundaries

The characterization of the existing environment for the traffic study area focused on the current condition of transportation infrastructure and maintenance requirements. The assessment of traffic volumes and vehicle accidents included the previous 10 years to understand trends. Traffic volume data were sourced from the Saskatchewan MOHI for the years 2011 to 2019 (Saskatchewan MOHI 2021). Vehicle accident statistics were sourced from Saskatchewan Government Insurance (2011 to 2019).

The characterization of the existing environment for community infrastructure and services in the LSA and RSAs focused on the current status of Infrastructure and Services.

The temporal scope of the assessment for all MPs of the traffic and community infrastructure and services KIs was forward looking and included the period from initial Construction to the end of Decommissioning as defined by the following Project phases:

- Construction: includes site preparation; wellfield and freeze hole drilling; processing plant construction; other service infrastructure; and electrical infrastructure. The duration of Construction will be approximately two years.
- Operation: includes operation of the wellfield; operation of the processing plant and production; maintenance activities; water withdrawal from groundwater or surface water for potable use, fire suppression, and make-up water in the processing plant; water treatment; waste management; environmental monitoring; package and transport of nuclear substances; reporting to regulators; engagement; and site security. The duration of Operation will be approximately 15 years.
- Decommissioning: includes mining chamber remediation; decontamination; asset removal; demolition and disposal; and reclamation. The duration of Decommissioning will be approximately five years.

12.3.2 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

Indigenous Knowledge, LK, and engagement were included in the assessment through workshops, surveys, and KPIs identified in Section 3 and Section 4 of the EIS. Indigenous Knowledge, LK, and engagement for the assessment are described in Section 3 and Section 4 of the EIS. Sources of information relevant to the influence of IK and LK include the *Wheeler River Project – Summary of Health and Socio-Economy Study Results – English River First Nation* (ERFN and SVS 2022a), *Wheeler River Project – Summary of Traditional Knowledge Study Results – English River First Nation* (ERFN and SVS 2022b), and the *Kineepik Métis Local #9 Kineepik Valued Ecosystem Components pre-statement for the Denison EIS* (KML 2022). The MN-S submitted *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) to Denison in October 2023. The Métis knowledge summarized therein included secondary literature approved for use by the MN-S and primary information collected during interviews with nine Métis citizens from Northern Region 1 (NR1) and Northern Region 3 (NR3), exclusive of information from the KML at Pinehouse who formally revoked its delegated Duty to Consult from the MN-S. Further information relevant to IK and LK is provided in Section 11.

As related to Infrastructure and Services, Denison sent all known local cabin and lodge leaseholders a survey to complete regarding their interests in the Project, which informed the understanding of their uses in the area and interests regarding elements to be assessed as part of the EA. The survey is provided in Appendix 4-A in Section 4. Engagement identified that changes in traffic and traffic volumes are an interest and concern regarding the Project and the EA. Respondents also expressed interest and concern for the kinds of infrastructure that will be used at the Project (e.g., road infrastructure and electrical infrastructure). Comments through community engagement identified 'changes in traffic' as an interest and concern regarding the Project[17]. Community engagement with Pinehouse Lake raised the concern for increased traffic on the road from the Project (including increased risk of truck traffic vehicle incidents with land users) and a need for better information on transportation safety processes (KML 2022).

Local Knowledge informed the assessment of the traffic and community infrastructure and services KIs through KPIs with community members, service providers, and government employees. A KPI Program was undertaken to address gaps that could not be readily filled by secondary sources and to provide context and perspectives on community interests and concerns.

Denison has recorded and stored information regarding IK, LK and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 18-EN-ERFN-5.58). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment. Appendix 12-A provides a summary of unique identification numbers referenced within Section 12.3.

12.3.3 Existing Environment

12.3.3.1 Methods and Limitations

The characterization of the existing environment includes both primary and secondary data sources. Data collection began with a review of existing literature and databases from a variety of public sources. Primary data collection was undertaken in the form of KPIs. Online surveys, workshops, and other forms of engagement assisted in identifying community interests and concerns relative to existing conditions.

[17] 20-LK-LEASESUR-267.104, 20-LK-LEASESUR-267.105, 20-LK-LEASESUR-267.106, 20-LK-LODGESUR-267.107, and 20-LK-LODGESUR-267.108.

Literature Review

The review of literature and databases included the following sources:

- statistical data sources (e.g., Statistics Canada);
- federal, provincial, and municipal government reports and data;
- regional level documents;
- community profiles;
- publicly available profiles, reports, and EAs of past projects in the area; and
- online sources (e.g., community websites).

The most recent data from these sources were used to characterize the existing environment.

Traffic Volume Data

The Saskatchewan MOHI conducts infrequent traffic counts on northern highways due to their relatively low traffic density. The Saskatchewan MOHI estimates the truck average annual daily traffic (TAADT) and average annual daily traffic (AADT) on Highways 914 and 165 based on actual traffic counts conducted on these highways and known travel patterns on similar highways. Traffic counts are conducted over a 48-hour period but are not completed every year (Government of Saskatchewan 2018). Traffic is counted in both directions, making it difficult to determine whether traffic has been counted twice in a 48-hour counting period. The Government of Saskatchewan operates 76 continuous traffic monitoring stations (Government of Saskatchewan 2018). Highways 914 and 165 do not have continuous traffic monitoring stations; therefore, average daily traffic volume reports are not produced for these highways.

Vehicular Accident Data

The Traffic Accident Information System compiles information on traffic collisions occurring on Saskatchewan roads (SGI 2021). Collisions involving bodily injury or death, a hit and run, an out-of-province vehicle, an unregistered vehicle, an impaired operator, and instances where vehicles must be towed are reported through police agencies (SGI 2021). A Motor Vehicle Accident form is completed in accordance with Section 253 of *The Traffic Safety Act*, 2004 (Government of Saskatchewan 2021b) and forwarded to Saskatchewan Government Insurance. Information for all other types of collisions is collected through Saskatchewan Government Insurance's claims reporting process (SGI 2021). Both data sources are combined to create the Traffic Accident Information System. The collision database and its publications are administered by Saskatchewan Government Insurance.

Statistics Canada Census of Population

Statistics Canada Census of Population data were used to develop an understanding of the LSA and RSA and gain an understanding of housing characteristics. Statistics Canada suppresses data for confidentiality or data quality. Data suppression for confidentiality reasons is meant to prevent the disclosure of data that could be used to identify individuals. Data suppression for data quality is done for a variety of reasons, including incompletely enumerated Indian reserve parcels or Indian settlements, or a global non-response rate of greater than or equal to 50%. To address these limitations, key trends or findings were confirmed through multiple sources where possible, otherwise known as triangulation. Triangulation involves seeking multiple sources from different perspectives to corroborate data, such as through KPIs and other published reports and data (Pierce 2007).

Statistics Canada enumerates data for Wapachewunak 192D and La Plonge 192 separately. Information on ERFN citizens residing off-reserve is not readily available from secondary sources. To the extent possible, these communities are described separately within this document, but the interconnectedness among the locations means certain topics related to the community infrastructure and services KI are described collectively.

Key Person Interview Program

A KPI Program was undertaken to address gaps that could not be readily filled by secondary sources and to provide context and information on community interests and concerns. Interview guides were developed to address gaps in information and solicit local context. Key Person Interviews were conducted from June 2021 to May 2022. Interviews were conducted with the consent of individual interview participants, including an informed consent that provided each participant with an understanding of the Project and the reasons for the interview, an understanding that responses provided were confidential and would not be associated to the participant, and an understanding that the interview was voluntary.

Data retrieved from KPIs are not representative of the perspectives of all community members. Key persons were selected based on their knowledge and experience that could be relevant to characterizing the existing environment. Participants in the KPI Program were identified by InterGroup based on a community member or organization that was anticipated to have expertise or knowledge on a specific topic (e.g., for information on health care facilities and services, a health care professional was a contact). During the interview, if it was determined that additional information or local context was required, participants were asked if they were aware of other experts and knowledge holders locally or regionally that could serve as a resource on the topic. This sampling method is referred to as snowball sampling in which existing subjects and interviewees are asked to assist and provide referrals for further potential subjects and research (whether local or regional residents, organizations, or reports and documentation) (OSU 2010). If the topic was of a sensitive or personal nature, care was taken to make sure that the potential subjects’ privacy was not violated. For example, the interviewee may have been the one to reach out to the potential referral to ask for permission to share their contact information. Data presented from the KPIs is to the best of the interviewed community member’s knowledge.

Other Sources of Information

Indigenous Knowledge was incorporated into the description of the existing environment as described in Section 12.3.2, including results from the *Wheeler River Project – Summary of Health and Socio-Economy Study Results – English River First Nation* (ERFN and SVS 2022a), *Wheeler River Project – Summary of Traditional Knowledge Study Results – English River First Nation* (ERFN and SVS 2022b), and the *Kineepik Métis Local #9 Kineepik Valued Ecosystem Components and pre-statement for the Denison EIS* (KML 2022). Further information relevant to IK and LK is provided in Section 11. Information from engagement activities, workshops, and surveys was also used to inform the description of the existing environment.

12.3.3.2 Key Indicator: Traffic

The traffic overview was developed to characterize the socio-economic baseline in the traffic study area. Understanding baseline traffic volumes and trends will contribute to the eventual understanding of how the Project may affect traffic. The existing environment describes:

- highway infrastructure, including highway weight limits, seasonal highway restrictions, and highway maintenance;
- traffic volume, including AADT and TAADT; and
- traffic related accidents (collisions and persons).

12.3.3.2.1 Description of Highway Infrastructure (Highway 914 and Highway 165)

The Project is in a relatively undisturbed area of the boreal forest off Highway 914, approximately 35 km north-northeast of the Key Lake uranium operation. Access to Highway 914 north of the Key Lake uranium operation is controlled by a gatehouse operated by Cameco Corporation (Cameco). Access to Highway 914 north of the Key Lake gatehouse is restricted to employees of northern mines, Indigenous resource harvesters from select communities, cabin owners, and lease owners (KPI Program 2021–2022). Access north of the Key Lake gatehouse for employees of northern mines, Indigenous resource harvesters from select communities, cabin owners, and lease owners provides for controlled access to users. Community engagement identified the following:

> "*There has not been a problem with the access set-up [at the Key Lake gatehouse], so I do not anticipate one with this [Project]. I do not think there will be a problem*" (21-EN-ERFN-473.6).

> "*For the Key Lake gatehouse access I do not think it will be an issue for the people*" (21-EN-BLFN-570.5).

The south access to Highway 914 is at Highway 165. Figure 12.3-4 shows the location of the Project in relation to Highway 914 and Highway 165.

Highway 914 is an all-weather, unpaved highway that is approximately 8 m wide (shoulder to shoulder) (KPI Program 2021–2022). Highway 914 begins at Highway 165 and extends north to the

Key Lake uranium operation (approximately 268 km) where it is controlled by a gatehouse operated by Cameco. Highway 914 continues north of the Key Lake gatehouse to the McArthur River uranium operation (approximately 80 km). There are no communities located directly on Highway 914; however, the turnoff for Pinehouse Lake is located approximately 48 km north of the intersection of Highway 914 and Highway 165. Pinehouse Lake is located approximately 1.5 km off Highway 914. The speed limit on Highway 914 is 80 km/hr (KPI Program 2021–2022). Given the traffic volumes observed during the Key Lake and McArthur River uranium operations, and the low traffic volumes observed on Highway 914 (see Section 12.3.3.2.2), traffic volumes on Highway 914 have not resulted in any recent issues with road integrity and the highway is in good condition (KPI Program 2021–2022).

Highway 165 is an all-weather, paved highway that is approximately 8.5 m wide (shoulder to shoulder) (KPI Program 2021–2022). The section of the highway extending from Highway 155 to Highway 2 in the traffic study area is approximately 177 km. Beauval is the only community located on Highway 165 and is located approximately 8 km northeast of the Highway 155 and Highway 165 intersection. The speed limit on Highway 165 is 80 km/hr (KPI Program 2021–2022). Given the traffic volumes on Highway 165 (see Section 12.3.3.2.2), traffic volumes on Highway 165 are not an issue with respect to road integrity and the highway is in good condition (KPI Program 2021–2022).

Highway 165 and Highway 914 are designated as nine-month (July through March) primary highways and three-month (April through June) secondary highways (KPI Program 2021–2022). A nine-month primary highway allows for a maximum gross vehicle weight of 62,500 kg and a nine-axle configuration (e.g., a tridem drive truck tractor B train combination); however, from April to June, the maximum gross vehicle weight is reduced and is subject to vehicle tire size, inter-axle spacing, and axle spread (Government of Saskatchewan 2019, KPI Program 2021–2022).

Maintenance for highways in Saskatchewan is provided by the Saskatchewan MOHI and is prioritized by AADT, as per the following (KPI Program 2021–2022):

- Level 1 highways (inter-provincial routes) receive the highest priority and have an AADT of over 1,500.
- Level 2 highways have priority after level 1 highways and have an AADT of 300 to 1,500.
- Level 3 highways have the lowest priority with an AADT of less than 300.

Highway 914 is a level 3 highway. Maintenance of Highway 914 from Highway 165 to the Key Lake gatehouse is primarily provided by the Saskatchewan MOHI maintenance shop at Pinehouse Lake (KPI Program 2021–2022). Maintenance north of the Key Lake gatehouse is provided by Cameco (KPI Program 2021–2022). Highway 914 from Highway 165 to the Key Lake gatehouse is contracted out for gravel blading and dust treatment on an as-needed basis (KPI Program 2021–2022). Highway 914 does not have any formal services for travellers (e.g., gas stations) (KPI Program 2021–2022).

Highway 165 is a level 2 highway. Maintenance is provided by the Saskatchewan MOHI maintenance shop in Beauval (KPI Program 2021–2022). Highway 165 does not have any formal services for travellers (e.g., gas stations) outside of Beauval (KPI Program 2021–2022).

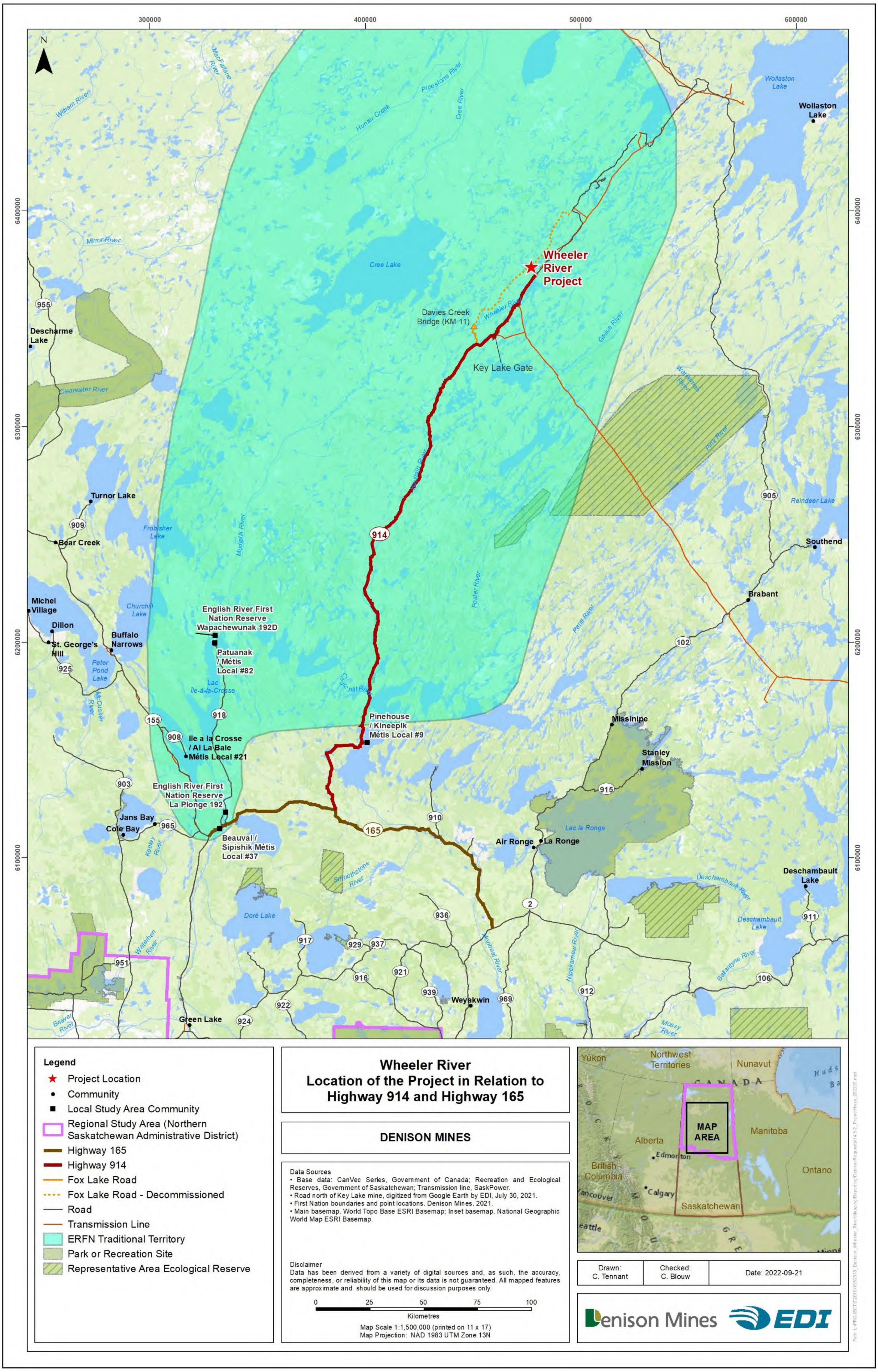

Figure 12.3-4: Location of the Project in Relation to Highway 914 and Highway 165

12.3.3.2.2 Traffic Volumes

A previous traffic study was conducted for the unmonitored road between the Key Lake and McArthur River uranium operations for the Millennium EIS in 2011. Since this study, some changes have occurred in northern Saskatchewan that affect traffic levels. One substantial change has been the Key Lake and McArthur River uranium operations moving from operation to care and maintenance status in 2018 due to prolonged market weakness (Cameco 2021a). This has resulted in fewer trucks on Highway 914. The McArthur River uranium mine was in safe state of care and maintenance until early 2022 and is in the RSA, northwest of the LSA. In early 2022, Cameco announced plans for the gradual return of the Key Lake and McArthur River uranium operations to production (Cameco 2022). Another current event affecting traffic has been the coronavirus pandemic. This has affected uranium markets, and as a result, mining exploration companies in northern Saskatchewan have ceased activities since early 2020 (Cameco 2021b). Table 12.3-2 summarizes TAADT data for Highways 914 and 165. The TAADT data reflect a slight decrease in truck traffic occurring alongside the move from operations to care and maintenance for the Key Lake and McArthur uranium operations since July 2018 (Cameco 2021a). Segment 5B on Highway 165 (Highway 918 to Highway 155) experienced the highest TAADT, which included a TAADT of 60 in 2019. Beauval is located on segment 5B.

Table 12.3-3 summarizes AADT data for Highways 914 and 165. There are no data for Highway 914 north of the Key Lake uranium operation gatehouse as it is maintained by Cameco rather than the Saskatchewan MOHI. The AADT data reflect a decrease in truck traffic occurring alongside the move from operations to care and maintenance for the Key Lake and McArthur River uranium operations since July 2018 (Cameco 2021a). Segment 5B on Highway 165 (Highway 918 to Highway 155) experienced the highest AADT, which included a AADT of 780 in 2019. Beauval is located along segment 5B. The methods for traffic volume data are provided in Section 12.3.3.1. Figure 12.3-5 shows Highway 914 and Highway 165 with the segments identified by data summarized in Table 12.3-2 and Table 12.3-3.

Table 12.3-2: 2011 to 2019 Truck Annual Average Daily Traffic on Northern Saskatchewan Highways (Highway 914 and Highway 165)[1]

Segment (Figure Ref.)	Highway	From	To	TAADT[2] 2011	TAADT 2012	TAADT 2013	TAADT 2014	TAADT 2015	TAADT 2016	TAADT 2017	TAADT 2018	TAADT 2019	Average 2011–2019
1[3]	Access Road	Wheeler River Project Camp	Highway 914	-	-	-	-	-	-	-	-	-	-
2[3]	Highway 914	Project Access Road	Key Lake Gate	58[4]	-	-	-	-	-	-	-	-	-
3A	Highway 914	Key Lake Gate	Gordon Lake Access	35	35	35	35	35	35	35	35	35	35
3B	Highway 914	Gordon Lake Access	Snake Rapids Bridge	35	35	35	35	35	35	35	35	35	35
3C	Highway 914	Snake Rapids Bridge	Pinehouse Lake Access	40	40	40	40	40	35	35	35	35	38
4	Highway 914	Pinehouse Lake Access	Highway 165	65	65	65	65	65	50	50	50	50	58
5A	Highway 165	Highway 914	Highway 918	35	40	40	40	40	35	35	35	35	37
5B	Highway 165	Highway 918	Highway 155	50	65	65	65	65	60	60	60	60	61
6A	Highway 165	Highway 914	Highway 910	25	30	30	30	30	30	30	25	25	28
6B	Highway 165	Highway 910	Highway 2	30	30	30	40	40	40	40	45	45	38

Source: Saskatchewan MOHI 2021.

Notes:

1 Traffic counts are taken over a 48-hour period and are not conducted every year. Truck annual average daily traffic provided in Table 12.3-2 is counted in both directions, making it difficult to determine whether traffic has been counted twice in a 48-hour counting period (Government of Saskatchewan 2018).

2 TAADT = Truck Annual Average Daily Traffic.

3 No data are available for TAADT as this road is maintained by Cameco rather than the Saskatchewan MOHI.

4 Data is from the 2010 TAADT used in the Millennium EIS for this segment of highway.

Table 12.3-3: 2011 to 2019 Annual Average Daily Traffic on Northern Saskatchewan Highways (Highway 914 and Highway 165)[1]

Segment (Figure Ref.)	Highway	From	To	AADT[2] 2011	AADT 2012	AADT 2013	AADT 2014	AADT 2015	AADT 2016	AADT 2017	AADT 2018	AADT 2019	Average 2011–2019
1[3]	Access Road	Wheeler River Project Camp	Highway 914	-	-	-	-	-	-	-	-	-	-
2[3]	Highway 914	Project Access Road	Key Lake Gate	60[4]	-	-	-	-	-	-	-	-	-
3A	Highway 914	Key Lake Gate	Gordon Lake Access	50	50	50	50	45	45	45	45	45	47
3B	Highway 914	Gordon Lake Access	Snake Rapids Bridge	50	50	50	50	45	45	45	45	45	47
3C	Highway 914	Snake Rapids Bridge	Pinehouse Lake Access	90	90	90	90	90	90	90	90	90	90
4	Highway 914	Pinehouse Lake Access	Highway 165	170	170	230	230	230	230	230	190	190	208
5A	Highway 165	Highway 914	Highway 918	300	270	300	300	240	240	240	180	180	250
5B	Highway 165	Highway 918	Highway 155	740	780	810	810	960	960	960	780	780	842
6A	Highway 165	Highway 914	Highway 910	120	120	130	130	130	130	130	70	90	117
6B	Highway 165	Highway 910	Highway 2	220	220	230	230	230	230	230	210	190	221

Source: Saskatchewan MOHI 2021.

Notes:

1 Traffic counts are taken over a 48-hour period and are not conducted every year. Annual average daily traffic provided in Table 12.3-3 is counted in both directions, making it difficult to determine whether traffic has been counted twice in a 48-hour counting period (Government of Saskatchewan 2018).

2 AADT = Annual Average Daily Traffic.

3 No data are available for AADT as this road is maintained by Cameco rather than the Saskatchewan MOHI.

4 Data is from the 2010 TAADT used in the Millennium EIS for this segment of highway.

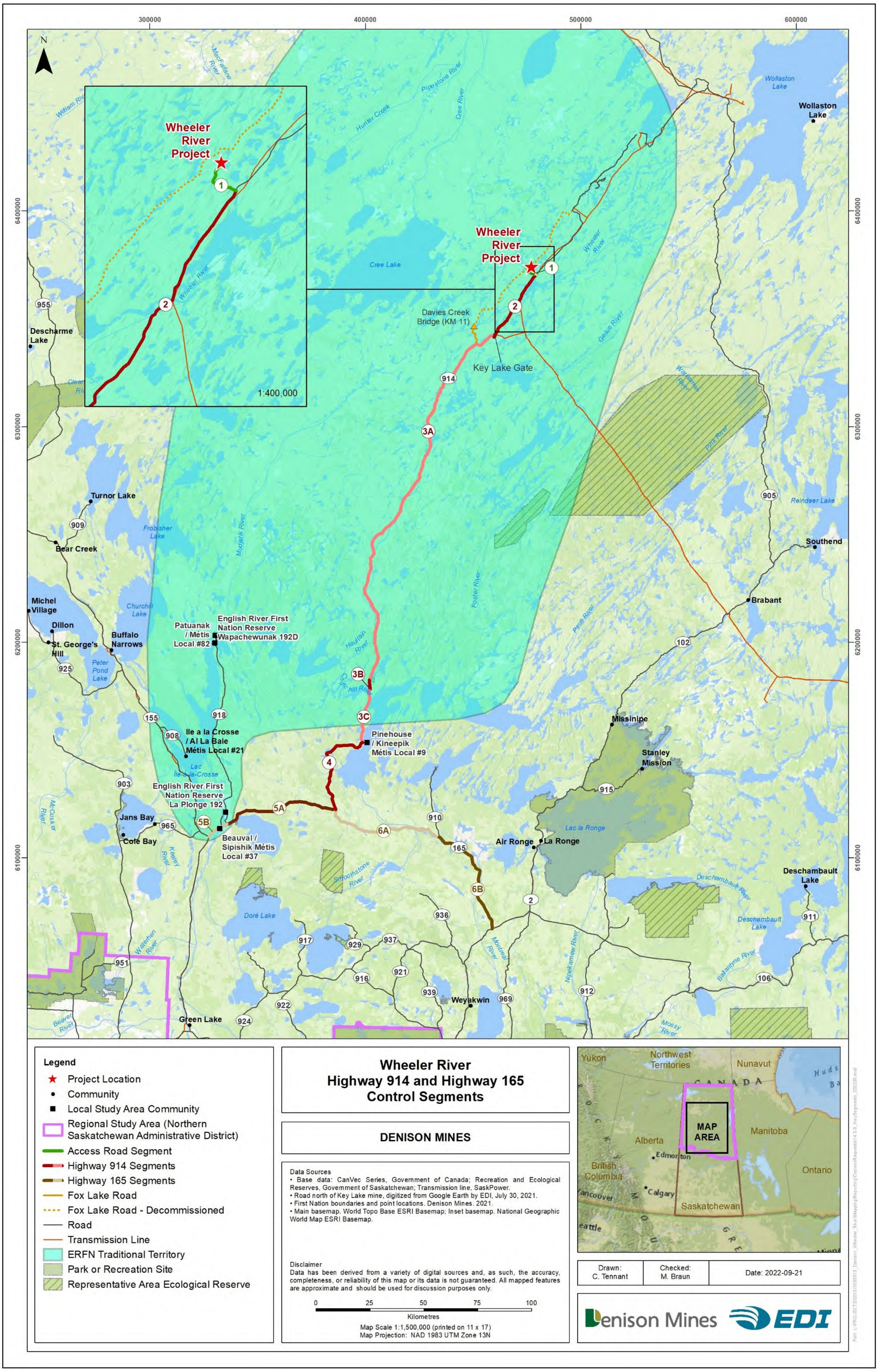

Figure 12.3-5: Highway 914 and Highway 165 Segments

12.3.3.2.3 Vehicular Accidents

Table 12.3-4 summarizes the collisions per million vehicle kilometres (MvKm), persons injured, and persons killed on Highways 914 and 165. The data indicate that for both Highway 914 and Highway 165, there has been an overall decrease in collisions per MvKm from 2011 to 2019. Highway 914 had 0.93 collisions per MvKm in 2011 and 0.00 collisions per MvKm in 2019, with a peak of 1.11 collisions per MvKm in 2015. Highway 165 had 0.73 collisions per MvKm in 2011 and 0.62 collisions per MvKm in 2019, with a peak of 1.71 collisions per MvKm in 2016. Since 2017, Highways 914 and 165 have had less collisions per MvKm than Saskatchewan as a whole. The methods for vehicular accident data are provided in Section 12.3.3.1.

Table 12.3-4: Collisions per Million Vehicle Kilometres, Persons Injured, and Persons Killed on Highways 914 and 165

Year	Highway 914			Highway 165[1]			All Provincial Highways
	Coll./ MvKm[2]	Persons Injured	Persons Killed	Coll./ MvKm[2]	Persons Injured	Persons Killed	Coll./ MvKm[2]
2019	0.00	0	0	0.62	2	0	0.88
2018	0.18	0	0	0.52	0	0	0.87
2017	0.48	1	0	0.73	3	0	0.83
2016	0.64	2	0	1.71	11	1	0.81
2015	1.11	3	2	1.47	8	0	0.72
2014	0.78	1	0	0.54	0	2	0.66
2013	0.93	3	0	0.89	6	0	0.82
2012	0.31	1	0	1.18	9	1	0.74
2011	0.93	2	0	0.73	1	0	0.84

Source: SGI (2021).

Notes:

1 Table 12.3-4 provides a summary of the Highway 165 control segments from Highway 155 to Highway 2. The summary does not include the Highway 165 control segment from Highway 106 to Highway 2. The calculations to support collisions per MvKm are provided in Appendix 12-E.

2 Coll./ MvKm = collisions per million vehicle kilometres.

12.3.3.3 Key Indicator: Community Infrastructure and Services

The community infrastructure and services overview was developed to characterize the socio-economic baseline in the LSA. Understanding the baseline for community infrastructure and services will contribute to the eventual understanding of how the Project may affect community infrastructure and services. Community profiles for each of the LSA communities were developed to characterize the socio-economic baseline. Greater detail for each community is provided in Appendix 12-B.

This section provides details about community facilities and services available in ERFN (on-reserve communities of Wapachewunak and La Plonge), the Northern Hamlet of Patuanak, the Northern Village of Pinehouse Lake, and the Northern Village of Beauval, including a discussion of how these communities compare to northern Saskatchewan and Saskatchewan, where data are available. Community infrastructure and services discussed in this section include the following:

- educational facilities and programs;
- health care facilities and services;
- emergency services;
- social services and programs;
- airport infrastructure;
- recreation services; and
- housing.

12.3.3.3.1 English River First Nation and Patuanak

For the purposes of the EIS, references to ERFN refer primarily to the on-reserve communities of Wapachewunak and La Plonge, the two locations with year-round residents. English River First Nation's main reserve parcel, Wapachewunak, is adjacent to the Northern Hamlet of Patuanak on the Churchill River and acts as the administrative centre for the First Nation (Meadow Lake Tribal Council n.d.). Although separate administrative entities, the two communities are interconnected. The two communities share much of the same infrastructure and services, including a school, roads, an airport, a landfill, and medical facilities.

<u>Educational Facilities and Programs</u>

Childcare

St. Louis School located in Patuanak has a daycare centre for childcare services (Yellow Pages n.d.b).

Elementary and High Schools

St. Louis School provides education to children from kindergarten to grade twelve. St. Louis School includes Dene language in its curriculum to ensure ERFN residents can speak the language (NWMO 2013a). The school has staff employed who provide literacy and mathematics assistance, as well as special education for students (English River School n.d.). Classes at St. Louis School have TK built into the curriculum to help maintain traditional identity. English River First Nation also runs Mission Hill Elementary School in La Plonge. Following graduation from Mission Hill Elementary School, La Plonge students attend Valley View Highschool in Beauval (NWMO 2013a).

In recent years, St. Louis School has hired a culture and Dene language teacher who is responsible for organizing the school's annual cultural conference where Elders discuss traditional activities, such as sweat lodge building and tanning animal hides. These sessions are recorded with the intention of uploading them to YouTube. Additional resources for the culture and Dene language teacher were noted as they could be useful in integrating land-based education throughout all grades. St. Louis School has purchased drum-making kits for students in Patuanak and La Plonge, with the hopes that Elders can teach students traditional art. There was strong consensus among interview participants that land-based education should be prioritized (ERFN and SVS 2022a).

Although the Education Department is the largest department by funding from Chief and Council, technical classrooms are said to require upgrades. Upgraded science, engineering, and technical classrooms are said to be needed to strengthen science, technology, engineering, and mathematics education. Specific technical classrooms in need include a science lab for students to conduct experiments, an upgraded industrial arts classroom for skilled trades, and an upgraded computer lab to enable the school to teach digital skills to students (ERFN and SVS 2022a).

Post-secondary Education

In 2011, the University of Saskatchewan opened the Office of Aboriginal Initiatives in ERFN's Grasswood urban reserve south of Saskatoon. This centre provides a place for ERFN members to access general information about the university, such as enrollment, potential employment, and research opportunities (University of Saskatchewan n.d.).

There are several options for community members to access post-secondary education within the RSA. The University of Saskatchewan offers courses through Northlands College, with campuses located in La Ronge, Creighton, Île-à-la-Crosse, and Buffalo Narrows. Each of these campuses require a commute, with Île-à-la-Crosse being the closest (a two-hour drive one way). As a result, students are required to relocate to attend classes at these campuses. Students have access to a variety of certification options such as university education, technology and trades diplomas and certificates, and Adult Basic Education (Northlands College n.d.). Northlands College, in partnership with Saskatchewan Housing Authority, provides housing for students that attend Northlands College (KPI Program 2021–2022).

The University of Regina has an extensive list of online courses spanning different disciplines, providing flexible learning opportunities (University of Regina n.d.). Details on educational attainment for ERFN and Patuanak residents can be found in Section 13.

First Nations students who meet eligibility criteria can receive financial assistance for post-secondary education through Indigenous Services Canada. To obtain financial assistance, post-secondary students must be enrolled in a recognized educational institution and successfully complete courses towards their degree, diploma, or certificate (Government of Canada 2020).

Through a Collaboration Agreement between Cameco, Orano Canada Inc. (formerly AREVA Resources Canada Inc.), and ERFN, a trust for post-secondary education has been assisting ERFN members with post-secondary education funding since 2012. Through the trust, 58 students from

ERFN received scholarships in 2018. The trust also aids with purchasing school supplies for children in elementary and high school, and funding sports and recreation programs (Joint Implementation Committee 2018).

Health Care Facilities and Services

English River Health Services is located in Patuanak and is run by the Saskatchewan Health Authority's Integrated Northern Health Division. The health facility is open during the week from 8:30 am to 4:30 pm with a one-hour closure for lunch. The health facility is staffed with a Registered Nurse and Registered Practical Nurse. Specialty health services, including dental, psychological, and optical, are not offered on a regular basis in Patuanak (Northern Saskatchewan Health Services n.d.). Residents of La Plonge access health services through the health clinic in Beauval, which is also operated by the Saskatchewan Health Authority's Integrated Northern Health Division (NWMO 2013a).

English River Health Services facility has the following services, service providers, and programs for residents in the area:

- Services:
  - addiction services;
  - emergency air medevac;
  - home care services;
  - mental health/holistic health services (services may include family support, suicide prevention, youth suicide services, addictions, National Native Alcohol and Drug Abuse Program workers, and mental health therapists); and
  - TeleHealth Services (Northern Saskatchewan Health Services n.d.).
- Service providers:
  - community health developer/representative;
  - dental therapist;
  - dietician;
  - medical transport coordinator/clerk; and
  - primary care services (nurse practitioner, physician services, and maternal child health worker) (Northern Saskatchewan Health Services n.d.).
- Programs:
  - Jordan's Principle Program (provides First Nations children access to services they need);
  - addictions counselling; and
  - Elder Care Program (ERFN and SVS 2022a).

English River First Nation residents have indicated that the four components of the medicine wheel (i.e., physical, mental, spiritual, and emotional health) are considered the core foundation of the community's health and well-being. The Health Department's programs and services are structured to reflect this (ERFN and SVS 2022a).

The Health Clinic in Patuanak is run by ERFN's Health Department, which *"is the second largest department by funding under the management of ERFN Chief and Council, with the Education Department being the largest department"* (ERFN and SVS 2022a). The Health Department provides diverse services and programming to increase access and help eliminate barriers that leaving the community may cause. Interview participants expressed that travel requirements outside of the community to access health services are considered a deterrent in seeking health care. When youth or Elders are required to leave the community, they are often joined by other family members, so leaving the community can be seen as a burden to families. In the future, ERFN's Health Department intends to expand their service and program offering to provide as many in-community offerings as possible (ERFN and SVS 2022a).

To encourage positive emotional health, the ERFN Health Department encourages ERFN members to follow key Dene laws and teachings that include the following:

1. Share what you have.
2. Help each other.
3. Love each other as much as possible.
4. Be respectful of Elders and everything around you.
5. Sleep at night and work during the day.
6. Be polite and don't argue with anyone.
7. Young girls and boys should behave respectfully.
8. Pass on teachings.
9. Be happy at all times. (ERFN and SVS 2022a).

Emergency Services

English River First Nation has the following emergency services:

- Fire services are provided by fire suppression groups that work towards reducing fire risks around ERFN. There are basic fire halls in Patuanak and Beauval (NWMO 2013a).
- Policing services are provided by the RCMP, which has a detachment office located in Beauval. Services provided by the detachment include criminal record checks, document verification, fingerprinting, general information, non-emergency complaints, crime reporting, and vulnerable sector checks (RCMP 2015).

- Ambulance services are available in Patuanak and Beauval for La Plonge residents. Most emergency health services are accessed by medevac air transport to larger hospitals such as Île-à-la-Crosse, Prince Albert, Meadow Lake, or Saskatoon (NWMO 2013a).

Social Services and Programs

Some social services and programs that are available to ERFN residents include the following:

- interagency forum, including health, social, education, and other organizations;
- National Native Alcohol and Drug Abuse Program;
- Indian Child Family Services Program;
- Aboriginal Head Start Program;
- Women’s group;
- community youth group;
- fundraising group; and
- healing group (NWMO 2013a).

In addition to social services, there are annual events held by the community to strengthen social connections. Every year ERFN holds a healing canoeing journey, with 2019 marking the tenth year of the event. The healing journey helps people heal from grief and trauma and brings mental health awareness to the community. The tenth event in 2019 consisted of 50 Elders and youth who paddled down Pine River and Beaver River (APTN National News 2019b).

For over 25 years, members of the community have returned to a traditional lifestyle for a week, with the goal of strengthening families. The event is referred to as the Family Conference. Workshops are planned for all family members to participate in to bring strength and overcome historical and generational trauma. Each morning begins with a prayer and pipe ceremony. Some of the activities offered free of charge to all family members include massages, haircuts, foot care, beading, and beauty services (APTN National News 2019a).

English River First Nation holds an annual Culture Camp in the fall called “Kilometre 160”. The event is held north of Patuanak and provides an opportunity for Elders to teach the youth of the community about TK and activities, including the languages of Cree and Dene (ERFN and SVS 2022a).

Airport Infrastructure

The Patuanak airport is located west of the community off Highway 918. The airport was constructed in the early to mid 1970s and is in fair to good condition. The airport has a wide gravel runway with pilot-activated lighting at both ends of the runway, allowing for both daytime and nighttime access. The main runway is 3,000 ft by 75 ft and can accommodate single engine and light twin airplanes that can hold up to 19 passengers. Buildings at the airport include a field electrical centre and small waiting room. The field electrical centre is in poor condition and is set to be replaced in 2022. The waiting room was originally supplied by Cameco and is in good condition. The main uses of the airport are for medevac, charter flights transporting mine workers, and general charter flights. The maintenance operations are primarily undertaken by Saskatchewan MOHI personnel, with approximately 40% of the work awarded to ERFN (KPI Program 2021–2022).

Recreation Services

Several recreational buildings can be found in Patuanak for community use. The Ovide G. McIntyre Memorial Arena is operated by the First Nation and has four dressing rooms, broadcasting capability during games, and a kitchen for preparing and selling food. Hockey games, travelling attractions that come through the community, and (on occasion) graduation ceremonies are held at the arena. The adult-supervised Youth Centre in Patuanak has several forms of entertainment for youth, including a television, stereo, foosball, pool tables, and games. The William Apesis Memorial Band Hall can be used for social gatherings such as weddings, receptions, and town meetings. Musicians frequently use the Band Hall as there is a stage inside (NWMO 2013a).

There are recreational or protected areas near some of the reserve parcels. These include Lac La Plonge, Little Amyot Lake Recreation Site, Migratory Bird Concentration Site, and Fort Black. There are three parks within or close to Patuanak, including the treaty grounds near the Band Office, the Lein Wolverine Park near the Band Hall, and a community beach and picnic area near Patuanak (NWMO 2013a).

Housing

Statistics Canada has several important indicators that help provide an understanding of the state of housing in communities. Taken together, the total number of houses and the total population in the communities on Census Day 2021 can provide a glimpse into the average number of residents living in each home.

Table 12.3-5 summarizes the housing characteristics on-reserve for Wapachewunak and La Plonge compared to northern Saskatchewan and the province of Saskatchewan. In 2021, there were 180 occupied private dwellings on-reserve in Wapachewunak and 50 occupied private dwellings on-reserve in La Plonge. On-reserve, La Plonge had the lowest average number of rooms per dwelling (5.1), while Wapachewunak had a higher average number of rooms per dwelling (5.4) compared to northern Saskatchewan (5.7). The province of Saskatchewan had the highest average number of rooms per dwelling (6.5). On-reserve, Wapachewunak and La Plonge had a comparable average number of persons per household (3.2 and 2.9, respectively), which was less compared to northern Saskatchewan (3.4) but higher compared to the province of Saskatchewan (2.5). The percentage of households requiring major repairs on-reserve in Wapachewunak (36.1%) and La Plonge (30.0%) was greater than for northern Saskatchewan (26.1%) and the province of Saskatchewan (7.9%).

Table 12.3-5: Housing Characteristics On-Reserve for Wapachewunak and La Plonge compared to Northern Saskatchewan and Saskatchewan (2021)

Housing Characteristics	English River First Nation On-Reserve		Northern Saskatchewan[2]	Saskatchewan
	Wapachewunak[1]	La Plonge[1]		
Private Households Occupied by Residents	180	50	10,475	449,585
Average Number of Rooms per Dwelling	5.4	5.1	5.7	6.5
Average Number of Persons per Household	3.2	2.9	3.4	2.5
Households Requiring Major Repairs[3]	65 (36.1%)	15 (30.0%)	2,735 (26.1%)	35,365 (7.9%)

Source: Statistics Canada 2022.
Notes:
1. Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases 10. Columns may not add up due to rounding.
2. Northern Saskatchewan is defined as Census Division No.18.
3. Major repairs include defective plumbing or electrical wiring, and structural repairs to walls, floors, or ceilings.

Table 12.3-6 summarizes the housing characteristics for Patuanak compared to northern Saskatchewan and the province of Saskatchewan. In 2021, there were 30 occupied private dwellings in Patuanak. Patuanak had the lowest average number of rooms per dwelling (5.2) compared to northern Saskatchewan (5.7) and the province of Saskatchewan (6.5). Patuanak and the province of Saskatchewan had a similar average number of persons per household (2.3 and 2.5, respectively), both lower than for northern Saskatchewan (3.4). Approximately a third of Patuanak households (33.3%) required major repairs, which was higher than both northern Saskatchewan (26.1%) and the province of Saskatchewan (7.9%).

Concerns have been raised regarding a lack of housing in both Patuanak and La Plonge. Concerns of overcrowding due to a lack of housing have been raised, with negative effects on all four components of the Medicine Wheel. Residents who live in houses that require major repairs experience negative mental health effects. A lack of federal funding and house-building skills were raised as the primary causes of ERFN’s inability to construct new houses (ERFN and SVS 2022a).

Table 12.3-6: Housing Characteristics in Patuanak compared to Northern Saskatchewan and Saskatchewan (2021)

Housing Characteristics	Patuanak[1]	Northern Saskatchewan[2]	Saskatchewan
Private Households Occupied by Residents	30	10,475	449,585
Average Number of Rooms per Dwelling	5.2	5.7	6.5
Average Number of Persons per Household	2.3	3.4	2.5
Households Requiring Major Repairs[3]	10 (33.3%)	2,735 (26.1%)	35,365 (7.9%)

Source: Statistics Canada 2022.

Notes:

1. Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases 10. Columns may not add up due to rounding.
2. Northern Saskatchewan is defined as Census Division No.18.
3. Major repairs include defective plumbing or electrical wiring, and structural repairs to walls, floors, or ceilings.

12.3.3.3.2 Pinehouse Lake

The Northern Village of Pinehouse Lake is a village located in northwestern Saskatchewan adjacent to Pinehouse Lake, approximately 34 km north on Highway 914 from its junction with Highway 165. Kineepik Métis Local Inc. is the Métis Local committee for Pinehouse Lake. The following sub-sections describe the community infrastructure and services available for Pinehouse Lake residents.

Educational Facilities and Programs

Childcare

Pinehouse Lake offers childcare and nursery services for children through several daycare programs, some of which are funded by the Northern Lights School Division No. 113. There are three childcare providers in the community, each offering care for different age ranges. Magloire Teen Infant Day Care provides daycare for children between six weeks to three years of age, Magloire Kiddie Care provides care for children aged 18 months to kindergarten, and the Awasis Centre provides programs for preschool children. Families looking for in-home assistance with childcare can also access services provided by the KidsFirst North program (Northern Business Directory 2019).

Primary and Secondary Education

The Minahik Waskahigan Elementary School and Minahik Waskahigan High School are in separate buildings beside each other. They are both part of the Northern Lights School Division No. 113.

The Minahik Waskahigan Elementary School has approximately 170 students and provides education from kindergarten to grade six. The school also has 41 preschoolers as of 2022. Students at the elementary school have access to a library, gymnasium, and a community school room with an attached kitchen where students are provided food and snacks daily. The elementary school has approximately four classrooms that are fully equipped with laptops, plus two carts with approximately 20 to 25 laptops that can be brought into classrooms that are not equipped with computers. Support staff open the gymnasium Monday through Thursday after school for an hour and allow different grades to play intramural sports. There is a Northern Sport, Culture, and Recreation Coordinator at the school who organizes programming in the gym, such as Toddler Time. The school purchased large bouncy castles and sets them up approximately three to four times a year for the students to play on. Students must read for a certain amount of time to earn time on the bouncy castles. The elementary school usually employs a Cree teacher to teach the language to students, though currently the school is operating without one (KPI Program 2021–2022)

The community school room is also used for community programming in the evenings, such as Father/Son night, Mother/Daughter night, Literacy night, and Cultural Day for students and community members, as well as the Breakfast Club of Canada, which provides food hampers for struggling families. The school received a grant through True North Aid to give 25 beds and bedding to residents of the community. Parents were asked to nominate themselves or others that are in need of beds. On March 15, 2022, the school completed a survey on how it can vest help the community. As an incentive, each family was given pizza and pop. The school ended up giving out 103 free pizzas to families who participated in the survey (KPI Program 2021–2022)

Approximately 200 students attend the Minahik Waskahigan High School, which aims to provide a well-rounded education to its students. The high school provides education from grades seven to twelve and the students have access to a gymnasium, science lab, home economics classroom, library, art room, and computer lab (Northern Lights School Division No. 113 n.d.b.). There are also a variety of athletic programs offered to high school students such as football, volleyball, basketball, soccer, and badminton. The school offers several extracurricular activities such as Drama Club, the Gender and Sexuality Alliance, Yearbook, Grad club, and the Science Fair. The staff at the high school includes 10 high school teachers and six educational assistants. The schools offer accommodations for teachers employed at the schools. There are also resources for numeracy, literacy, social work, career transitions, and student support, and an Elder on staff (Minahik Waskahigan High School n.d.).

Post-secondary Education

There are several ways Pinehouse Lake residents can access post-secondary education in Northern Saskatchewan. Northlands College provides post-secondary education to communities in Northern Saskatchewan, with campuses in La Ronge, Buffalo Narrows, Île-à-la-Crosse, and Creighton.

Residents from Pinehouse Lake attend courses at these campuses as they are the closest post-secondary schools to the community. Students have access to a variety of certification options such as university education, Technology and Trades diplomas and certificates, and Adult Basic Education (Northlands College n.d.). The Northlands College 2017 to 2018 Annual Report stated that their newly added Nursing Degree program through Saskatchewan Polytechnic in La Ronge had 15 graduates from northern Saskatchewan communities, including from Pinehouse Lake (Northlands College 2018).

The University of Regina offers three stand-alone programs to northern communities in Saskatchewan, including a Liberal Arts Certificate program in Pinehouse Lake (Regina Leader-Post 2019). In 2019, the first group of Pinehouse Lake students graduated from the Liberal Arts Certificate program in Pinehouse Lake (University of Regina n.d.). The University of Regina also has an extensive list of online courses spanning different disciplines, providing flexible learning opportunities (University of Regina n.d.).

The Gabriel Dumont Institute (GDI) of Native Studies and Applied Research provides education in partnership with post-secondary institutions for Métis people. The GDI of Native Studies and Applied Research offers education and career counselling for adults with or without a high school diploma, as well as for those looking for post-secondary education. Following a Collaboration Agreement between Pinehouse Lake, Cameco, and Orano Canada Inc. signed in 2012, an apprenticeship program for carpentry, heavy duty mechanics, industrial mechanics, and welding was created through a partnership between the GDI of Native Studies and Applied Research and Pinehouse Lake (GDI of Native Studies and Applied Research 2019). The GDI of Native Studies and Applied Research has recently offered a Security Officer program and Business Certificate program in the community (GDI of Native Studies and Applied Research 2018a, b). Details on educational attainment for Pinehouse Lake residents can be found in Section 13.

Through the 2012 Collaboration Agreement, Pinehouse Lake received a one-time payment of $30,000 for school programming, plus other contributions for education and training. The one-time payment helped:

- identify training requirements for the community;
- fill internships and student positions with community members;
- educational institutions to organize career fairs;
- provide pre-employment training programs;
- identify candidates within the community for training programs;
- provide unpaid work placements for residents enrolled in mining training programs; and
- provide scholarship programs to build skillsets (The Northern Village of Pinehouse, Kineepik Métis Local Inc., Cameco Corporation, and AREVA Resources Canada Inc. 2012).

Health Care Facilities and Services

Health care services in Pinehouse Lake can be accessed at the Health Centre run by the Saskatchewan Health Authority's Integrated Northern Health Division. The Health Centre is open during the week for eight hours a day, Monday to Friday, but offers a call-in service to a nurse outside of regular business hours for emergencies. Services provided include primary care, public health, mental health, health education, telehealth services, and home care services (Saskatchewan Health Authority n.d.b.). Pinehouse Lake residents have access to pharmaceuticals from a local pharmacy in the community (NWMO 2013b). The mental health services available through the Health Centre could be bolstered by adding a texting option to remove any barriers for residents seeking help (KPI Program 2021–2022).

Specialists come to the community monthly and will hold day-long clinics for local health needs such as diabetes care, foot care, eye care, and physiotherapy services. Resident travel for health services not available within the community can be arranged with the Health Centre. Children can access dental care within the community at the dental clinic in Minahik Waskahigan Elementary School, but adults are required to travel for dental care. While non-urgent health care can be accessed within Pinehouse Lake, minor emergency, urgent care services, and access to specialized equipment require residents to travel to other communities, such as Meadow Lake, Prince Albert, La Ronge, or Saskatoon (InterGroup 2011).

KidsFirst North is a program offered in Pinehouse Lake that helps parents gain important parenting skills and assists in supporting child development. Through the program, families living off-reserve can access home visits as well as take part in community programming (Saskatchewan Health Authority n.d.a.). The Growing Great Kids curriculum is the primary program offered by KidsFirst North, which is delivered through home visits to off-reserve families who enrolled during pregnancy or shortly after childbirth. The KidsFirst North program includes the following:

- screening and assessment;
- prenatal case finding;
- home visiting services;
- mental health and addictions;
- early learning; and
- family support (KidsFirst North n.d.).

Emergency Services

Pinehouse Lake has the following emergency services:

- Fire services are provided by a volunteer fire crew (The Northern Village of Pinehouse n.d.).
- Policing services are provided by the RCMP, which has a detachment across from the Town Office. The Pinehouse Lake Police Management Board acts as a liaison between the RCMP and

Pinehouse Lake residents and is made up of volunteers who assist with coordinating the concerns of the community and the RCMP (InterGroup 2011).

The community does not have ambulance service; the nearest ambulance service is located in Beauval. Emergency hospital services are located in La Ronge, Prince Albert, Meadow Lake, and Saskatoon. Residents requiring emergency health care are medevacked by air to one of these locations (NWMO 2013b). There is a phone line available 24 hours a day, seven days a week, that residents can call in the case of an emergency (KPI Program 2021–2022).

Social Services and Programs

The Health Centre also provides social services to residents of Pinehouse Lake, and the Mamawetan Churchill River Regional Health Authority and Minahik Waskahigan High School provide social workers to the community (Minahik Waskahigan High School n.d.). Other social services offered through the Health Centre include addiction services and holistic health services (Saskatchewan Health Authority n.d.b.).

There are other social services offered within the community, including Elders that can provide family assistance, youth intervention meetings, and cultural camps offered through Minahik Waskahigan High School (NWMO 2013b).

Approximately 40 years ago, the 'Reclaiming our Community' initiative was created to address social development in Pinehouse Lake. Road access to the community was developed in the 1970s with the construction of Highway 918, at which time Pinehouse Lake saw new opportunities for economic development and connectivity to surrounding communities. This connectivity to other communities resulted in an increased access to drugs and alcohol, which led to abuse within the community. Through the initiative, Pinehouse Lake has overcome social challenges via recreation, education, awareness, and traditional teachings. To ensure its effectiveness, several interagency partnerships promote and support the initiative (NWMO 2013b).

Through the 2012 Collaboration Agreement, several initiatives received funding, such as the Annual Elders Gathering, scholarships, recreation, and housing (Cameco n.d.b).

Airport Infrastructure

The Pinehouse Lake airport is located on the northern edge of the community. The airport was constructed in the early to mid 1970s and is in good condition. The airport has a wide gravel runway with pilot-activated lighting at both ends of the runway, allowing for both daytime and nighttime access. The main runway is 2,998 ft by 65 feet and can accommodate single engine and light twin airplanes that can hold up to 19 passengers. Buildings at the airport include a field electrical centre and small waiting room. The field electrical centre is in very good condition, and the waiting room originally supplied by Cameco is in fair to poor condition. The main uses of the Pinehouse Lake airport are for medevac, charter flights transporting mine workers, and general charter flights. The maintenance operations are handled exclusively by Saskatchewan MOHI personnel (KPI Program 2021–2022).

Recreation Services

There are several recreational facilities and programs available in Pinehouse Lake. Through a Collaboration Agreement between Pinehouse Lake, Kineepik Métis Local Inc., Cameco, and Orano Canada Inc., $1.3 million was invested in the community arena for an artificial ice plant (Global News 2014). Other facilities include a community recreation hall and outdoor green space in Pinehouse Lake (NWMO 2013b). There is a local committee that runs recreational programs and organizes a variety of team sports, including baseball, volleyball, and hockey. The KML have noted that profits from their business participation in the uranium industry have gone towards community infrastructure, including infrastructure to support youth programming and activities, such as the arena (KML 2022).

In September 2019, a group of high school students formed the Pinehouse Youth Panel, which is supervised by a Restorative Program Co-ordinator. The Youth Panel uses a community building for their programs, including youth drop-in and information nights, grief and loss support, sharing circles, boys' and girls' clubs, and a homework club. They also run the canteen in the Pinehouse Lake arena as a source of revenue. The Pinehouse Youth Panel has plans to access provincial and federal funding in the future by becoming incorporated (LaRongeNOW 2019).

The community holds an annual Elders Gathering. The gathering provides an opportunity for people of all ages to learn about their culture from Elders. Food, music, dance, and art are all part of the annual event. Opportunities to learn how to cook, prepare fish, carve wood, and make boats and paddles were some of the activities held in recent years (CBC News 2019).

There are community and family camps on lakes and rivers surrounding Pinehouse Lake that residents like to use. North of the community on Key Lake Road, there are camp sites available for use as well as the Gordon Lake Recreation Site (NWMO 2013b). For details on the Gordon Lake Recreation Site, and ILRU activities, see Section 11.

Housing

Statistics Canada has several important indicators that help provide an understanding of the state of housing in communities. Taken together, the total number of houses and the total population in the communities on Census Day 2021 can provide a glimpse into the average number of residents living in each home.

Table 12.3-7 summarizes the housing characteristics for Pinehouse Lake, northern Saskatchewan, and the province of Saskatchewan. In 2021, Pinehouse Lake had 265 occupied private dwellings. Pinehouse Lake had a similar average number of rooms per dwelling (5.3) compared to northern Saskatchewan (5.7). The province of Saskatchewan had the highest average number of rooms per dwelling (6.5). Pinehouse Lake had a higher average number of persons per household (3.8) compared to northern Saskatchewan (3.4) and the province of Saskatchewan (2.5). The percentage of households requiring major repairs in Pinehouse Lake (5.7%) was lower than both northern Saskatchewan (26.1%) and the province of Saskatchewan (7.9%). The KML have noted that profits from their business participation in the uranium industry have gone towards community infrastructure, including building increased energy efficient housing (KML 2022).

Table 12.3-7: Housing Characteristics for Pinehouse Lake, Northern Saskatchewan, and Saskatchewan (2021)

Housing Characteristics	Pinehouse Lake[1]	Northern Saskatchewan[1,2]	Saskatchewan[1]
Total Number of Occupied Private Dwellings[3]	265	10,475	449,585
Average Number of Rooms per Dwelling	5.3	5.7	6.5
Average Number of Persons per Household	3.8	3.4	2.5
Households Requiring Major Repairs[4]	15 (5.7%)	2,735 (26.1%)	35,365 (7.9%)

Source: Statistics Canada 2022.

Notes:

1. Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases 10. Columns may not add up due to rounding.
2. Northern Saskatchewan is defined as Census Division No.18.
3. “Total number of occupied private dwellings” is 100% data.
4. Major repairs include defective plumbing or electrical wiring, and structural repairs to walls, floors, or ceilings.

The Saskatchewan Housing Corporation and representatives from Pinehouse Housing Corporation completed a “tiny homes” project in June 2022 to support the availability and affordability of housing in Pinehouse Lake (Government of Saskatchewan 2022). The “tiny homes” project included six affordable rental homes for vulnerable individuals and families of Pinehouse (Government of Saskatchewan 2022). Furthermore, housing affordability support available to residents of Pinehouse Lake includes the Government of Saskatchewan’s Social Housing Program, which provides safe and adequate housing to families and seniors with low incomes and for people with disabilities (Government of Saskatchewan 2023). The program subsidizes rent in accordance with the degree of financial need on a case-by-case basis (Government of Saskatchewan 2023).

12.3.3.3.3 Beauval

The Northern Village of Beauval is in northwestern Saskatchewan, west of Lac La Plonge, and is approximately 8 km northeast on Highway 165 from its junction with Highway 155. The following subsections describe the community infrastructure and services available in Beauval.

Educational Facilities and Programs

Childcare

Aboriginal HeadStart provides care for children aged three and four years old, as well as support for parents (Village of Beauval n.d.). Childcare can also be accessed through the Beauval Childcare Centre Inc. located in the community (Yellow Pages n.d.a). Key Person Interviews with residents of Beauval indicated that childcare services are currently meeting the demand within the community (KPI Program 2021–2022).

Primary and Secondary Education

Valley View School is the only school in Beauval, providing education from kindergarten to grade 12. The school is part of Northern Lights School Division No. 113. Valley View School has approximately 320 students and is equipped with computers and internet access for students. There are board-owned teacherages available for rent within Beauval for teachers who work at the school (Northern Lights School Division No. 113 n.d.a.). The school has a gymnasium, library, home economics room, and Practical Applied Arts room. Several sports programs are available such as football, volleyball, basketball, and skiing. The school delivers cultural programs and has access to several Elders who regularly come to the school (KPI Program 2021–2022). The school has a kitchen for student use where Elders help teach the importance of the food guide (KPI Program 2021–2022).

Post-secondary Education

There are several ways Beauval residents can access post-secondary education in northern Saskatchewan. The GDI of Native Studies and Applied Research in Beauval provides Métis-specific education and training in partnership with post-secondary institutions. The GDI of Native Studies and Applied Research offers education and career counselling for adults with or without a high school diploma, as well as for those looking for post-secondary education. Programs currently available at the GDI of Native Studies and Applied Research in Beauval include a month-long Heavy Equipment Operator course (GDI of Native Studies and Applied Research n.d.).

The University of Regina has an extensive list of online courses spanning different disciplines, providing flexible learning opportunities (University of Regina n.d.).

The University of Saskatchewan offers courses through Northlands College, with campuses located in La Ronge, Creighton, Île-à-la-Crosse, and Buffalo Narrows. Beauval residents must commute to each of these campuses, with Île-à-la-Crosse being the closest (a one-hour drive one way). Students have access to a variety of certification options such as university education, technology and trades diplomas and certificates, and Adult Basic Education (Northlands College n.d.). Residents of Beauval may leave the community to attend Northland College campus in Buffalo Narrows (KPI Program 2021–2022). Details on educational attainment for Beauval residents can be found in Section 13.

Health Care Facilities and Services

Health services in Beauval can be accessed at the Beauval Health Centre run by Integrated Northern Health. The Health Centre is open Monday to Friday from 8am to 5pm. The Beauval Health Centre has the following services and service providers for residents in the area:

- Services:
  - addiction services;
  - ambulance services;
  - diabetes education;
  - home care services;
  - mental health/holistic health services (may include family support, suicide prevention, youth suicide services, addiction, National Native Alcohol and Drug Abuse Program workers, mental health therapists); and
  - public health.
- Providers:
  - dental therapist;
  - nurse in charge/nurse manager; and
  - physician services (immunization, public health services and programs, nutrition) (Saskatchewan Health Authority n.d.b.).

Health specialists from Île-à-la-Crosse visit the community routinely to provide services not available in Beauval. Beauval residents can access bloodwork services twice a week from visiting personnel. On a weekly basis, a general practitioner takes in-person appointments made through the Health Clinic. A mental health therapist visits Beauval weekly to provide mental health services to residents. Mental health services are available through the Health Centre and visiting specialists from Île-à-la-Crosse are currently meeting the demands of the community (KPI Program 2021–2022). To access health services that are not available within the community, the Health Centre can arrange TeleHealth appointments. There is a taxi service available to transport Beauval residents for in-person appointments with specialists outside of the community. The taxi service is primarily for First Nations or individuals that may not have the means to travel outside the community for appointments (KPI Program 2021–2022).

Integrated Northern Health is a partner with KidsFirst North, a program offered in Beauval that helps parents gain important parenting skills and assists in supporting child development. Through the program, families living off-reserve can access home visits as well as take part in community programming (Saskatchewan Health Authority n.d.a.). The Growing Great Kids curriculum is the primary program offered by KidsFirst North, which is delivered through home visits to off-reserve families who enrolled during pregnancy or shortly after childbirth. The KidsFirst North program includes:

- screening and assessment;
- prenatal case finding;
- home visiting services;
- mental health and addictions;
- early learning; and
- family support (KidsFirst North n.d.).

Emergency Services

Beauval has the following emergency services:

- Fire services are provided by a volunteer fire crew at a Fire Hall located within the community (FNMR – Northern Affairs Division 2012, Village of Beauval n.d.). A fire truck previously used at Cameco's Key Lake uranium operations was provided to the community after the truck was scheduled for replacement (Cameco n.d.a).
- Policing services are provided by the RCMP through a detachment in Beauval (FNMR – Northern Affairs Division 2012). In addition to regular policing services, the detachment provides:
  - criminal record checks;
  - document verification;
  - fingerprinting;
  - general information;
  - non-emergency complaints;
  - report a crime; and
  - vulnerable sector checks (RCMP 2015).
- Ambulance services are provided by Integrated Northern Health (Saskatchewan Health Authority n.d.b.).

Social Services and Programs

The Beauval Health Centre provides social services to residents of Beauval, including mental health and addiction services and holistic health services (Saskatchewan Health Authority n.d.b.). A social development position employee and community events coordinator oversee programming and daily activities in the community. These social services and programs are made possible by a grants and proposal writer in charge of securing the required funding. A community food bank provides meals for the less fortunate and is available through a social development program (KPI Program 2021–2022).

Airport Infrastructure

The Beauval airport is located southeast of the community. The airport was constructed in the mid-1970s and is in fair condition. The airport has two narrow gravel runways that are restricted to smaller aircrafts and are mainly used by ambulance services. Historically, the runways were used for transporting mine workers prior to lay offs from Cameco. With lighting at both ends of the runways, usage is possible during daytime and nighttime. The main runway is 3,189 ft by 75 feet and can accommodate single engine and light twin airplanes that can hold up to 19 passengers. The field electrical centre is the only building on site and is in fair condition. The Beauval airport is used mainly for medevac purposes and by the RCMP. The maintenance operations are handled exclusively by Saskatchewan MOHI personnel (KPI Program 2021–2022).

Recreation Services

The Beauval Curling Rink has two rinks for residents to use. The Sports Ground includes two baseball fields, a stage for entertainment, and the “woody”. The “woody” is a garage with walls that can act as an open-air space with a roof or fully enclosed building for entertainment purposes. The Sports Ground has a canteen, portable toilets for rent, a mud bog area, and an adjacent community arena (KPI Program 2021–2022). The community arena (i.e., the Charles Gauthier Memorial Arena) provided recreational opportunities to Beauval residents before burning down in 2011 (CBC News 2011). The arena was the main source of recreation for the community. The loss of the arena primarily affected winter sports such as hockey. In its absence, the community has created an outdoor rink and youth drop-in centre, and improved existing baseball fields, field turf, and fencing (KPI Program 2021–2022). Other recreational facilities available in the community include:

- ball diamonds;
- a running track;
- a gymnasium;
- playgrounds;
- River Edge Park (camping, picnics); and
- trails (biking, skiing, and jogging).

Housing

Statistics Canada has several important indicators that help provide an understanding of the state of housing in communities. Taken together, the total number of houses and the total population in the communities on Census Day 2021 can provide a glimpse into the average number of residents living in each home.

Table 12.3-8 summarizes the housing characteristics for Beauval, northern Saskatchewan, and the province of Saskatchewan according to the 2021 Census of Population. In 2021, Beauval had

295 occupied private dwellings. Beauval had a higher average number of rooms per dwelling (6.3) compared to northern Saskatchewan (5.7), but less compared to the province of Saskatchewan (6.5). Beauval had a lower average number of persons per household (2.8) compared to northern Saskatchewan (3.4), but higher compared to the province of Saskatchewan (2.5). The percentage of households requiring major repairs in Beauval (11.9%) was less than half of the percentage for northern Saskatchewan (26.1%) but was higher than the percentage for the province of Saskatchewan (7.9%).

Table 12.3-8: Housing Characteristics for Beauval, Northern Saskatchewan, and Saskatchewan (2021)

Housing Characteristics	Beauval[1]	Northern Saskatchewan[1,2]	Saskatchewan[1]
Total Number of Occupied Private Dwellings[3]	295	10,475	449,585
Average Number of Rooms per Dwelling	6.3	5.7	6.5
Average Number of Persons per Household	2.8	3.4	2.5
Households Requiring Major Repairs[4]	35 (11.9%)	2,735 (26.1%)	35,365 (7.9%)

Source: Statistics Canada 2022.

Notes:

1. Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases 10. Columns may not add up due to rounding.
2. Northern Saskatchewan is defined as Census Division No.18.
3. 'Private dwelling' refers to a separate set of living quarters with a private entrance either from outside the building or from a common hall, lobby, vestibule, or stairway inside the building. The entrance to the dwelling must be one that can be used without passing through the living quarters of some other person or group of persons.
4. Major repairs include defective plumbing or electrical wiring, and structural repairs to walls, floors, or ceilings.

Low income and social housing is available in Beauval (KPI Program 2023). The amount of income support a low income renter is eligible to receive is dependent on their household size and the percentage of their income spent on shelter costs (rent and utilities) (Government of Saskatchewan 2023; KPI Program 2023). The community has sufficient housing to meet demand (KPI Program 2023). Two issues have been identified by community members: available private rentals tend to be of lower quality and a standard two bedroom, two bathroom rental is approximately $650 to $750 a month, which is considered expensive in this northern community (KPI Program 2023). Concern has been expressed about the need for more diversity in housing options in the community, including bachelor suits and mixed family units (KPI Program 2023). Past mining projects in the area have not resulted in a lack of available rental units in the community (KPI Program 2023).

Beauval has the following initiatives and/or supports to support the availability and affordability of housing:

- Beauval is in the process of completing a housing study in partnership with Primrose Lake Economic Development Corporation to determine future housing needs for the community (Northern Municipal Services n.d.). Beauval anticipates that additional mixed-use housing will be needed to accommodate a growing and changing population (Northern Municipal Services n.d.).
- In 2007, an affordable housing project opened in Beauval with eight one-bedroom affordable housing units under the Province of Saskatchewan's Centenary Affordable Housing Program (Government of Saskatchewan 2007). The project was undertaken by Lac La Plonge Holdings Ltd. and K&L Construction and supported through the Centenary Affordable Housing Program.
- Housing affordability support available to residents of Beauval includes the Government of Saskatchewan's Social Housing Program, which provides safe and adequate housing to families and seniors with low incomes and for people with disabilities (Government of Saskatchewan 2023). The program subsidizes rent in accordance with the degree of financial need on a case-by-case basis (Government of Saskatchewan 2023).

12.3.4 Assessment of Project-related Effects

12.3.4.1 Potential Interactions Between the Project and Valued Component / Key Indicators

Potential interactions between Project components and activities and the Infrastructure and Services VC and its associated KIs were considered for the Construction, Operation, and Decommissioning phases of the Project in the traffic study area, LSA, and RSA, with an emphasis on change in traffic within the LSA (Figure 12.3-3, Figure 12.3-4, and Figure 12.3-5). The potential interactions between Project components and activities and the Infrastructure and Services VC are summarized in Table 12.3-9.

The identification of Project components and activities and their potential interactions is based on IK, LK, discussions with Indigenous groups, government agencies and the public, KPIs for the Project, and the professional judgment of members of the Project team, with consideration of existing conditions in the study areas for the VC and its KIs. Potential interactions in Table 12.3-9 are ranked as:

- **Primary Interaction** (✓): Project activity is expected to interact with the VC/KI, which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- **Other Interaction (✓):** Project activity is expected to interact with the VC/KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.

- **No Interaction:** Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

Pathways to effects and potential effects prior to mitigation are described in Section 12.3.4.2.

Table 12.3-9: Potential Project Interactions for Infrastructure and Services

Project Phase/Activity	Infrastructure and Services		
	Key Indicator 1 – Change in Traffic	Key Indicator 2 – Change in Community Infrastructure and Services	Key Indicator 3 – Change in Emergency Services Capacity
Construction Activities			
Development of access roads and air strip	✓	✓	✓
Site preparation and earthworks; clearing, levelling, and grading of the Project Area	✓	✓	✓
Power generation – generators			
Installation of main substation and distribution of power around site			
Wellfield and freeze hole drilling			✓
Ground freezing			
Batch plant operation (concrete); crusher at borrow area			
Development of surface infrastructure (camp, operations centre plants, ponds, pads, and support facilities)	✓	✓	✓
Waste management (composting, domestic and industrial landfill operation, recycling)			
Water management (including treatment and site runoff)			
Groundwater supply			
Surface water withdrawal			
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)			
On-site and off-site operation of vehicles and transport of materials	✓	✓	✓
Air transportation for workers			✓
Regulatory site inspections			

Project Phase/Activity	Infrastructure and Services		
	Key Indicator 1 – Change in Traffic	Key Indicator 2 – Change in Community Infrastructure and Services	Key Indicator 3 – Change in Emergency Services Capacity
Engagement – site visit from Interested Parties			
Employment and expenditures[1]		✓	✓
Operation Activities			
Operation of the in situ recovery (ISR) wellfield			✓
Wellfield and freeze wall drilling			✓
Operation and expansion of freeze wall			
Batch plan operation (grout and cement); crusher at borrow area			
Expansion of pond and pads	✓	✓	✓
Operation of the processing plant and production of uranium concentrate			✓
Water withdrawal from groundwater or surface water body			
Management of surface water (including seepage and site runoff)			
Water treatment, both domestic and industrial			
Water release to surface water body			
Waste management (composting, domestic and industrial landfill operation, recycling)			
Hazardous waste management (temporary storage, handling, and off-site transportation)	✓		✓
Storage and disposal of drill waste rock, process precipitates, and industrial wastewater treatment plant precipitates	✓		✓
On-site and off-site operation of vehicles and transportation of materials	✓		✓
Power supply – primarily power from the grid, also generators and back-up generators			

Project Phase/Activity	Infrastructure and Services		
	Key Indicator 1 – Change in Traffic	Key Indicator 2 – Change in Community Infrastructure and Services	Key Indicator 3 – Change in Emergency Services Capacity
Package and transport of nuclear substances	✓		✓
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)			✓
Air transportation for workers			✓
Progressive decommissioning and reclamation			
Regulatory site inspections			
Engagement – site visit from Interested Parties			
Employment and expenditures[1]		✓	✓
Decommissioning Activities			
Site water management, treatment, and release			
Mining horizon remediation and thawing of freeze wall			✓
Process water treatment and release			✓
Closure of ISR and freeze wells and related infrastructure			✓
Decontamination of surface facilities and injection, recovery, and monitoring wells			
Asset removal (including site power transmission lines and electrical infrastructure)	✓	✓	✓
Demolition and disposal of non-salvageable surface infrastructure and materials	✓	✓	✓
Remediation of contaminated areas (wellfield, waste pads, ponds, water treatment location, and process plant area)		✓	✓
Generators			
Waste management (composting and landfill operation)			

Project Phase/Activity	Infrastructure and Services		
	Key Indicator 1 – Change in Traffic	Key Indicator 2 – Change in Community Infrastructure and Services	Key Indicator 3 – Change in Emergency Services Capacity
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)			✓
On-site and off-site operation of vehicles and transportation of materials	✓		✓
Reclamation of disturbed areas			✓
Regulatory site inspections			
Engagement – site visit from Interested Parties			
Employment and expenditures[1]		✓	✓
Post-Decommissioning Activities			
Environmental monitoring	✓		✓
Regulatory site inspections			
Engagement–- site visit from Interested Parties			
Employment and expenditures[1]		✓	✓

Notes:

1. Project employment and expenditures are generated by most Project activities and components throughout the phases of the Project. Hence, Project employment and expenditures have been added into the table as a separate column for each Project phase instead of acknowledging these individually by component or activity.

12.3.4.2 Potential Project-related Effects

The various phases of the Project would have different effects on the Infrastructure and Services VC. The pathways to effects include:

- increased traffic volumes and potential increases in collisions on roadways due to the transportation of equipment, materials, supplies, and personnel to site, and the transport of nuclear substances off site;
- increased demand on community infrastructure and services (e.g., support for family members of workers during absences for work); and
- increased demand for emergency services. The Project may put increased pressure on emergency services in the event of an accident or malfunction, particularly if an event were to occur off site (such as a vehicular collision or accident).

Most of the physical Project activities, except for the movement of vehicles, equipment, supplies, and personnel, are not expected to affect Infrastructure and Services in the LSA. Initial construction will be supported by temporary camps and utilities (and/or the existing exploration camp and utilities) while permanent facilities are being established. The Project site and associated camp will be fully serviced to meet the needs of the Project and its workforce and will operate independently. As such, it will not place additional demands on most existing community infrastructure and services (e.g., community facilities, sewer, water/wastewater, waste disposal facilities). The closest community by road access (i.e., the Northern Village of Pinehouse Lake) is located approximately 260 km from the Project site.

Although the LSA communities are removed from the Project site, the Project may create an increased demand on Infrastructure and Services through the need for additional services (e.g., additional need for social services for families of workers) and health and emergency services in the event of an accident or malfunction. The extent to which this may affect any given community is expected to vary by community and individual and depend on the capacity of existing facilities and services.

Three KIs were identified for the Infrastructure and Services VC: change in traffic, change in community infrastructure and services, and change in emergency services capacity. As noted in Table 12.3-9, Project components and activities may result in changes to the KIs throughout the phases of the Project, although to varying degrees. Hence, all KIs for the Infrastructure and Services VC are assessed for the Project.

The pathway analysis identified potential Project-related effects on Infrastructure and Services, identified mitigation measures for these potential Project-related effects, and determined whether any of the potential Project-related effects can be sufficiently mitigated such that they are not expected to cause a residual adverse effect.

Further information on potential effects prior to mitigation for each KI is outlined below. Mitigation measures for each KI are outlined in Section 12.3.5 and residual effects following mitigation measures are outlined in Section 12.3.6.

12.3.4.2.1 Potential Effect 1 – Change in Traffic

The Project will involve the movement of personnel, materials, supplies, and equipment to the site, particularly during Construction. Operation will involve truck movements (e.g., delivery of well materials from the site, food deliveries, fuel/propane deliveries, transport of uranium product offsite) and Decommissioning is expected to involve similar truck movements in addition to traffic related to removal of site infrastructure. Project-related Construction, Operation, and Decommissioning traffic will increase traffic volumes.

During the engagement process, cabin and leaseholders were concerned about effects related to change in traffic[18]. Concerns were also raised regarding air quality and the transportation of hazardous substances, including community safety from through traffic (21-EN-SUR-446.77). Community engagement with Pinehouse Lake identified the concern of increased traffic on the road from the Project (including increased risk of truck traffic vehicle incidents with land users) and a need for better information on transportation safety processes (KML 2022). Kineepik Métis Local #9 has also provided that increased traffic on Highway 914 may erode the current standard of the road (KML 2022).

The traffic study area (Figure 12.3-5) includes the highways anticipated to be used throughout the Project phases, including Highway 914 and Highway 165 where increases in traffic volumes are anticipated to be highest relative to existing traffic volumes (Table 12.3-2 and Table 12.3-3). Section 12.3.3.2.1 details the existing conditions and notes the following relative to these highways:

- Highway 165 is an all-weather paved highway and is considered a level 2 priority highway (i.e., having an AADT of 300 to 1,500 vehicles).
- Highway 914 is an all-weather gravel highway and is considered a level 3 priority highway (i.e., having an AADT of less than 300 vehicles).

Access north of the Key Lake gatehouse on Highway 914 is restricted and provides for controlled access for employees of northern mines, Indigenous resource harvesters from select communities, cabin owners, and lease holders.

Project-related truck traffic during Construction and Operation (such as surface construction equipment, materials, and drill rigs) is expected to originate from Saskatoon or other southern locations. Project-related traffic originating from the west may travel through Beauval via Highway 165, whereas traffic from the south and east may access Highway 165 via Highway 2. Traffic from Saskatoon would likely use Highway 11 to Prince Albert and Highway 55 to Beauval, then travel via Highway 165. Highways are under the authority of the Saskatchewan MOHI.

Table 12.3-10 summarizes the expected increase in TAADT during Project Construction and Table 12.3-11 summarizes the expected increase in TAADT during Operation along segments of Highway 914 and Highway 165. Segment 1 is the Wheeler River Project Camp to Highway 914. Segment 2 is the access road to the Project site and Segment 3 is along Highway 914 from the access road to the Northern Village of Pinehouse Lake. Segment 4 includes Highway 914 from Pinehouse Lake to Highway 165. Segments 5 and 6 include the intersection of Highway 165 to the Northern Village of Beauval and Highway 2, respectively.

[18] 20-LK-LEASESUR-267.104, 20-LK-LEASESUR-267.105, 20-LK-LEASESUR-267.106, 20-LK-LODGESUR-267.107, and 20-LK-LEASESUR-267.108.

The Project is anticipated to have the most notable effect on Highway 914. Traffic is expected to increase 23% during Construction and 30% during Operation north of the Key Lake gatehouse (Denison 2022). However, from a total volume basis, this amounts to an additional 14 trucks per day during Construction and 18 trucks per day during Operation (or less than one truck per hour if operating on a 24-hour basis).

On Highway 914 between the Key Lake gatehouse and the Northern Village of Pinehouse Lake access road, traffic is expected to increase between 16% to 40% over the life of the mine. From a total volume basis, this amounts to an additional 14 trucks per day during Construction and 18 trucks per day during Operation (or less than one truck per hour if operating on a 24-hour basis).

On Highway 914 from Highway 165 to the Pinehouse Lake access road, traffic is expected to increase between 6% to 8% over the life of the mine. From a total volume basis, this amounts to an additional 14 trucks per day during Construction and 18 trucks per day during Operation (or less than one truck per hour if operating on a 24-hour basis during construction).

On Highway 165 from Highway 155 to Highway 914, traffic is expected to increase between 0.7% to 3.0% during Construction and between 0.9% to 4.0% during Operation. From a total volume basis, this amounts to an additional seven truck per day during Construction and nine trucks per day during Operation. Beauval is located along Highway 165; however, Highway 165 bypasses most of the community.

Table 12.3-10: Estimated Truck Annual Average Daily Traffic during Project Construction

Segment	Highway	From	To	2017 TAADT[1]	2017 AADT[2]	TAADT Increase	% Truck Increase	Overall % Increase in Traffic
1	Access Road	Wheeler River Project Camp	Highway 914	n/a	n/a	n/a	n/a	n/a
2	914	Project Access Road	Key Lake Gate	58	60	14	24%	23%
3A	914	Key Lake Gate	Gordon Lake Access	35	45	14	41%	31%
3B	914	Gordon Lake Access	Snake Rapids Bridge	35	45	14	41%	31%
3C	914	Snake Rapids Bridge	Pinehouse Lake Access	35	90	14	41%	16%
4	914	Pinehouse Lake Access	Hwy 165	50	230	14	28%	6%
5A	165	Hwy 914	Hwy 918	35	240	7	20%	3%
5B	165	Hwy 918	Hwy 155	60	960	7	12%	0.7%
6A	165	Hwy 914	Hwy 910	30	130	7	23%	5%
6B	165	Hwy 910	Hwy 2	40	230	7	18%	3%

Source: Denison 2022.

Notes:

1 TAADT = Truck Annual Average Daily Traffic.

2 AADT = Annual Average Daily Traffic.

Table 12.3-11: Expected Increase in Truck Annual Average Daily Traffic during Project Operation

Segment	Highway	From	To	2017 TAADT[1]	2017 AADT[2]	TAADT Increase	% Truck Increase	Overall % Increase in Traffic
1	Access Road	Wheeler River Project Camp	Highway 914	n/a	n/a	n/a	n/a	n/a
2	914	Project Access Road	Key Lake Gate	58	60	18	31%	30%
3A	914	Key Lake Gate	Gordon Lake Access	35	45	18	51%	40%
3B	914	Gordon Lake Access	Snake Rapids Bridge	35	45	18	51%	40%
3C	914	Snake Rapids Bridge	Pinehouse Lake Access	35	90	18	51%	20%
4	914	Pinehouse Lake Access	Hwy 165	50	230	18	36%	8%
5A	165	Hwy 914	Hwy 918	35	240	9	26%	4%
5B	165	Hwy 918	Hwy 155	60	960	9	15%	0.9%
6A	165	Hwy 914	Hwy 910	30	130	9	30%	7%
6B	165	Hwy 910	Hwy 2	40	230	9	23%	4%

Source: Denison 2022.

Notes:

1 TAADT = Truck Annual Average Daily Traffic.

2 AADT = Annual Average Daily Traffic.

Table 12.3-12 outlines anticipated truck volumes to the Project site during Construction (Years 1 to 3) and Operation (Years 3 to 18). As stated previously in this sub-section, anticipated truck volumes during Decommissioning are expected to be similar to Operation. During Construction, the TAADT and AADT volumes are anticipated to increase by 14 and 22 vehicles, respectively. During Operation, the TAADT and AADT volumes are anticipated to increase by 18 and 18 vehicles, respectively. The TAADT and AADT volumes for both Construction and Operation assume travel to/from the site on the same day.

Table 12.3-12: Anticipated Volume of Trucks to the Project during the Construction and Operation Phase

Phase	TAADT[1] Expected Increase	AADT[2] Expected Increase
Construction (Years 1 to 3)	14	22
Operation (Years 3 to 18)	18	18

Source: Denison 2022.

Notes: Traffic volumes assume travel to/from the site on the same day.

1 TAADT = Truck Annual Average Daily Traffic.

2 AADT = Annual Average Daily Traffic.

Highway 914 and Highway 165 experienced an overall decrease in collisions per MvKm between 2011 to 2019 (see Table 12.3-4). This decrease in collisions may be a result of a decrease in truck traffic when the Key Lake and McArthur River uranium operations moved from operations to care and maintenance in July 2018 (Cameco 2021a). Highway 914 had 0.9 collisions per MvKm in 2011 and 0.0 collisions per MvKm in 2019, with the highest number of collisions in 2015. Highway 165 had 0.7 collisions per MvKm in 2011 and 0.6 collisions per MvKm in 2019 (SGI 2021).

As summarized in Table 12.3-12, the TAADT and AADT are anticipated to increase by 14 and 22 vehicles, respectively, during Construction, while the TAADT and AADT are both anticipated to increase by 18 vehicles during Operation. A slight increase in traffic volume during Construction and Operation may result in an increase in collisions. Community engagement with Pinehouse Lake identified the concern of increased Project traffic on Highway 914 (including increased risk of truck traffic vehicle incidents with land users) and a need for better information on transportation safety processes (KML 2022). Kineepik Métis Local #9 has also provided that increased traffic on Highway 914 may erode the current standard of the road (KML 2022). Understanding whether collisions may increase as a result of the Project is difficult to determine and cannot be predicted with accuracy.

Saskatchewan Government Insurance (2022) reported that for two-thirds of the time in Saskatchewan, the cause of collisions is related to driver condition or improper action. The most common contributing factors to collisions across Saskatchewan include driver inattention, failing to yield the right of way, driving too fast for road conditions, driving under the influence of drugs or alcohol, driver inexperience or confusion, following too closely, backing up unsafely, and changing lanes or passing improperly (SGI 2022). Saskatchewan Government Insurance (2022) also reported that most traffic collisions occur during peak traffic times (such as late afternoon/early evening); the highest total number of collisions occur in November and December while the most severe collisions and the most traffic deaths tend to occur in August and October; alcohol is a factor in approximately 4% of all collisions and 40% of fatal collisions; approximately 90% of all collisions in rural Saskatchewan are single-vehicle collisions; and wearing a seatbelt can decrease your chances of being killed or seriously injured in a collisions by as much as 50%.

An assessment of accidents and malfunctions (Ecometrix 2022; Appendix 14-A in Section 14) suggested that a vehicle accident (including a rollover, collision, or run-off the road) resulting in a release of radioactivate materials, fuel, hazardous chemicals, or reagents to the aquatic or terrestrial environment has a probability of occurrence of highly unlikely to unlikely (Table 12.3-13).

Table 12.3-13: Bounding Scenarios Identified for Further Assessment by the Hazard Identification Process

Potential Accident / Malfunction	Potential Effect Pathway	Probability	Effect Severity	Overall Risk Rating[1]
Vehicle accident, including rollover, collision, run off road	Aquatic release of radioactive material	Highly unlikely	Moderate	Low
Vehicle accident, including rollover, collision, run off road	Aquatic release of fuel, hazardous chemicals, and reagents	Unlikely	Moderate	Low
Vehicle accident, including rollover, collision, run off road	Terrestrial release of radioactive material and chemicals	Unlikely	Minor	Low

Notes:

1 Based on Section 14 Accidents and Malfunctions, Table 14.5-2.

It is expected that routine maintenance by the Saskatchewan MOHI along Highway 914 would be adjusted if required to accommodate increased traffic volumes on the highway. All drivers serving the Project will receive appropriate training relative to the nature of materials being transported, including driver training to the highest standards based on the transportation of nuclear substances. All Project vehicles will follow designated highway corridors and accidents will be monitored on Highways 165 and 914 for noticeable increases (particularly during Construction of the Project). This will support continued safe road travel by community members along public roads. The mitigation is well understood and expected to be effective. Mitigation measures for the Project are outlined in Section 12.3.5 and are expected to minimize potential effects.

12.3.4.2.2 Potential Effect 2 – Change in Community Infrastructure and Services

The Project has the potential to result in changes in Community Infrastructure and Services. As the Project is a remote site, no communities are in close proximity to the Project. The LSA communities, and distance by road, to the Project site are as follows:

- The closest community via road access to the Project is the Northern Village of Pinehouse Lake, which is approximately 1.5 km off of Highway 914 and approximately 260 km away from the site.
- The Northern Village of Beauval is the only community located on Highway 165 and is located approximately 8 km northeast of the Highway 155/Highway 165 intersection and is approximately 370 km away from the Project site.
- English River First Nation Indian Reserve La Plonge 192 is located along Highway 918, approximately 4 km north of the intersection of Highway 165/Highway 918. La Plonge 192 is approximately 472 km by road from the Project site.

- The Northern Hamlet of Patuanak is located near the north end of Highway 918 and serves as the only access road to the community. Access to Highway 918 is located off Highway 165, near Beauval. Patuanak is approximately 460 km by road away from the Project site.
- English River First Nation Indian Reserve Wapachewunak 192D is located an additional 9 km north of Patuanak and is approximately 469 km by road away from the Project site.

Evidence from other jurisdictions indicated that remote workforces have the potential to place pressure on existing services in communities, with up to 90% of the demands associated with primary care needs – not occupational or emergency related (Northern Health 2015). However, the distance to communities, combined with the services to be offered on site, and the fly-in/out nature of the operation, should prevent any potential need for non-local workers to interact with local service delivery.

The main pathway from the Project to community infrastructure and services relates more to potential demands created through Project employment and the associated commuter rotation system. Residents of the LSA have commented that they would like to understand how workers would get to site (22-EN-VB-622.5). Air transport pick-up and drop-off points are being planned at two locally central points to communities in the LSA, one additional site in northern Saskatchewan, and potentially other locations, and individuals participating in employment and their families may experience changes as a result.

Lifestyle changes can occur as a result of large projects (e.g., time away from family and communities, increased income for individuals and families) and can create the need for additional services necessary to support local workers and family members. Effects to individual employees may include challenges adjusting to work and home life, feelings of isolation and loneliness, increased rates of substance abuse as a coping mechanism, and challenges adjusting to shift work. If a family member is away for an extended period of time through worker rotation, remaining family members will likely have more responsibilities, and may require additional support (e.g., childcare, counselling, family support services) (Villeneuve 2019, Gardner et al. 2018, CVMPP 2005, Bowers et al. 2018).

A recent study on fly-in fly-out workers in Australia (Gardner et al. 2018) found that workers reported difficulty in balancing the demands of a worker rotation pattern with domestic commitments, and many reported being unable to achieve a work-life balance, which has led to distrust and tension among families. Many participants have stated the geographical distance and regular and prolonged absences led to psychological detachment of workers from their families (Gardner et al. 2018). Modern advances in communication (e.g., video calls and social media) can help reduce, but not fully alleviate, concerns regarding geographical distance.

Preparing and educating fly-in fly-out workers and their families prior to employment can help them make informed choices on a worker rotation lifestyle. Preparation and education could include strategies to plan and manage a fly-in fly-out lifestyle, educating on common issues, coping strategies, management of transition between work rotation and home life, building skills for effective communication, tips and ideas from other successful worker rotation families, and financial literacy (Centre for Transformative Work Design 2018). For household members, including partners and spouses, effects of a worker rotation could include increased stress from managing a household and assuming all household roles while their partner is away, increased rates of domestic violence from family strain and fragmentation, and emotional distress from children while a partner is away, depending on the temperament and age of the child (CVMPP 2005).

Communities in the LSA have social services and organizations in place. Table 12.3-14 provides a summary of social services and organizations for communities in the LSA.

Table 12.3-14: Summary of Social Services and Organizations for English River First Nation, Pinehouse Lake, and Beauval

English River First Nation and Patuanak	Pinehouse Lake	Beauval
• Interagency forum (health, social, education and other organizations) • National Native Alcohol and Drug Abuse Program • Indian Child Family Services Program • Aboriginal Head Start Program • Women's group • Community youth group • Healing group	• Health centre provides social services, including addictions services and holistic health services • Mamawetan Churchill River Regional Health Authority and Minahik Washahigan School provide social workers to community.	• Health centre provides social services, including mental health, addictions, and holistic services • Access to out of community health specialists through telehealth conference • Taxi service to bring residents to see specialists in larger city centres • Social development program, including a community food bank

Source: KPI Program 2021–2022, NWMO 2013a, Minahik Waskahigan High School n.d., Saskatchewan Health Authority n.d.b.

The potential stresses to employees and their families could place increased demands on social services in the communities as individuals/families adjust to the change. The extent to which these changes could affect any given community would vary and depend on a combination of individual coping strategies, combined with the capacity of existing facilities and services. Current challenges in the delivery of services that have been identified include the following:

- Beauval residents have provided that mental health services typically include a specialists from Île-à-la-Crosse visiting the community routinely to provide services not available in Beauval; however, services at the clinic are for diagnoses rather than treatment (KPI Program 2021–2022).
- Residents in the LSA have raised concern for the general lack of addictions supports and facilities within the region (KPI Program 2021–2022).
- Pinehouse Lake residents have raised concern that the community may inherit significant impact of becoming a through road community that could further dilute the limited community and emergency services currently provided (KML 2022).

- Local Study Area residents have identified the need to travel to Saskatoon, or other large city centres, to see specialists, which can be difficult for residents to access (KPI Program 2021–2022). Beauval, for example, does offer a taxi service for residents to see specialists in larger city centres; however, the travel and distance is still seen as a challenge (KPI Program 2021–2022).

The Project may alleviate some pressures on health facilities in the LSA communities by providing programs for workers on site (e.g., health awareness and education). With other uranium operations in Saskatchewan, evidence exists that workers often rely on health services on site, which can be easier to access than the offerings in their community (CVMPP 2014).

Increased pressure on community health and emergency services can also result from increased income, which could lead to increased drug or alcohol use, domestic violence, and the increased need for RCMP to respond to traffic accidents along the highways. This increased pressure has been documented for other development projects (Native Women's Association of Canada 2018, Amnesty International 2016, Keeyask Hydropower Limited Partnership 2012); however, attributing such changes to the Project directly may be difficult.

In addition to offering an appropriate suite of health-related programming and services on site, mining companies have, in the past, developed social responsibility guidelines, which have included donating to community infrastructure and services (e.g., health, education and community development). Although communities in the LSA have experience with remote mining operations, the uranium mining industry cannot address all the socio-economic needs in northern Saskatchewan communities. This will require a coordinated effort from governments and other interested parties (e.g., other industries, the business community, health agencies and individuals), as well as the uranium mining industry (CVMPP 2013).

Mitigation measures, as outlined in Section 12.3.5, will minimize potential effects to services offered in communities.

12.3.4.2.3 Potential Effect 3 – Change in Emergency Services Capacity

The Project may put increased pressure on emergency services in the event of an accident or malfunction, particularly if the event occurs off site, such as vehicular collision or accident. It is anticipated that most emergency events can be addressed by the staff on site, including the medical and safety staff included in the complement of employees. Denison will provide the appropriate amount of First Aid and CPR training to employees to provide adequate coverage. Primary care paramedics will be provided through all phases of the Project. More serious incidents may require treatment in La Ronge or Saskatoon. If a serious accident occurs, the individual would be flown to an appropriate medical facility from the on-site airstrip.

Accidents or malfunctions off site could increase the need for First Responders and fire departments, particularly if an emergency occurs on Highways 914 or 165.

The Northern Village of Pinehouse Lake and the Northern Village of Beauval, the two closest communities, have RCMP detachments. English River First Nation uses the RCMP detachment in the Northern Village of Beauval. It is anticipated that, if required, the RCMP detachments from Beauval and Pinehouse Lake might respond to incidents on Highways 914 and 165.

Although both Pinehouse Lake and Beauval have health care centres, and ambulance services are available in Patuanak and Beauval, the closest communities for emergency services are La Ronge, Prince Albert, Meadow Lake, and Saskatoon. For the LSA communities, most emergency health services are accessed by medevac air transport to larger hospitals such as Île-à-la-Crosse, Prince Albert, Meadow Lake, or Saskatoon (NWMO 2013a). It is anticipated that, if required, emergency services for the Project would use facilities in LaRonge, Prince Albert, Meadow Lake and Saskatoon (NWMO 2013b).

The extent to which these changes could affect any given community would depend on the nature of the accident or malfunction. Accidents and malfunctions (Ecometrix 2022; Appendix 14-A in Section 14) for vehicle accidents including rollover, collision, and run off road for the Project were determined to generally have a highly unlikely to unlikely probability with an overall risk rating of low, although the severity for accidents and malfunctions was determined to be minor to moderate. The experience gained from accidents that have occurred in past mining projects has resulted in improved safety features and operating procedures, and the probability that similar accidents might occur in the future is considered low (Ecometrix 2022). However, it is the intention of Denison to develop and operate Project activities in a manner that mitigates potential adverse effects on human health. Denison is committed to setting high standards for various aspects of its operations that will mitigate potential Project-related effects, including those associated with accident and malfunction scenarios (Ecometrix 2022).

A summary of the scenarios for accidents and malfunctions as it relates to events that could occur off site and result in demands for emergency services (i.e., accidents or malfunction on the highway) area provided in Table 12.3-14 (Ecometrix 2022). Other accidents and malfunctions are detailed in Section 14 Accidents and Malfunctions and Appendix 14-A.

Mitigation measures, as outlined in Section 12.3.5, will minimize potential effects.

12.3.5 Mitigation Measures

The following mitigation measures will be implemented to reduce adverse traffic effects:

- Air transportation will be used to transport most workers between the Project site and designated pick-up and drop-off points in communities.
- All drivers serving the Project will receive appropriate training related to the nature of materials being transported, including driver training to the highest standards based on the transportation of nuclear substances.

- Vehicles transporting dangerous goods and/or hazardous products will display required placards and labels in accordance with provincial legislation and will follow designated highway corridors.
- An Emergency Response Plan will be developed in case there is a spill during the transportation of dangerous goods and/or hazardous products.
- All materials transported by truck will be compliant with any weight restrictions or permits, spring road restrictions, or geometric constraints set out by the Saskatchewan MOHI.
- Denison will maintain Project roads and the main access road to the site.
- Denison will require truck traffic to slow to 40 km/hr for a minimum of 2.5 km on either side of the culture camp(s), which are understood to occur in September and October (dates may be adjusted at the direction of each community).

Although it is difficult to predict Project-related effects on community infrastructure and services within the LSA communities, the following mitigation measures will be implemented to reduce adverse effects:

- Services and programs will be provided on-site and will be accessible to workers. These services and programs may alleviate pressures on social and health services within LSA communities.
  - Health and wellness programming will be established on-site, including recreation options.
  - Health promotion and on-site health care programming will be designed to reflect the needs and interests of the workforce and may include tobacco cessation, health and stroke awareness, diabetes awareness, mental health and additions support, cancer awareness, and nutrition awareness, among others.
  - Immunization programs may be administered through the on-site health team.
  - Programming may include the development of life skills programming to address issues such as coping with stressful situations and/or managing personal finances.
  - Workforce education will be provided to encourage healthy lifestyles.
  - Recreation options will be offered onsite to promote health and wellness.
  - Denison will also provide space for an on-site Elder councillor to provide culturally relevant programming and support.
- An EFAP will be part of each worker’s benefits package and will provide supports to individuals and their families that may not be readily available in the communities. Employee and family assistance programs typically provide free assessments, short-term counselling, referrals, and follow-ups to employees and their family members who are having personal or work-related problems. Generally, EFAPs can be accessed remotely by workers and their immediate family. Denison will aim to educate their staff on the offerings of their EFAPs, as well as making that information shareable with individuals’ families.

- Ongoing communication between Denison, LSA communities, and relevant authorities (e.g., RCMP, health and service providers) to provide updates, discuss any Project-related concerns, and make sure that the required resources are in place

The following mitigation measures will be implemented to reduce adverse effects on emergency services capacity:

- First aid facilities will be supplied during construction. A primary care paramedic will be contracted to provide care on site through all phases of the Project. Denison will provide the appropriate amount of First Aid and CPR training to make sure employees have adequate coverage.
- Mandatory safety orientations will be held for contractors and workers.
- First aid personnel will provide transport to a hospital by air when required or by Saskatchewan's air ambulances;
- Health and safety management programs will be developed for Construction, Operation, and Decommissioning.
- Workers will be trained in fuel handling, equipment maintenance, and fire prevention and response measures.
- Denison's Environment, Health, Safety, and Sustainability Policy will be enforced.
- Continued liaison with LSA communities and relevant authorities (e.g., RCMP, health and service providers) will be undertaken to provide updates, discuss any Project-related concerns, and make sure that the required resources are in place.
- Project-specific contingency, emergency response, and spill prevention plans will be developed to reduce the likelihood and severity of accidents and potential fires.
- Based on the outcomes of discussions with COI, Denison may provide support and/or training to local emergency services to make sure that staff are adequately prepared in the unlikely event of an accident, malfunction, or spill on Highways 914 or 165. This may include the provision of speciality materials or equipment to deal with an emergency response.

12.3.6 Residual Effects Evaluation

12.3.6.1 Residual Effects Characterization

General definitions of the Residual Effects Characteristics are provided in Table 5.8-1 in Section 5. Residual Effects Characteristics specific to Infrastructure and Services are defined in Table 12.3-15**.**

Table 12.3-15: Infrastructure and Services – Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Negative effect or effect is not desirable. **Positive** – Beneficial effect or effect is desirable.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Negligible** – No measurable change on Infrastructure and Services from existing conditions. **Low** – Minimal amount of change on Infrastructure and Services relative to existing conditions. **Moderate** – Moderate amount of change on Infrastructure and Services relative to existing conditions. The demand approaches current capacity but will not result in a reduction in the standard of services. **High** – High amount of change on Infrastructure and Services relative to existing conditions. Demand exceeds current capacity and standard of services.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project Area. **Local** – Effect is limited to the LSA for the Infrastructure and Services VC. **Regional** – Effect extends beyond the LSA into the RSA for the Infrastructure and Services VC. **Beyond Regional** – Effect extends beyond the RSA for the Infrastructure and Services VC.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during Construction only). **Medium-term** – 3 years to 38 years (i.e., effect happens from Construction through to the end of Post-Decommissioning). **Long-term** – More than 38 years (i.e., effect extends beyond Post-Decommissioning).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions. **Partially Reversible** – A residual effect that partially diminishes to baseline conditions. **Irreversible** – A residual effect that will not diminish to baseline conditions.
Context	The extent to which the Infrastructure and Services VC or associated KIs have been affected by past and present	**Low** – Infrastructure and Services VC/KIs have high resilience to stress and are able to accommodate change.

Residual Effect Characteristic	Definition	Rating
	environmental and socio-economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its ability to recover from that effect (i.e., resilience).	**Moderate** – Infrastructure and Services VC/KIs have moderate resilience to stress and are able to accommodate some change. **High** – Infrastructure and Services VC/KIs have weak resilience to stress and are unable to accommodate change.
Likelihood	Likelihood that the residual effect will occur, including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability that the residual effect will occur. **Unlikely** – A low probability that the residual effect will occur.

The characterization of residual effects is based on the review of the existing environment (Section 12.3.3), the assessment of Project-related effects and proposed mitigation measures, IK, KPIs, and professional judgment. All residual effects (independent of their significance rating) are carried forward to the CEA.

Effects on Infrastructure and Services and its KIs are expected to be mostly adverse. A significant effect on the Infrastructure and Services VC (including the MPs of traffic and community infrastructure and services, and emergency services) would result if projected demands are above the current capacity, are routinely above the current levels for an extended period of time, are unlikely to return to existing conditions, and cannot be mitigated through adjustments to programs, policies, plans, or through other mitigations.

In terms of confidence, a low level is assigned when the VC/KI and/or the Project-related interaction is not well understood, and/or the mitigation measures have not been proven effective. A moderate level is assigned when the VC/KI is understood and/or the mitigation measures have been proven effective elsewhere. A high level is assigned when the VC/KI and Project interactions are well understood, and the mitigation measures have been proven effective. Significance and confidence for Infrastructure and Services are provided in Section 12.3.6.3.

12.3.6.2 Summary of Project-related Residual Adverse Effects on Infrastructure and Services

12.3.6.2.1 Change in Traffic

This section summarizes the residual effects of the Project (i.e., after mitigation) on the traffic MP. The mitigation measures for changes to the Infrastructure and Services VC are described in Section 12.3.5. A summary of the Project-related residual effects on traffic is provided in Table 12.3-16**.**

The residual effects on traffic during Construction, Operation, and Decommissioning are due to the movement of equipment, materials, supplies, and personnel to and from the site. These residual effects may include increased traffic volumes and associated wear and tear of road infrastructure along with increased collision risk. Traffic volumes are expected to be similar during Construction and Operation, and are anticipated to be similar or less during Decommissioning. Effects are anticipated to be more discernable on Highway 914 due to the low volume of traffic.

During Construction, the TAADT and AADT volumes are anticipated to increase by 14 and 22 vehicles, respectively. During Operation, both the TAADT and AADT are anticipated to increase by 18 vehicles. If Decommissioning activities are confirmed to be similar to Operation activities, then the same volume (or less) could be expected during the Decommissioning phase. For comparison, Highway 165 is predicted to experience an overall increase in traffic of 0.7% to 7.0% over the life of the Project. This increased truck traffic as a result of the Project would not be considered a material change. Highway 914 is predicted to experience an overall increase in traffic of 8% to 40%. However, a portion of Highway 914 is currently gated with restrictions on those able to travel past the Key Lake gatehouse, meaning the potential risk for conflict between road users and mining traffic will be limited to a small number of individuals.

Mitigation measures such as air transportation for workers between drop-off locations and communities, compliance with weight restrictions and permits, spring road restrictions, geometric constraints set out by the Saskatchewan MOHI, signage, driver training, and requirements for Denison truck traffic to slow to 40 km/hr for a minimum of 2.5 km n either side of cultural camp(s), which are understood to occur in September and October (dates may be adjusted at the direction of each community) are expected to minimize effects.

With the implementation of Project mitigation measures, Project-related residual effects on traffic are expected to be adverse, low in magnitude, local in geographic extent, medium-term in duration, continuous in frequency, and fully reversible following Decommissioning.

Table 12.3-16: Infrastructure and Services – Summary of the Characteristics Ratings for Change in Traffic

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project is expected to result in increased traffic and potential increased collisions most discernable in the highway network in the LSA.
Magnitude	Low	Increased traffic and potential increased collisions are expected to occur mainly during Construction (2 years), Operation (15 years), and Decommissioning (5 years).
Geographic Extent	Local	Delivery of materials during Construction and Operation, transportation of nuclear materials during Operation, and removal of well materials during Decommissioning are expected to be most discernable in the highway network in the LSA.
Duration	Medium-term	The period of time from Project Construction to end of Post-Decommissioning is 38 years, although effects on traffic are expected to vary within each phase.
Frequency	Continuous	Effects on traffic are expected to occur throughout the Project, especially during Construction, Operation, and Decommissioning.

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Reversibility	Fully Reversible	Effects on traffic are expected to be fully reversible after Decommissioning.
Context	Moderate	The Saskatchewan MOHI maintains highways in the region. The region is also accustomed to remote mining projects.
Likelihood	Likely	The Project is expected to result in increased traffic and collisions along highways are expected to be most discernable in the LSA highway network.

12.3.6.2.2 Change in Community Infrastructure and Services

This section summarizes the residual effects of the Project (i.e., after mitigation) on the community infrastructure and services MP. A summary of the Project-related residual effects on community infrastructure and services is provided in Table 12.3-17.

Effects on community infrastructure and services will occur primarily in the LSA as a result of prioritization for employment of individuals from LSA communities. As the Project site will be self-sufficient in terms of meeting the needs of the Project and its workforce, the residual effects related to local communities are associated with the effects of participation in employment and the associated commuter rotation system, which may cause increased stress for individuals and their families. This may result in an increased demand on social services at the community level, such as childcare and mental health services. With the application of mitigation measures described in Section 12.3.5, and given the distance between communities in the LSA and the Project site, the residual adverse effects are expected to be low in magnitude and medium-term in duration. The residual effects are also expected to be frequent throughout Construction, Operation, and Decommissioning, although the demands may decrease as workers and their families become accustomed to the commuter rotation system. The effects on community infrastructure and services (particularly social services) are expected be fully reversible following Decommissioning.

Table 12.3-17: Infrastructure and Services – Summary of the Characteristics Ratings for Change in Community Infrastructure and Services

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project has the potential to cause increased stress on community infrastructure and services because of increased income and lifestyle changes that can result from large projects (e.g., additional support services for community members).
Magnitude	Low	There are no communities near the Project. The closest community to the Project is the Northern Village of Pinehouse Lake, which is located along Highway 914, approximately 260 km by road from the site. Denison will provide power, water, and waste/wastewater treatment for the Project. As such, the Project will not affect these services in LSA communities.

Residual Effects Characteristic	Rating	Summary Rationale for Rating
		The Project may create an increased demand on community infrastructure and services (e.g., additional need for social services for families of workers), particularly for communities in the LSA.
Geographic Extent	Local	Project Construction, Operation, and Decommissioning have the potential to put increased pressure on community infrastructure and services in the LSA.
Duration	Medium-term (Construction, Operation, and Decommissioning)	The period of time from Project Construction to end of Post-Decommissioning is 38 years, although effects on community infrastructure and services are expected to be most discernable during Construction and Operation.
Frequency	Frequent	Any effects on community infrastructure and services are expected to be based on demand and are anticipated to occur at regular intervals.
Reversibility	Fully Reversible	Effects on community infrastructure and services are expected to be fully reversible after Decommissioning.
Context	Moderate	Communities in the LSA and RSA are expected to adapt to the Project. The Project is expected to have positive effects on communities in the LSA (e.g., increased income).
Likelihood	Likely	The Project will likely result in some effects on community services and infrastructure.

12.3.6.2.3 Change in Emergency Services Capacity

This section summarizes the residual effects of the Project (i.e., after mitigation) on the emergency services capacity MP. A summary of the Project-related residual effects on emergency services capacity is provided in Table 12.3-18**.**

In terms of emergency services capacity, a primary care paramedic will be contracted to provide care on site through all phases of the Project; Denison will provide the appropriate amount of first aid and CPR training to employees; and security will be supplied at the site by Denison**.** On-site security staff will assist in minimizing demands on the RCMP detachments in the LSA. Project personnel will also be trained in the implementation of Denison's safety and environmental programs. Environmental protection measures (e.g., emergency response and spill prevention plans) will reduce the likelihood of accidents and potential fires. Project personnel will also be trained in fuel handling, equipment maintenance, and fire prevention and response measures. If a serious accident occurs, injured individuals would be flown to an appropriate medical facility from the on-site airstrip. Fire extinguishers will be available at designated locations on site in the event of a fire, and a sprinkler system will be installed on site wildfire protection.

Increased pressure on emergency services is most likely to stem from an accident or malfunction on Highways 914 or 165. The extent to which these changes could affect any given community would depend on the nature of the accident or malfunction. Accidents and malfunctions (Ecometrix 2022) for the Project were determined to (generally) have a highly unlikely to unlikely probability of occurrence, with an overall risk rating of low to moderate; however, the severity of accidents and malfunctions was determined to be minor to major (Table 12.3-14).

If such an event were to occur, local resources may be called upon to provide support, which may result in a call to fire, RCMP, or ambulance services depending on the nature of the event. Denison will provide any necessary training and/or equipment to local first responders to make sure they are sufficiently prepared to deal with an unlikely accident or malfunction.

Table 12.3-18: Infrastructure and Services – Summary of the Characteristics Ratings for Change in Emergency Services Capacity

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The Project has the potential to cause increased stress on health and emergency services in the LSA.
Magnitude	Moderate	The Project has the potential to create increased pressure on health and emergency services during Construction, Operation, and Decommissioning. With required mitigation measures, the capacity is expected to be able to handle any increased requirements.
Geographic Extent	Site specific and could occur at any location	Health and emergency services are largely expected to be affected in the event of an accident or malfunction, which would be most challenging for emergency services capacity in the LSA.
Duration	Medium-term	The period of time from Project Construction to end of Post-Decommissioning is 38 years, although effects on health and emergency services are expected to be most discernable during Construction and Operation.
Frequency	Infrequent	The demand on health and emergency services is only expected in the event of an accident or malfunction.
Reversibility	Fully Reversible	Effects on health and emergency services are expected to be fully reversible after Decommissioning.
Context	Moderate	Health and emergency services are expected to be able to adapt to the Project.
Likelihood	Unlikely	The Project is unlikely to result in an increased demand on health and emergency services.

12.3.6.3 Significance and Confidence

A summary of the residual effects conclusions for each of the MPs relative to the Infrastructure and Services VC are provided in Table 12.3-19**.**

Table 12.3-19: Summary of Residual Effects Characterization for Infrastructure and Services

Residual Effects Characteristic	Traffic	Community Infrastructure and Services	Emergency Services
	Ratings		
Direction	Adverse	Adverse	Adverse
Magnitude	Low	Low	Moderate
Geographic Extent	Local	Local	Site specific (most challenge if it occurs in the LSA)
Duration	Medium-term	Medium-term	Medium-term
Frequency	Continuous	Frequent	Infrequent
Reversibility	Fully Reversible	Fully Reversible	Fully Reversible
Context	Moderate	Moderate	Moderate
Likelihood	Likely	Likely	Unlikely

The determination of significance is based only on adverse residual effects. All changes to KIs for Infrastructure and Services are expected to be low to moderate in magnitude, with a moderate effect only resulting in the event of an accident or malfunction. The effects are likely and are expected to occur through the duration of Construction, Operation, and Decommissioning and are anticipated to vary in frequency. Upon Decommissioning, it is expected that the effects will be reversed. The communities overall are resilient and are expected to accommodate the anticipated changes as there is already considerable experience with other similar uranium operations in the region. The overall conclusion relative to changes to Infrastructure and Services is **not significant**.

The overall confidence in the determination is moderate to high. This is based on previous experience of the COI with the uranium industry in northern Saskatchewan, knowledge of other uranium mining operations, evidence gathered from processes such as the Community Vitality Monitoring Partnership, and relevant project experiences in Canada and beyond.

12.3.7 Cumulative Effects

Consideration of cumulative effects is based only on residual adverse effects. Projects considered in the CEA (Section 5.9 in Section 5) were systematically examined for temporal and spatial overlap. Temporal overlap occurs when a project is a reasonably foreseeable development, meaning that the project is fairly certain and the development will take place within the planning horizon and expected life cycle of the Project (i.e., 38 years). The only project carried through to the CEA relative to Infrastructure and Services was the 914 All-Weather Road Extension Project. Although there is some uncertainty as to when construction of the road would start, it is reasonable to assume that it could overlap with Construction, Operation, and/or Decommissioning of the Project.

The planned Wollaston Lake all-season road and Highway 914 all-weather road extension project (Highway 914 extension project) are removed from the Project site and communities within the

Infrastructure and Services LSA; however, they fall within the boundary of the RSA. Cumulative effects on Infrastructure and Services considered change in traffic, changes in community infrastructure and services, and changes in emergency response capacity. Each of these MPs are considered separately.

Traffic

Both the Project and the Highway 914 extension project have the potential to increase traffic volumes along the existing Highway 914. The TAADT and AADT volumes are expected to increase with the Project, meaning drivers may notice up to two additional vehicles per hour relative to current conditions. The Highway 914 extension project EIS did not estimate the precise increase in traffic volumes, but indicated the increases are expected to be minimal. Cumulatively, both projects have the potential to result in increased requirements for maintenance, along with increased potential for vehicle collisions that may result in injury or death to people or wildlife, or damage to property. The Highway 914 extension project implemented the following mitigations:

- reducing project-related traffic during construction;
- implementing speed limits in specific areas of concern;
- installing and maintaining signage along the highway; and
- conducting regular inspection and maintenance activities on the highway and associated components.

Although the cumulative changes to traffic may be discernable to users of the highway, it is anticipated that the overall increases in traffic can be effectively managed with the mitigation practices described in Section 12.3.5. As such, the assessment of cumulative effects and determination of significance for traffic does not change with consideration of the all-weather road.

Community Infrastructure and Services

Changes to community infrastructure and services stem from the Project's demand for infrastructure (deemed negligible as the Project will supply its own infrastructure) and employment and participation in the commuter-rotation system, which may result in an increased demand in services at the community level. Construction of the Highway 914 extension project will create an equivalent of 300 full time employees, along with 6 to 10 long-term full time employment positions associated with maintenance, snow clearing, highway grading, and other repairs. An on-site camp(s) will provide accommodations and services for workers during construction of the road. Although the Highway 914 extension project indicates a commitment towards Indigenous employment in the procurement process, commitments towards individual First Nations or Métis communities are not specified. The list of Indigenous communities with whom the Saskatchewan MOHI consulted is broader than Denison's Indigenous COI, and is inclusive of numerous communities in the Northern Administrative District. This means there is some uncertainty as to whether the all-weather road would draw upon the same labour pool as the Project, although it is possible that some positions may be available to those from Denison's Indigenous COI. The opportunities associated with the all-weather road would be of shorter duration, with construction occurring over a three to five year period depending on the final design, and it is anticipated that some of the employment would be seasonal.

Given the understanding of the Highway 914 extension project, the overlap in effects stemming from employment, such as those associated with community infrastructure and services, is unlikely to result in any discernable changes, particularly as the opportunities associated with the Highway 914 extension project may involve a broader labour pool. As such, the assessment of cumulative effects and determination of significance for community infrastructure and services does not change with consideration of the Highway 914 extension project.

Community Emergency Response Capacity

For the Project, security and emergency response plans along with appropriate first aid training and a primary care paramedic will be provided on site. This will reduce the likelihood of cumulative effects on health, safety, and emergency services at the community level.

The Highway 914 extension project would have two distinct phases, with construction and operation interacting differently with community emergency response capacity. During construction, access restrictions would remain in place for the Highway 914 extension project, meaning public access would remain limited. The contractor responsible for implementing the project would be responsible for meeting health and occupational safety requirements for the site, thus minimizing any potential pressures on community emergency response capacity. During the operations phase, the Highway 914 extension project would be publicly accessible, meaning that accidents or malfunctions along the highway would become the most likely pathway for emergency response services. However, the extension to Highway 914 allows for connections to communities and services further north, which may or may not result in any potential demand on community emergency services to extend to communities outside of the LSA and into the RSA.

Exactly how community emergency responses are deployed in the future would need to be determined in collaboration with the Province and the communities in the future; however, it is not anticipated that conditions with the Project would be exacerbated by the Highway 914 extension project.

With the application of mitigation measures, the assessment of cumulative effects and determination of significance for community emergency services capacity does not change with consideration of the Highway 914 extension project.

12.3.7.1 Climate Change Considerations

The Project must also be considered in the context of climate change. The sensitivities of the Project to severe weather (e.g., extreme temperatures and excessive precipitation) and forest fires have been examined as they have the potential to adversely affect the Project. Events including flooding, tornadoes, and forest fires, which are likely to become more frequent and/or more severe under climate change, have been considered in the Accidents and Malfunctions report, although the risk for these events has been determined to be low, very low, or not expected (Ecometrix 2022). Detailed plans and procedures would be developed for the Project that are site specific, including:

- process monitoring and operational procedures;
- mine development and control procedures;
- radiation protection plan;
- spill and emergency response plan;
- traffic and transportation plan;
- security procedures;
- travel management plan;
- environmental monitoring procedures;
- personnel training procedures;
- regular and preventive inspection and testing procedures; and
- surface water and flood management procedures.

Based on a consideration of the mitigation strategies to be applied, past experience, and application of best management practices, the effects of a changing climate on the Project are expected to be **not significant**.

12.3.8 Monitoring and Follow-up

Vehicular accidents will be monitored on Highway 165 and Highway 914, particularly during construction of the Project, for noticeable increases. In terms of traffic, the Saskatchewan MOHI is responsible for highway maintenance. Government departments and private-sector companies that provide community infrastructure and services will continue to monitor the ongoing demand for community health and emergency services. Denison will also continue to liaise with local communities, service providers, and emergency response providers for the duration of the Project.

12.3.9 Infrastructure and Services Summary

The various phases of the Project will have different effects on Infrastructure and Services and its MPs: traffic, community infrastructure and services, and emergency services capacity. The pathways to effects include:

- increased traffic volumes and potential increases in collisions on roadways due to transportation of equipment, materials, supplies, and personnel, and the transport off-site of nuclear substances;

- increased demand on community infrastructure and services (e.g., support for family members of workers during absences for work and the associated commuter rotation system); and
- increased demand for emergency services as the Project may put increased pressure on emergency services in the event of an accident or malfunction, particularly if an event were to occur off-site (such as a vehicular collision or accident).

As the LSA communities are removed from the Project site, most of the physical Project activities, except for the movement of vehicles, equipment, supplies, and personnel, are not expected to affect Infrastructure and Services in the LSA. The Project site and associated camp will be fully equipped to meet the needs of the Project and its workforce and will operate independently. The extent to which community infrastructure and services and health and emergency services will be affected would vary by community and individual and depend on the capacity of existing facilities and services. However, accidents and malfunctions (Ecometrix 2022) were determined to generally have a highly unlikely to unlikely probability. Mitigation measures to reduce adverse effects on traffic, community infrastructure and services, and emergency and health services include:

- transportation between the Project site and communities will occur at designated pick-up and drop-off points;
- all drivers serving the Project will receive appropriate driver training;
- an Emergency Response Plan will be in place in case of a spill during transportation of dangerous goods or hazardous products, and all material transported by trucks will be compliant with weight restrictions or permits set out by the Saskatchewan MOHI;
- services and programs will be available on site and will be accessible to workers and families (such as health and wellness programming, life skills programming, and an EFAP);
- ongoing communication will occur between Denison, LSA communities, and relevant authorities (e.g., RCMP, health and service providers);
- a primary care paramedic will be on-site through all phases of the Project, and appropriate first aid and CPR training will be available for workers; and
- health and safety management programs will be developed for the Project, and Denison's Environment, Health, Safety and Sustainability Policy will be enforced.

The determination of significance is based only on adverse effects. The residual effects for all KIs of the Infrastructure and Services VC are expected to be low to moderate in magnitude, with a moderate effect only resulting in the event of an accident or malfunction. The effects are likely and are expected to occur through Construction, Operation, and Decommissioning and may vary in frequency. Upon Decommissioning, it is expected that the effects will be reversible. The communities overall are expected to be resilient and are anticipated to accommodate the changes as there is already considerable experience with other similar uranium operations in the region.

The overall conclusion relative to changes to Infrastructure and Services is **not significant**. The overall confidence in the determination is moderate to high.

With the application of mitigation measures, cumulative effects on Infrastructure and Services are expected to be adverse, low in magnitude, medium-term in duration, continuous in frequency, and fully reversible, and occur in a resilient socio-economic context. No additional mitigation measures are required.

In regard to monitoring and follow-up, vehicular accidents will be monitored on Highway 165 and Highway 914, particularly during construction of the Project, for noticeable increases. In terms of traffic, the Saskatchewan MOHI is responsible for highway maintenance. Government departments and private-sector companies that provide community infrastructure and services will continue to monitor the ongoing demand for community health and emergency services. Denison will also continue to liaise with local communities, service providers, and emergency response providers for the duration of the Project.

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Appendix 12-A Engagement Database Summary – Quality of Life

See file "S12_App 12-A Quality of Life Engagement_Wheeler River.pdf"

Appendix 12-B Community Profiles

See file “S12_App 12-B Community Profiles_Wheeler River.pdf”

Appendix 12-C Demographic and Population Indicators

See file "S12_App 12-C Demographic and Population Indicators_Wheeler River.pdf"

Appendix 12-D Crime Statistics

See file “S12_App 12-D Crime Statistics_Wheeler River.pdf”

Appendix 12-E Traffic Collision Data

See file “S12_App 12-E Traffic Collision Statistics_Wheeler River.pdf”.

Denison Mines

Wheeler River Project

Final Environmental Impact Statement

November 2024

Powering
PEOPLE, PARTNERSHIPS
AND PASSION.

Wheeler River Project

Final Environmental Impact Statement

Section 13 – Economics

November 2024

Denison Mines

Denison Mines Corp.

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Roadmap

This roadmap of the Wheeler River Project Environmental Impact Statement (EIS) has been provided to summarize the main document sections and appendices of the EIS.

Wheeler River Project
Environmental Impact Statement

Executive Summary

PART I: INTRODUCTION AND CONTEXT
- Section 1: Project Introduction and Overview
- Section 2: Project Description
- Section 3: Indigenous and Local Knowledge
- Section 4: Engagement
- Section 5: Approach and Methodology of the Assessment

PART II: BIOPHYSICAL ENVIRONMENTAL ASSESSMENTS
- Section 6: Atmospheric and Acoustic Environment
- Section 7: Geology and Groundwater
- Section 8: Aquatic Environment
- Section 9: Terrestrial Environment

PART III: HUMAN ENVIRONMENT ASSESSMENTS
- Section 10: Human Health
- Section 11: Land and Resource Use
- Section 12: Quality of Life
- Section 13: Economics

PART IV: INTEGRATED TOPICS AND SUMMARY
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Abbreviations and Acronyms

Abbreviation / Acronym	Definition
CEA	Cumulative effects assessment
COI	Communities of Interest
CSC	Construction Sector Council
CVMPP	Community Vitality Monitoring Partnership Process
Denison	Denison Mines Corp.
EA	Environmental Assessment
ERFN	English River First Nation
EIS	Environmental Impact Statement
FNIGC	First Nations Information Governance Centre
GDP	Gross domestic product
IAA	Impact Assessment Agency of Canada
IK	Indigenous Knowledge
KI	Key Indicator
KML	Kineepik Métis Local #9
KPI	Key Person Interview
LK	Local Knowledge
LSA	Local Study Area
MiHR	Mining Industry Human Resources
MN-S	Métis Nation-Saskatchewan
MOH	Ministry of Highways
MP	Measurable Parameter
MSLA	Mineral surface lease agreements
NAICS	North American Industry Classification System
NR1	Northern Region 1
NR3	Northern Region 3
NVP	Northern Village of Pinehouse
NWMO	Nuclear Waste Management Organization
Project	Wheeler River Project
RSA	Regional Study Area
SIIT	Saskatchewan Indian Institute of Technology
SLA	Surface lease agreements
SVS	Shared Value Solutions
VC	Valued Component

Glossary

Term	Definition
Employment rate	Refers to the number of persons employed during the census reference period (for example, during the week of Sunday, May 2 to Saturday, May 8, 2021), expressed as a percentage of the total population aged 15 years and over. The employment rate for a particular group (age, sex or gender, marital status, geographic area, etc.) is the number of employed persons in that group, expressed as a percentage of the total population in that group.
Indigenous Community of Interest	A community whose traditional land or potential or established Aboriginal and/ or Treaty rights are in proximity to the Project or has existing transportation infrastructure that would be used by the Project. An Indigenous Community of Interest is more likely to experience impacts from the Project.
Indigenous community	An Indigenous community with a potential interest in the Project, including any Indigenous community identified by a Regulatory Agency as having a potential interest in the Project.
Indigenous Knowledge	Indigenous Knowledge is also known as Aboriginal Traditional Knowledge and Traditional Ecological Knowledge. Generally, Aboriginal Traditional Knowledge is considered as a body of knowledge built up by a group of people through generations of living in close contact with nature. Aboriginal Traditional Knowledge is cumulative and dynamic. It builds upon the historic experiences of a people and adapts to social, economic, environmental, spiritual and political change.
Indigenous people	Section 35 of the *Constitution Act, 1867* defines the term "Aboriginal peoples of Canada" as referring to the First Nation, Inuit and Métis peoples of Canada. The term "Indigenous" is used interchangeably with "Aboriginal".
Key indicator	An important component or aspect of the Valued Component that is expected to be affected (changed) as a result of the Project.
Labour force status	Labour force status refers to whether a person (person 15 years or over) was employed, unemployed or not in the labour force during the census reference period. The labour force consists of persons who contribute or are available to contribute to the production of goods and services falling within the System of National Accounts production boundary.
Local Knowledge	Specialized knowledge developed through long-term association, interaction, and cumulative experience.
Measurable parameter	A parameter or metric associated with the Key Indicator that can be used to detect and measure Project-related changes.
Northern Saskatchewan Administration District	The Northern Saskatchewan Administration District is defined in the province of Saskatchewan's *Northern Municipalities Act, 2010.* The Northern Saskatchewan Administration District includes approximately 250,000 square kilometres (about 44% of Saskatchewan's land area) but is home to only 38,000 people or less than 4% of the province's population. Residents of the Northern Saskatchewan Administration District live in over 40 communities, which include incorporated municipalities (towns, villages, hamlets and settlements – most of which self-identify as Métis communities), First Nation reserves, and unincorporated areas. More than 80% of people who live in the Northern Saskatchewan Administration District self-identify as Indigenous.
Participation rate	Refers to the labour force during the census reference period (for example, during the week of Sunday, May 2 to Saturday, May 8, 2021), expressed as a percentage of the population aged 15 years and over. The participation rate for a particular group (age, sex or gender, marital status, geographic area, etc.) is the total labour force in that group, expressed as a percentage of the total population in that group.
Unemployment rate	Refers to the unemployed expressed as a percentage of the labour force during the census reference period (for example, during the week of Sunday, May 2 to Saturday, May 8, 2021). The unemployment rate for a particular group (age, sex or gender, marital status, geographic area, etc.) is the unemployed in that group, expressed as a percentage of the labour force in that group.
Valued Components	Valued Components are aspects of the biophysical and human environments that may be affected (adversely or positively) by the Project. The value of a component not only relates to its role in the environment, but also the value people place on it.

13 Economics

Section 13 of the Environmental Impact Statement (EIS) for the Wheeler River Project (the Project) is focused on Economics. The integrated biophysical and human environment assessment approach is illustrated in Figure 13-1. As a guide for EIS reviewers, Figure 13-2 provides a preview of the Valued Components (VCs) associated with the assessments completed in this section of the EIS.

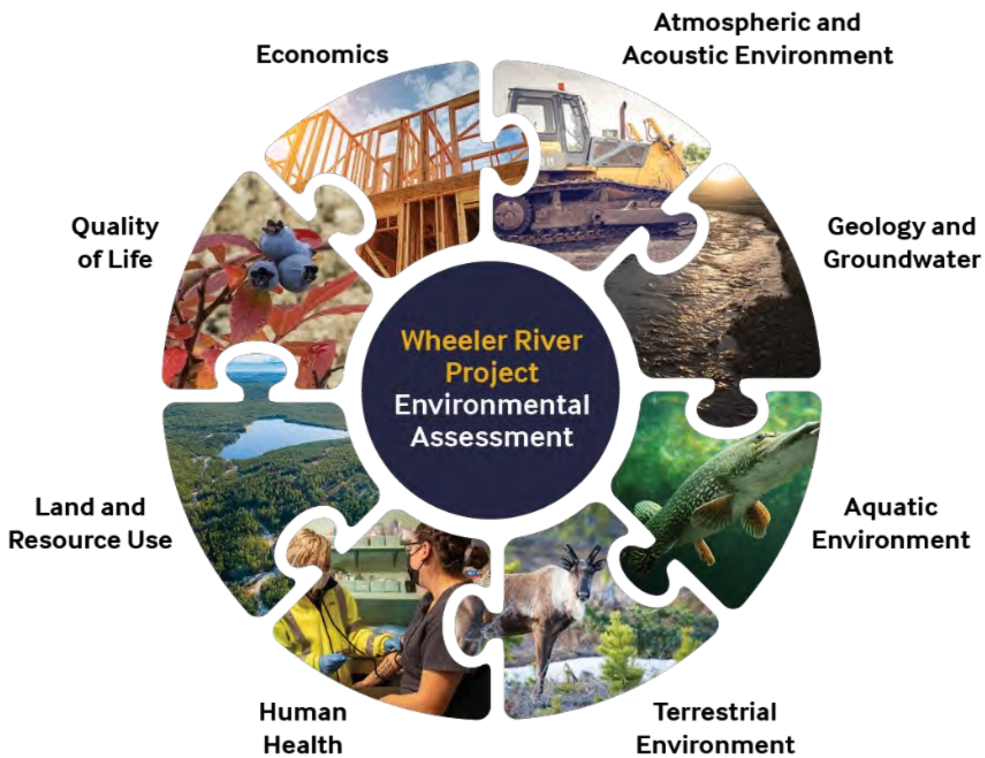

Figure 13-1: Biophysical and Human Environment Assessments for the Wheeler River Project Environmental Assessment

Figure 13-2: Economics - Valued Components

13.1 Scope of the Assessment

The purpose of this section is to meet the Terms of Reference (EASB# 2019-005) requirements for the Project as issued by the Saskatchewan Ministry of Environment and Canadian Nuclear Safety Commission. This section includes a detailed assessment of potential Project-specific effects and cumulative effects from the Project and other developments on the economy. This section provides an understanding of how the Project will affect the economy, including:

- Will the Project increase training and employment in the Local Study Area (LSA)?
- Will the Project increase income in the LSA?
- Will the Project change participation in the traditional economy?
- Will the Project increase business opportunities in the LSA?
- Will the Project increase government revenues at the provincial and federal level?

The assessment of effects on the economy follows the approach and methods provided in Section 5 Approach and Methodology of the Assessment, which includes the following primary steps:

- **Define the valued component specific measurements:** Sections 13.1.1 to 13.1.4 present the specific approaches and methods used to measure and assess the effects of the Project on the economy as well as cumulative effects from the Project. This includes VC selection, identifying the Key Indicators (KIs) and Measurable Parameters (MPs), and defining the spatial and temporal boundaries for infrastructure and services.
- **Characterize existing conditions:** Section 13.2 describes and characterizes existing conditions to provide context and a basis for evaluating potential changes to the economy caused by the Project.
- **Assessment of Project-related effects and mitigation measures:** Sections 13.3 and 13.4 identify and summarize potential interactions between the Project and each VC and KI. The assessment then identifies and describes the potential Project-related effects and assesses the changes due to the Project (i.e., residual effects after mitigation) and their significance. Project activities with the potential to affect each VC are provided mitigation policies and actions committed to by Denison Mines Corp. (Denison) to avoid or minimize potential adverse effects. A pathways analysis is used to focus additional assessment on interactions between the Project and the economy by evaluating the different effect pathways to determine if, after incorporation of mitigation, potential still exists to cause residual adverse effects. Where potential adverse effects are adequately mitigated and are not forwarded for additional analysis (i.e., where mitigation results in negligible effects or avoids the pathway altogether), the reasons for concluding the assessment at this stage were provided. Primary pathways anticipated to lead to residual adverse effects after incorporation of mitigation were carried forward to the next step for further analysis.
- **Residual effects and cumulative effects assessment (CEA):** Sections 13.5 and 13.6 evaluate and describe the effects of the primary pathways from the Project on the economy. The residual effects analysis is presented as an integrated narrative that describes the effects of the Project over time and highlights predicted effects at the point when adverse effects of the Project are expected to be greatest. This section also includes an analysis of residual cumulative effects from the Project.
- **Monitoring and follow-up:** Section 13.7 Outlines the actions to verify predicted residual effects, evaluate effectiveness of planned mitigation designs, policies, and practices, and address key sources of uncertainty.

Figure 13.1-1 is a graphic representation of the assessment process used in this EIS.

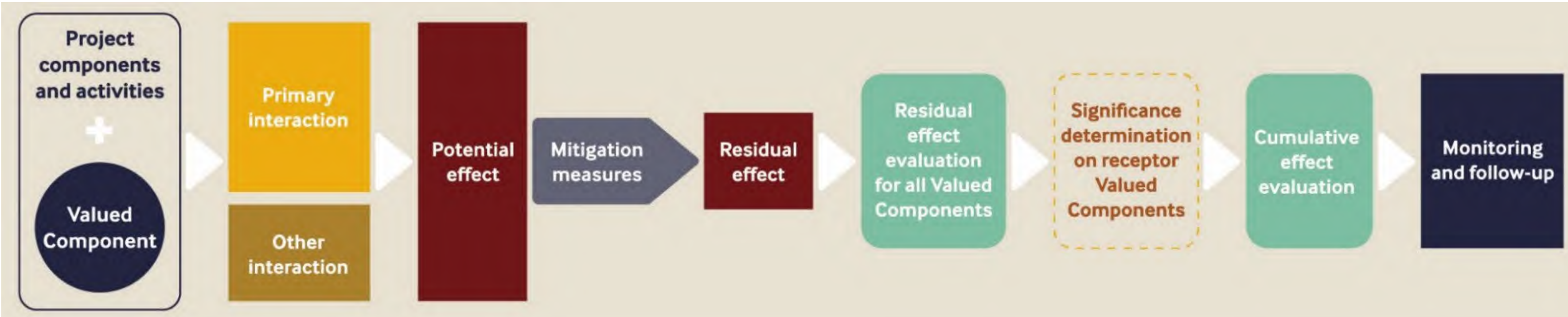

Figure 13.1-1: Environmental Assessment Process for the Wheeler River Project

13.1.1 Valued Component Selection

Consistent with standard Environmental Assessment (EA) practice, this EA is organized by and focused on VCs. The VCs are aspects of the biophysical and human environments that will likely be affected (adversely or positively) by the Project. The VCs reflect identified scientific, Local Knowledge (LK) and Indigenous Knowledge (IK), and community interests regarding the Project and its potential effects. The VCs are typically identified early in the EA process as a result of questions and concerns raised through engagement with Indigenous and community groups, government departments and agencies, and the general public.

The Economy VC was selected to reflect the probable impacts that Project-related activities may have on the prosperity of the local and regional economies and local and regional communities. Resource development projects require capital investment in facilities, equipment, and supplies, as well as labour and services. These Project expenditures may translate into employment and business opportunities locally and regionally if those markets can competitively supply the goods and services required by the Project. Residents in the LSA and Regional Study Area (RSA) have expressed interest and concern about the Project's effect on the local economy, through income, training and employment opportunities, and business opportunities.

- An online survey targeted at the Northern Village of Beauval ("Beauval") and the Northern Village of Pinehouse Lake ("Pinehouse Lake") sought insight into which aspects of the Project might provide benefits to respondents or their communities. Responses related to jobs, employment, or training opportunities that could arise as a result of the Project[1].
- Another online survey involving members of the English River First Nation (ERFN) sought insight into which aspects of the Project could be challenging or cause concern for the community. Responses indicated that jobs and employment were a concern, with several specifically identifying that ERFN members should be prioritized for employment opportunities (21-EN-ERFNSUR-456.6 to 21-EN-ERFNSUR-456.14).

Initial direction and input into VC selection was obtained from:

- discussions with Indigenous and non-Indigenous Communities of Interest (COI);
- discussions with LK holders;
- discussions with government agencies and the public;
- results of Denison's baseline studies;
- regional data from other EAs;
- results from engagement and consultation activity; and

[1] 21-EN-SUR-446.34 through 21-EN-SUR-446.42, 21-EN-SUR-446.52 through 21-EN-SUR-446.56, 21-EN-SUR-446.59, and 21-EN-SUR-446.60.

- similar or recent projects in the region.

Denison also met with the Métis Nation-Saskatchewan (MN-S) in early 2023 to share information about the Project, including discussion on VCs considered in the assessment; no new VCs were identified as part of that discussion.

Figure 13.1-2 is a graphic representation of the main linkages among the Economy VC and other VCs, illustrating the flow of assessment information into and from the Economy VC.

Figure 13.1-2: Integrated Assessment Approach - Key Connections between Economy and Other Valued Components

13.1.2 Key Indicators and Measurable Parameters

A KI, such as income, is an important aspect of a VC that may be affected by the Project and its activities. A MP is the metric associated with the KI that can be used to characterize changes to attributes of the environment that may change as a result of the Project and/or other human developments and natural factors. The changes in MPs are used to predict overall effects on VCs and KIs. The Economy VC is comprised of five KIs that capture the probable and measurable effects of Project-related activities on the local and regional economy. The Kis are:

- employment and training;
- income;
- traditional economy;

- business opportunities; and
- government revenues.

A description of each KI is provided in this subsection. Each of the five Kis of the Economy VC have associated MPs or metrics that are intended to detect and measure changes to the KI attributable to the Project. The Kis and associated MPs are presented in Table 13.1-1.

Employment and Training

Employment and training opportunities are tied to the increased demand for labour supporting the Project. Direct Project employment through Denison and Project contractors may be measured as a direct count of net-new employment opportunities filled by local or regional residents. Indirect and induced employment may be detectable through aggregated measures of employment and unemployment rates at the local and regional level if the Project-related activities are of sufficient scale relative to the local and regional economies.

Employment effects are common elements of economic-oriented VCs in major capital project EAs, where there is a material demand for labour. Results of engagement and consultation activities for the Project also support employment (and income) as Kis of the Economy VC, where approximately half of the recorded comments related to the Economy VC referenced employment, income, or job opportunities. Specific engagement results are identified throughout the following sections on existing environment. Common themes explored included desire for employment opportunities, and details regarding the types of skills and trades that would be required for the Project, the seasonal nature of employment, and the opportunities for advancement. The Economy VC was also designed to reflect the probable effect of Project-related activities on training opportunities intended to increase the supply of qualified labour to fill Project-related employment opportunities.

Education and training opportunities also figured prominently in the engagement and consultation results, with education and training accounting for about one quarter of the comments related to the Economy VC opportunities. Specific engagement results are identified throughout the existing environment subsections in Section 13.2. Common themes throughout the consultation comments concerned the availability of training programs, the appropriateness of existing training programs/facilities, and the potential for local training opportunities are detailed below.

The issue of scholarships for local students was advanced in consultations by an individual citing an interest and precedent for scholarships in a local community (18-EN-ERFN-5.30 and 18-EN-ERFN-5.31). This issue was not directly incorporated into the Economy VC as a KI, given the narrow focus and effect of scholarships, considering to the selected indicators. However, scholarships would be noted as a qualitative feature of training opportunities in the associated MP.

Income

Where the local and regional labour market is able to supply the needed skills and quantities of labour, employment income will tend to increase, particularly if available capacity exists in the labour market (i.e., Project-related activities do not out-compete existing labour demands and create shortages in other sectors of the local and regional economies).

Income is likely to be impacted through direct, indirect, and induced demand for labour that may be supplied from the local and regional labour supply. These terms are defined by the Impact Assessment Agency's guidance *Analyzing Health Social and Economic Effects Under the Impact Assessment Act* (IAA 2020) as:

- **Direct**: Effects of the initial Project expenditures.
- **Indirect**: Effects that are created through increased sales for suppliers to the direct activity.
- **Induced**: Effects that are created by additional income and profits earned by workers associated with the Project directly or indirectly. This additional income leads to more spending on food, housing, entertainment, transportation, and other expenses that make up typical household spending.

Income is closely tied to employment as local and regional resident incomes increase with additional and/or more lucrative employment opportunities. The effect of Project-related activities on income is measured as the increase in personal and household income relative to average personal and household income.

Traditional Economy

The traditional economy, or subsistence economy, refers to activities such as hunting, fishing, trapping, and crafts-making that take place outside of the market or wage economy. These activities provide food and other necessities of life that support people and communities through personal use, giving to other members of the community for personal use, exchange, or barter, but are not purchased with cash. The traditional economy is also important as it enables the transmission of societal norms and cultural values across generations (Usher et al. 2003). Participation in the traditional economy may be affected by Project activities, particularly because of increased labour demand for the Project, increased incomes as a result of net-new employment opportunities, and change in land and resource use. The importance of the traditional economy in the economic assessment was identified in the economy related consultation results. For example, a resident of ERFN commented through community engagement that the '*traditional economy could be included into the regular economic section, integrated into the Environmental Impact Statement, and added as a Valued Component*' (21-EN-ERFN-474.5). The ERFN members have stressed the importance of protecting the area and are concerned that impacts to the Project area will expand beyond the immediate lands and waters (ERFN and SVS 2022b). Traditional activities for ERFN members are often a community affair, making hunting, fishing, trapping, and gathering key cultural events (ERFN and SVS 2022b). Although culturally significant, these traditional land-based activities are also an important economic activity to ERFN. Members of the ERFN have noted that practising traditional activities such as hunting, fishing, trapping, and gathering is a crucial component of ERFN spiritual and cultural health (ERFN and SVS 2022b). Kineepik Métis Local and Pinehouse Lake members have raised concern that the Project may limit their current land use practices and traditional economic activity (KML 2022). The Kineepik Métis Local and the Pinehouse Lake members have indicated that one mining project will not materially affect land use practices, but substantial and growing projects in the area may limit the ability to continue practising in the area, including hunting for moose, bear, deer, and caribou (KML 2022). The Métis Knowledge Study (MN-S and Two Worlds Consulting 2023) notes that the Métis worldview and land and resource use are deeply intertwined with economic activities, stemming in part from the fact that the Métis as a people were an outcome of the fur trade. The Métis participated in a mixed economy “whereby life included both subsistence land-use and diverse commercial trade” (MN-S and Two Worlds Consulting 2023). The effect of Project-related activities on the traditional economy is measured as the change in the proportion of LSA residents participating in the traditional economy.

Business Opportunities

Business opportunities are expected to be available to local and regional businesses, increasing the amount of commerce otherwise conducted by new and existing businesses.

Major resource development projects require equipment, materials, supplies, and services that may be sourced from northern Saskatchewan supply and service companies, creating net-new business opportunities for those firms. These business opportunities increase sales and revenues for awarded firms and may themselves create employment opportunities as an indirect economic activity derived from the resource project. Business opportunities directed toward and accrued by local business is one form of local benefit associated with major resource development projects, and expectations around local business opportunities also figured notably in the engagement and consultation results. Specific engagement results are identified throughout the existing environment subsections in Section 13.2.

Contract and service opportunities were identified in the economy-related consultation results, with themes centred around surface lease agreements (SLAs), the availability and willingness of local businesses to supply materials and services to the Project, and competitiveness and capacity of local suppliers to compete with those from outside the region. Comments identified through community engagement include:

- Does Denison have plans to have contracts with northern Indigenous companies, especially those from impact/rights bearing communities? Will there be contracts for northern businesses for the life of the mine (21-EN-VPL-444.1)?

- Will local companies (Tron, Des Nedhe), and local community members get priority for contracts and employment? Will Tron and Des Nedhe get opportunities to have contracts (21-EN-ERFN-447.3)? Will there be opportunities for negotiations between ERFN and Denison, so our community members do not lose out on opportunities (21-EN-ERFN-447.4)?
- Continue to work together to identify areas the community may be able to support the Project activities from a business development perspective (17-EN-VB-116.5).
- Engagement with community members of Pinehouse Lake has indicated that residents routinely enjoy the employment and business opportunities that come with projects in the area, due to their combined and collaborative efforts. We take great pride in the work ethic of our people to add value to our community and province (KML 2022).

Government Revenues

Mineral royalties and personal and corporate income taxes resulting from the Project Construction and Operation are expected to measurably increase provincial government revenues and measurably affect federal government revenues.

The Economy VC is designed to consider the probable and measurable effect of Project-related activities on government revenues, through royalties, and personal and corporate income taxes at the provincial and federal level.

The effect on government revenues will be measurable through the royalty framework, and corporate and personal income taxes directly related to the Project. However, personal and corporate income taxes from indirect and induced employment may be difficult to identify and quantify. The total incremental taxation revenues attributable to the Project may also be undetectable in the context of overall provincial tax revenues.

The Economy VC does not consider increases in municipal taxes, which are normally associated with property ownership (e.g., property taxes, school taxes). The scale of the Project, and fly-in/fly-out nature of the labour force, does not suggest a likely material increase in property ownership in the local area. In-migration of workers to the local area is possible but the effect on municipal taxes is not expected to be detectable in the context of overall municipal tax revenues.

The Economy VC also does not consider the effect of sales taxes on goods and services purchased directly related to the Project, or those sales taxes associated with indirect demand from the Project.

Table 13.1-1: Key Indicators and Measurable Parameters for Economy

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Employment and Training	Project activities may affect employment opportunities. Employment opportunities are expected through the Construction, Operation, and Decommissioning phases of the Project. Survey respondents expressed an interest in employment and training opportunities, including that they may create jobs for local communities and residents (21-EN-SUR-446.34 and 21-EN-SUR-446.42). • These direct employment opportunities are measurable, based on the number of directly employed and directly contracted staff required for the Project. Indirect employment opportunities are a result of other businesses hiring net-new staff needed to provide goods and services to the Project. Indirect employment effects are generally lower than the direct employment effects.	• The number of Project-related employment opportunities. • The number of Project-related training, and educational opportunities. • Proportion of Project-related employment opportunities offered and attained by residents in the LSA. • Proportion of Project-related training and educational opportunities offered and attained by residents in the LSA. • Note that training and educational opportunities that accompany Project Construction and Operation will likely result from collaboration with the Project proponent, and possibly educational institutions serving northern Saskatchewan. These opportunities will be measurable as they are rolled out through Project Construction and Operation.
Income	Project activities may affect income. Survey respondents expressed an interest in income and employment rates, including that they may increase (21-EN-SUR-446.52 and 21-EN-SUR-446.53). • Increases in income may occur with net-new employment opportunities, either directly with the Project or as a result of indirect demand for goods and services to support the Project. • Increases to income may also result from tightening of local labour market as businesses compete for labour.	• Total wages and salaries paid by Denison and direct contractors on the Project. • Changes in income levels of residents in the LSA communities (personal and household). Note that income effects through induced demand may not be detectable given the size of the Project. The fly-in/fly-out labour force also increases the potential that labour for Construction and Operation of the Project may be sourced from a broad geographical region, which will spread the effect of increased household spending across a larger geographical area. This means that changes in income across the LSA may be harder to detect and quantify. • Employment income within the LSA communities, which will be sampled at five-year intervals through Statistics Canada census.
Traditional Economy	Project activities may affect participation in the traditional economy, particularly because of increased labour demand for the Project, increased income as a result of net-new employment opportunities, and change in land and resource use. Survey respondents expressed that Indigenous land use should be integrated into the economic assessment and its importance to the traditional economy (21-EN-ERFN-474.5).	• The change in LSA residents participating in the traditional economy due to the Project.

Key Indicator	Rationale for Key Indicator	Measurable Parameter
Business Opportunities	Project-related activities may affect local business opportunities. Survey respondents had an interest in the types of opportunities that would arise from the Project and Denison (21-EN-SUR-446.34 and 21-EN-SUR-446.42), such as agreements for hiring and working with northern peoples and companies (21-EN-SUR-446.54). Business opportunities may be expected through the Construction, Operation, and Decommissioning phases of the Project.	• The total expenditures of northern Saskatchewan businesses contracted by the Project and procurement agreements and policies in place with Indigenous and northern businesses. Note that the number of northern Saskatchewan businesses contracted by the Project and their expenditures will be measurable.
Government Revenues	Project-related activities may affect government revenues. Government revenues may be impacted by the Project depending on the jurisdiction of the government: • Federal government will collect personal and corporate income tax revenues. • Provincial government will collect royalties and personal and corporate income taxes. • Municipal governments will collect revenues through property taxes.	• Changes to provincial royalties and resource surcharges due to the Project. • Changes to federal and provincial corporate income tax due to the Project. • Change to federal and provincial direct employment income tax due to the Project. Note that the direct effect on government revenues will be measurable through taxes and royalties payable by Denison and taxes withheld from Project labour. Government revenue from either indirect or induced corporate and personal income taxes will be less measurable, and less material than the revenues from direct Project activity.

13.1.3 Spatial and Temporal Boundaries

13.1.3.1 Spatial Boundaries

Spatial boundaries for the Economy VC were selected to reflect the geographic areas where economic impacts from the Project are likely to be detectable and measurable. These impacts are expected to be driven primarily by the relationship and interactions between the Project and the COI. Economic benefits surrounding Project employment (including income and training) are likely to be targeted toward the communities identified within the spatial boundaries. The economic impacts concentrated within the LSA are expected to be detectable and measurable. Economic impacts extending beyond the LSA are likely to be diffused and undetectable within the broader economy. The spatial boundaries were selected based on the consideration of communities where Project recruitment is likely to be prioritized, consideration of previous EAs conducted in the region, and consideration of information shared through key persons in the interview program. The spatial boundaries may be further refined during study implementation based on feedback from regulators, local and Indigenous communities, and the public. Figure 13.1-3 provides the location of the Project in relation to the LSA communities.

Local Study Area

The LSA for the assessment of the economy includes the following communities:

- ERFN (including Indian Reserve Wapachewunak 192D and Indian Reserve La Plonge 192) and Patuanak, Northern Hamlet (Patuanak), and Métis Local #82 of Patuanak;
- Pinehouse Lake, Northern Village, and Kineepik Métis Local (KML) #9; and
- Beauval, Northern Village, and Métis Local #37.

Many of the economic data collected from Statistics Canada provided details for each of the two localities comprising ERFN. The underlying data are not available to aggregate certain economic indicators across the localities. As a result, ERFN data have been presented on a disaggregated basis throughout.

Regional Study Area

The RSA for the Economy VC is the Northern Saskatchewan Administrative District (Census Division 18), which is defined in *The Northern Municipalities Act, 2010* (Government of Saskatchewan 2010). This area shares many economic and demographic characteristics with the LSA and is a relevant reference point. The Northern Saskatchewan Administrative District includes MN-S Northern Region 1 (NR1), Northern Region 2, Northern Region 3 (NR3), and Eastern Region 1. The Local Study Area communities are located within NR3 and the Project is located within NR1.

For certain economic indicators, such as government revenues, the Province of Saskatchewan and Government of Canada are the relevant taxation collecting authorities and form the relevant spatial boundary.

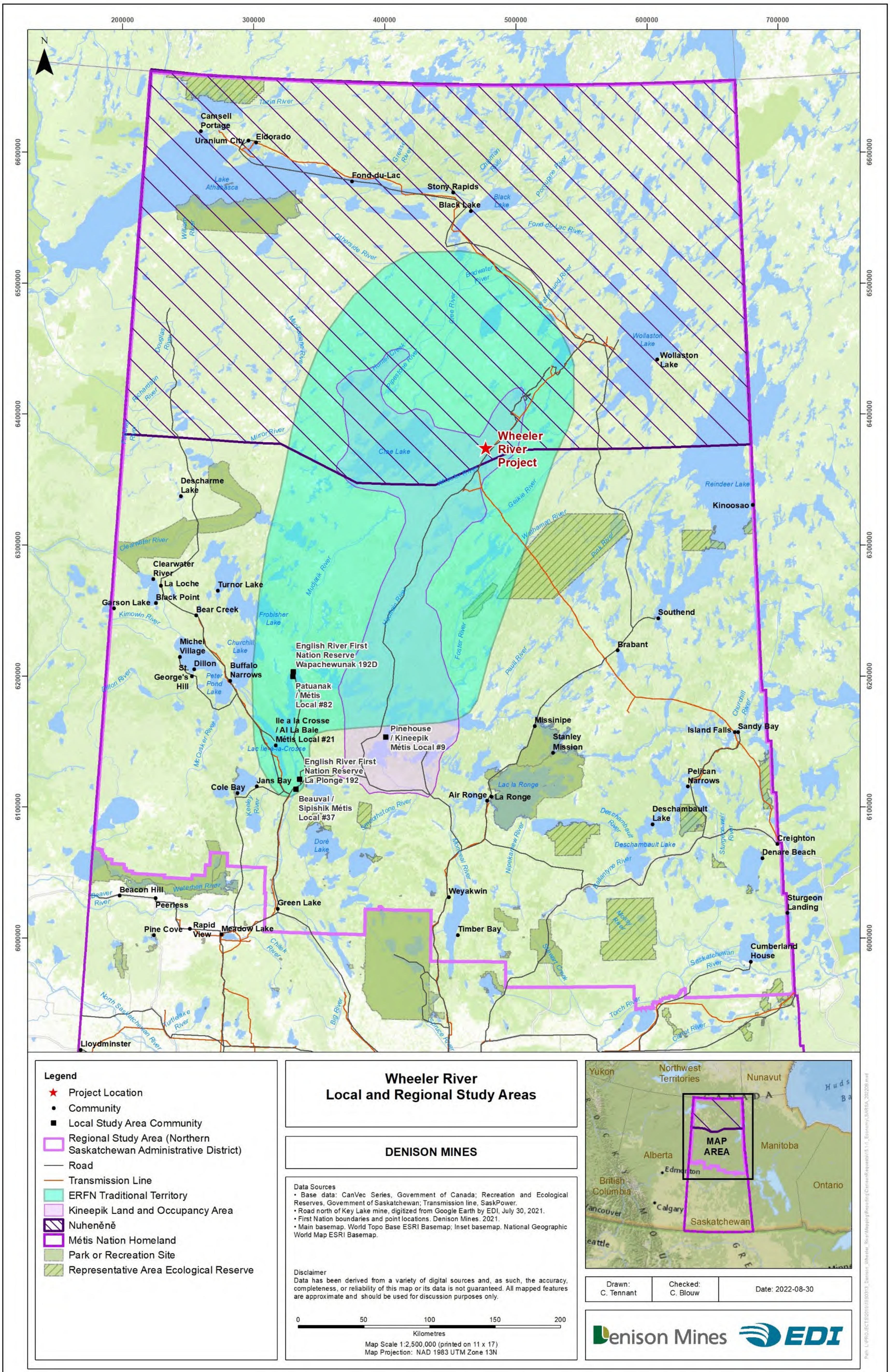

Figure 13.1-3: Location of the Project in Relation to the Communities in the Local and Regional Study Areas

13.1.3.2 Temporal Boundaries

The characterization of the existing environment for income and employment and training indicators will focus on the past four census periods (2006, 2011, 2016, and 2021) to provide continuity of data,[2] and provide a reasonable period to assess trends.

The existing environment for government revenues and business opportunities will be limited to currently available data to establish a context for the expected Project effects on those indicators. The scale of provincial and federal tax revenues relative to Project effects suggests that any trend would not be impacted by the Project. The existing environment for business opportunities will similarly be limited to currently available data, surveying businesses that are presently a going concern, and so may be affected by the Project.

The temporal scope of the assessment for MPs of the Economy VC will be forward looking and include the period from initial Construction to the end of Decommissioning as defined by the following Project phases:

- Construction: includes site preparation; wellfield and freeze hole drilling; processing plant construction; other service infrastructure; and electrical infrastructure. The duration of Construction will be approximately two years.
- Operation: includes operation of the wellfield; operation of the processing plant and production; maintenance activities; water withdrawal from groundwater or surface water for potable use, fire suppression, and make-up water in the processing plant; water treatment; waste management; environmental monitoring; package and transport of nuclear substances; reporting to regulators; engagement; and site security. The duration of Operation will be approximately 15 years.
- Decommissioning: includes mining chamber remediation; decontamination; asset removal; demolition and disposal; and reclamation. The duration of Decommissioning will be approximately five years.

These three phases represent most of the Project activities that will affect the Economy VC, through income, employment and training, traditional economy, business opportunities, and government revenues.

The fourth phase of the Project, Post-Decommissioning, is not included within the economic temporal boundaries as the monitoring and inspection activity is expected to be very limited compared to the Construction, Operation, and Decommissioning phases. The economic effect of Post-Decommissioning activities is not expected to be detectable at a scale consistent with the Construction, Operation, and Decommissioning phases. Lasting effects of employment, training and

[2] For 2011, the Census of Population was replaced with the National Household Survey and does not contain all indicators. The 2006, 2016, and 2021 Census are expected to contain comparable data across relevant indicators.

business opportunities may exist in the Post-Decommissioning period (and perhaps beyond), through accumulation of skills and experience at an individual and business level; however, such impacts are uncertain and unlikely to be quantifiable.

13.1.4 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

Indigenous Knowledge, LK, and engagement were included in the assessment through workshops, surveys, and Key Person Interviews (KPIs) identified in Section 3 Indigenous and Local Knowledge and Section 4 Engagement of the EIS. Indigenous Knowledge, LK, and engagement for the assessment are described in Sections 3 and 4 of the EIS. Sources of information relevant to the influence on IK and LK include the *English River First Nation Wheeler River Project Summary of Health and Socio-Economy Study Results* (ERFN and SVS 2022a), *Summary of Traditional Knowledge Study Results* (ERFN and SVS 2022b), and the *Kineepik Métis Local and the Northern Village of Pinehouse Lake Kineepik Valued Ecosystem Components and Pre-statement for the Denison EIS* (KML 2022).

The MN-S submitted *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) to Denison in October 2023. The Métis knowledge summarized therein included secondary literature approved for use by the MN-S and primary information collected during interviews with nine Métis citizens from NR1 and NR3, exclusive of information from the KML at Pinehouse who formally revoked its delegated Duty to Consult from the MN-S.

Additional information relevant to IK and LK is provided in Section 11 Land and Resource Use.

The assessment of the Economy VC has been influenced by community engagement, which has identified issues of importance to community members across the COI. These identified issues include opportunities for income, employment and training, business and supply contracts, impact benefit agreements and memoranda of understanding, and the traditional economy (described in Section 13.2.3). The Kis in the Economy VC largely reflect the breadth of issues raised through community engagement. As part of engagement activities for Beauval and Pinehouse Lake, Denison prepared and shared an online survey that included information about Denison, the Project, and posed validation questions about the VCs being assessed as part of the EA process. The survey is provided in Appendix 4-A in Section 4.

Denison has recorded and stored information regarding IK, LK, and engagement activities in an Engagement Database. Within the database, records are given unique identification numbers (e.g., 21-EN-SUR-446.52). These numbers are referenced throughout the EIS, but particularly in Parts II and III, to indicate where specific information from the database has been integrated into the assessment. Appendix 13-A provides a summary of unique identification numbers referenced within Section 13.

Engagement identified an interest in income and employment rates, including that they may increase[3]; an interest in employment and training opportunities, including that they may create jobs for local communities and residents and an interest in the types of opportunities that would arise from the Project and Denison (such as agreements for hiring and working with northern peoples and companies)[4]; and that Indigenous land use should be integrated into the economic assessment and its importance to the traditional economy (21-EN-ERFN-474.5). Comments identified through community engagement include:

- The employment rates would rise [because of the Project] (21-EN-SUR-446.52).
- I could make a lot of money and help my family (21-EN-SUR-446.53).
- Local employment is important to me (22-EN-SUR-652.33).
- Employment for our young people (22-EN-SUR-652.36).
- [The Project] would bring jobs into the community (21-EN-SUR-446.42) and would [create] employment for our people (21-EN-SUR-446.34).
- The creation of jobs for northerners (22-EN-SUR-652.35).
- Can you integrate Indigenous land use into the economic assessment (21-EN-ERFN-474.5)?
- ERFN members have stressed the importance of protecting the area and are concerned that effects to the Project area will expand beyond the immediate lands and waters (ERFN and SVS 2022b).
- Kineepik Métis Local and the Northern Village of Pinehouse Lake members have raised concern that the Project may limit their current land use practices and traditional economic activity (KML 2022).

13.2 Existing Environment

The characterization of the existing environment includes both primary and secondary data sources. Data collection began with a review of existing literature and databases from a variety of public sources. Online surveys, workshops, and other forms of engagement documented by Denison also assisted in identifying community interests and concerns about existing conditions.

Literature Review

The review of literature and databases included the following sources:

- statistical data sources (e.g., Statistics Canada);
- federal, provincial, and municipal government reports and data;
- regional-level documents;

[3] 21-EN-SUR-446.52, 21-EN-SUR-446.53, 22-EN-SUR-652.33, and 22-EN-SUR-665.36.
[4] 21-EN-SUR-446.34, 21-EN-SUR-446.42, 21-EN-SUR-446.54, and 22-EN-SUR-665.35.

- community profiles;
- publicly available profiles, reports, and EAs of uranium mines in the area; and
- online sources (e.g., community websites).

The most recent data from these sources were used to characterize the existing environment.

Limitations of Secondary Data Collection

Statistics Canada Census of Population data contributed to developing an understanding of the LSA and RSA income and employment opportunities, and how they have changed over time. Data should be interpreted with caution because of issues of comparability across years, confidentiality, and data quality. Limitations relative to specific indicators are provided as notes to tables and figures. In 2011, a shift occurred in how the census was administered, with a National Household Survey replacing the long-form census. One of the key differences was a change from a mandatory to an optional response requirement, resulting in a reduction in survey response rates and challenges associated to variability of response rates at lower geographic levels, sampling error, and non-response bias.

As the census is conducted once every five years, the census data may not accurately reflect the most current socio-economic conditions. Changes in the local, regional, and national economy arising from the COVID-19 pandemic are not captured in the 2016 census data.

The Census of Population suppresses data for confidentiality or data quality. Data suppression for confidentiality reasons is meant to prevent the disclosure of data that could be used to identify individuals, particularly in small communities. Data suppression due to data quality is done for a variety of reasons, including incompletely enumerated reserve parcels or Indian settlements or a global non-response rate of higher than or equal to 50%. The Census of Population also relies on a random rounding procedure, where actual values are randomly rounded to the nearest integer of five to enhance confidentiality. This can impact very small populations, but is not believed to have a material impact on the LSA reporting.

The 2021 Census disaggregates by gender. Census years prior to 2021 disaggregate by sex (male and female). Although sex and gender refer to two different concepts, the introduction of gender is not expected to have a significant impact on data analysis and historical comparability, given the small size of the transgender and non-binary populations. Given that the non-binary population is small, data aggregation to a two-category gender variable is sometimes necessary to protect the confidentiality of responses provided. In these cases, individuals in the category "non-binary persons" are distributed into the other two gender categories (men+ and women+) and are denoted by the "+" symbol (Statistics Canada 2022b). When analyzing trends across time (2006, 2011, 2016, and 2021 Census), the terms sex or gender are used, along with male and female. When analyzing trends prior to the 2021 Census (2006, 2011, and/or 2016 Census), the term sex is used, along with male and female. When analyzing only 2021 Census data, the term gender is used, along with men+ and women+ in figures or men and women in the analysis. Footnotes expand on the explanation, where relevant, within sections.

Other Sources of Information

Indigenous Knowledge was incorporated into the description of the existing environment as described in Section 13.1.4, including the results from *the English River First Nation Wheeler River Project Summary of Health and Socio-Economy Study Results* (ERFN and SVS 2022a), *Summary of Traditional Knowledge Study Results* (ERFN and SVS 2022b), the *Kineepik Métis Local and the Northern Village of Pinehouse Lake Kineepik Valued Ecosystem Components and Pre-statement for the Denison EIS* (KML 2022), and *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023). Additional information relevant to IK and LK is provided in Section 11. Information from engagement activities, workshops, and surveys was also used to inform the description of the existing environment.

13.2.1 Key Indicator: Employment and Training

Employment and training are an important component of the local and regional economy. Employment, combined with education and training, is a pathway to higher income potential. To understand employment and training, this section examines the following indicators:

- labour force characteristics, including participation rate, employment rate, and unemployment rate;
- employment by sector; and
- educational attainment.

Due to the small populations of La Plonge and Patuanak, data from Statistics Canada have been suppressed to protect confidentiality. Accordingly, data for the LSA are not fully representative, but the effect on reported statistics is believed to be minimal at the LSA level, given the low population of those two localities.

13.2.1.1 Labour Force Characteristics

Labour force characteristics describe various aspects of labour use in an economy, using aggregate measures such as participation rate, employment rates, and unemployment rates. A foundational concept for labour force characteristics is that of labour force status, which refers to an individual's employment status during the referenced period (Statistics Canada 2016a). Individuals can occupy one of three statuses in the labour market: employed (full-time or part-time), unemployed, or not in the labour force[5]. Those not in the labour force can include people who are permanently unable

[5] Additional detail on Statistics Canada definitions of Labour Force Classification is available in the Guide to the Labour Force Survey. 2020. Catalogue no. 71-543-G. https://www150.statcan.gc.ca/n1/pub/71-543-g/71-543-g2020001-eng.htm (accessed January 2022).

to work, retired, full-time students, and discouraged workers (Gilmore and LaRochelle-Côté 2011). Labour force characteristics are defined in part around the labour force status. Labour force characteristics also rely on the distinction between the labour force and the working age population. The working age population is defined as those 15 years old and over. The labour force represents the portion of the working age population who identify as able and available to work (where work is formally defined as 'contribution to the production of goods and services falling within the System of National Accounts production boundary')[6]. Labour force status is reported for the working age population.

In October 2021, the Saskatchewan Bureau of Statistics reported that the labour force in Saskatchewan totalled 593,100 persons and was virtually unchanged from the October 2020 labour force of 592,000 persons (Saskatchewan Bureau of Statistics 2021).

13.2.1.2 Participation Rate

The participation rate is the number of people in the labour force (employed and unemployed combined), as against the whole working age population. Specifically, the participation rate is the proportion of people working (employed) or able and available to work (unemployed), from the entire working age population (15 years old and over). For example, during the 2021 Census reference week of Sunday, May 2 to Saturday, May 8, 2021, the population of those 15 years and older in the LSA was 1,895. Of those, 935 individuals identified as being in the labour force (employed or unemployed). Accordingly, the participation rate of the LSA in the 2021 Census was 49%.

Overall, in 2021, the labour force in the LSA (935), represented 8% of the 11,140 people in the northern Saskatchewan labour force, and 0.2% of the 577,510 people in the Saskatchewan labour force. The Saskatchewan Bureau of Statistics reported that in October 2021, the participation rate for Saskatchewan was 67%, virtually unchanged from 67% in October 2020 (Saskatchewan Bureau of Statistics 2021).

Figure 13.2-1 presents 2021 participation rates for the LSA communities, northern Saskatchewan (RSA), and Saskatchewan overall. The overall participation rate in the LSA (49%) was lower than Saskatchewan as a whole (65%), but higher than northern Saskatchewan (45%). Participation rates within LSA communities varied considerably, with ERFN localities (Wapachewunak 192D and La Plonge 192), Patuanak, and Pinehouse having lower participation rates (between 36% to 50%) compared to Beauval (69%). The ERFN and Pinehouse participation rates were also materially lower than northern Saskatchewan overall. Community engagement activities identified interest with

[6] For example, criminal enterprise or poaching would not be captured within the System of National Accounts; notwithstanding, individuals engaged in these activities are earning income.

understanding relative employment levels for the Project and the types of employment opportunities expected from the Project (21-EN-SUR-446.34 and 21-EN-SUR-446.42).

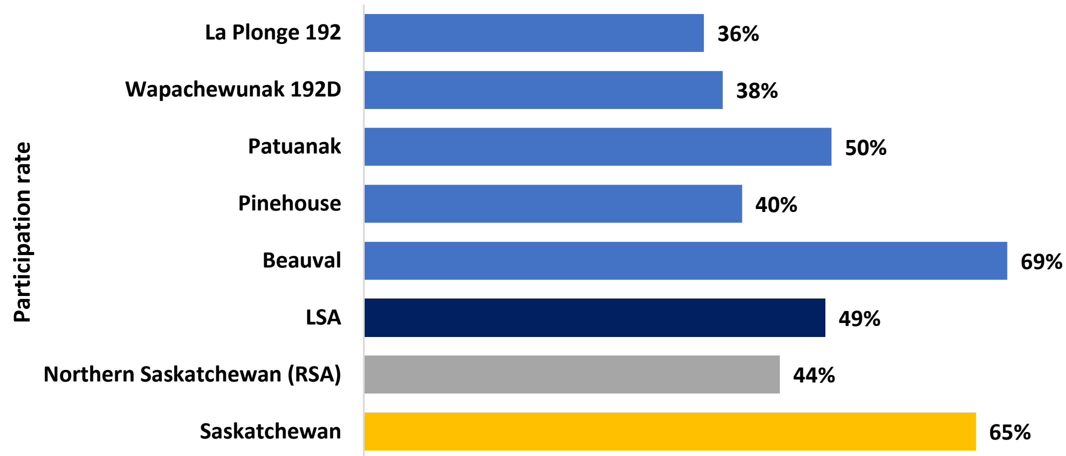

Figure 13.2-1: Participation Rate for the LSA, RSA, and Saskatchewan, 2021[1,2,3]

Source: Statistics Canada 2022b. See Appendix 13-B.

Notes:

1. Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10.
2. The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval.
3. Northern Saskatchewan (RSA) is defined as Census Division No.18.

Table 13.2-1 presents the participation rates for the LSA, RSA, and Saskatchewan in the last four census periods from 2006 to 2021. Over this time, the average participation rate for the LSA communities (49%) was similar to the RSA communities (48%), but lower than the province as a whole (68%). The participation rates in the LSA, RSA, and Saskatchewan were also quite stable between 2006 to 2021, changing no more than 6%.

For the LSA communities from 2006 to 2021, the highest average participation rate was in Beauval (56%), whereas the lowest was in Wapachewunak (40%).

Trends over the period from 2006 to 2021 were mixed. The overall average participation rate for the LSA increased from 48% (in 2006) to 49% (in 2021), with increases of 10% were found for Beauval over this timeframe. Pinehouse Lake and ERFN locality La Plonge have experienced decreases in participation rates over the same period. The small population, and small labour force, of La Plonge and Patuanak require consideration of trends and point estimates to be interpreted with caution. Statistics Canada data are subject to random rounding to the nearest multiple of 5 or 10, which can contribute to the appearance of material changes in localities with very small populations.

Table 13.2-1: Participation Rate for the Local Study Area, Regional Study Area, and Saskatchewan, 2006 to 2021

Location	2006[1]	2011[1]	2016[1]	2021[1]	Average
English River First Nation					
La Plonge 192	47%	50%	32%	36%	41%
Wapachewunak 192D	36%	44%	43%	38%	40%
Patuanak	42%	44%	36%	50%	43%
Pinehouse Lake	46%	52%	56%	40%	49%
Beauval	58%	42%	57%	69%	56%
LSA[2]	**48%**	**47%**	**51%**	**49%**	**49%**
Northern Saskatchewan (RSA)[3]	**50%**	**47%**	**49%**	**44%**	**48%**
Saskatchewan	**68%**	**69%**	**68%**	**65%**	**68%**

Source: Statistics Canada 2006, 2011, 2016a, and 2022b. See Appendix 13-B.
Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10.

2 The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval.

3 Northern Saskatchewan (RSA) is defined as Census Division No.18.

13.2.1.3 Employment Rate

Employment rate is the number of people employed as a percentage of the working age population (15 years and over), in the specified reference week (Statistics Canada 2022b). Conceptually, the employment rate is the proportion of people working out of all people who could theoretically work. For example, during the 2021 Census reference week of Sunday, May 2 to Saturday, May 8, 2021, the population of those 15 years and older in the LSA was 1,895. Within this population, 770 individuals were employed, indicating an employment rate in the 2021 Census of 41%.

Overall, in 2021, the employed in the LSA (770) represented 9% of the 9,020 employed people in northern Saskatchewan, and 0.1% of the employed in Saskatchewan overall (528,900).

Figure 13.2-2 shows the 2021 employment rate for LSA communities, northern Saskatchewan (RSA), and Saskatchewan overall. The employment rate for the LSA overall was 41%, which was lower than Saskatchewan as a whole (60%), but higher than the RSA (36%). For the LSA communities, the employment rates ranged from 29% (Wapachewunak) to 58% (Beauval). Community engagement activities identified interest with understanding relative employment levels for the Project and the types of employment opportunities expected from the Project[7].

[7] 21-EN-SUR-446.34, 21-EN-SUR-446.42, 22-EN-VPL/ML9-623.4, and 22-EN-ERFN-621.6.

Respondents would like to understand the training and employment opportunities available to local residents from the Project[8].

Engagement with community members of Pinehouse Lake indicated that residents routinely enjoy the employment and business opportunities that come with projects in the area, due to their combined and collaborative efforts (KML 2022). Profits from projects in the area have contributed to community infrastructure (KML 2022). Métis citizens have worked on industrial development projects in northern Saskatchewan and, as a result, bring a range of knowledge on uranium mining processes (MN-S and Two Worlds Consulting 2023).

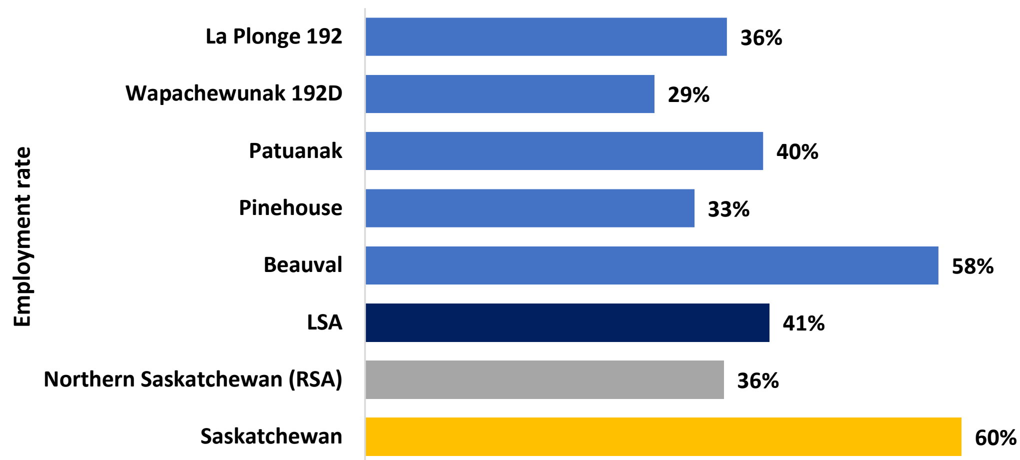

Figure 13.2-2: Employment Rate for the LSA, RSA, and Saskatchewan, 2021[1,2,3]

Source: Statistics Canada 2022b. See Appendix 13-B.
Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10.

2 The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval.

3 Northern Saskatchewan (RSA) is defined as Census Division No.18.

For October 2021, the Saskatchewan Bureau of Statistics reported total employment in Saskatchewan at 562,800, however it does not report an employment rate. Statistics Canada's Labour Force Survey reports the employment rate in Saskatchewan for persons 15 years and over at 63.2% in October 2021 (Statistics Canada 2022a).

Table 13.2-2 presents employment rates for the LSA, the RSA, and Saskatchewan in the last four census periods: 2006, 2011, 2016, and 2021. Over this period, the average LSA employment rate was 39% compared to 38% in the RSA and 63% in Saskatchewan as a whole. Communities in the LSA had similar levels of engagement in the labour market compared to the overall RSA, but both

[8] 21-EN-SUR-446.35, 22-EN-SUR-652.35, 22-EN-SUR-652.4, 22-EN-SUR-652.36, and 22-EN-SUR-652.39.

the LSA and RSA materially lagged behind the province as a whole. Employment rates within the LSA communities also varied, with ERFN communities and Patuanak having generally lower employment rates than other LSA communities. However, between 2006 and 2021, Wapachewunak and Patuanak employment rates increased 8% and 15%, respectively. The small populations in Patuanak and La Plonge warrant the same caveat that trends and point estimates should be interpreted with caution due to Statistics Canada rounding procedures. Whereas the employment rate in Pinehouse Lake decreased 4% (from 37% to 33%) over the 2006 to 2021 period. Beauval employment rates varied, dropping 8% (from 43% to 35%) between 2006 and 2011, and then increased to 45% in 2016 and 58% in 2021. The decrease to employment rates in 2011 may be a result of the National Household Survey replacing the long-form portion of the Census of Population in 2011. The National Household Survey (Statistics Canada 2011) was not mandatory and led to larger non-response rates, whereas the 2006, 2016, and 2021 Census of Population were mandatory (Statistics Canada 2022b).

Several barriers to employment in northern Saskatchewan have been identified, including lower levels of educational attainment, limited job and work experience opportunities in smaller communities, and the short-term or seasonal nature of many jobs (NLMC et al. 2011). At a virtual meeting for the community of Pinehouse Lake, it was noted that Human Resources Development Agreements with other uranium mines have not met the targets for northern hiring (21-EN-VPL-444.17). Comments from LSA residents expressed interest in Project employment targets, types of employment opportunities, and emphasis on hiring northern residents. Comments from community engagement include:

- Will Denison have agreements similar to other northern mines (Cameco and Orano) and will you have employment and training targets?[9]
- What kind of employment opportunities will we see from Denison?[10]
- Will northerners be hired for Project positions and will there be opportunities for local residents?[11]

English River First Nation members have also expressed that they feel there are limited current employment opportunities for ERFN members, and many members feel future opportunities may also be limited due to barriers ERFN members face when seeking opportunities for post-secondary education and employment (ERFN and SVS 2022a). The barriers include the remote locations of Patuanak and La Plonge and the need to rely on accessing employment opportunities and education outside of their communities (ERFN and SVS 2022a). Similarly, *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) noted that attaining

[9] 20-EN-VB-382.7, 21-EN-SUR-446.7, 21-EN-SUR-446.8, and 22-EN-VPL/ML9-623.4.
[10] 21-EN-SUR-446.34, 21-EN-SUR-446.40, and 22-EN-SUR-652.31, 22-EN-SUR-652.32, and 22-EN-SUR-652.34.
[11] 21-EN-SUR-446.34, 21-EN-VPL-444.16, 22-EN-SUR-652.33, and 22-EN-SUR-652.35.

meaningful employment can be challenging, and that access to training is an obstacle for Métis youth as training is not delivered in northern communities.

Table 13.2-2: Employment Rate for the Local Study Area, Regional Study Area, and Saskatchewan, 2006 to 2021

Location	2006[1]	2011[1]	2016[1]	2021[1]	Average[2]
English River First Nation					
La Plonge 192	37%	44%	32%	36%	37%
Wapachewunak 192D	21%	38%	34%	29%	31%
Patuanak	25%	44%	36%	40%	36%
Pinehouse Lake	37%	42%	43%	33%	39%
Beauval	43%	35%	45%	58%	45%
LSA[3]	**35%**	**39%**	**40%**	**41%**	**39%**
Northern Saskatchewan (RSA)[4]	**40%**	**38%**	**37%**	**36%**	**38%**
Saskatchewan	**65%**	**65%**	**64%**	**60%**	**63%**

Source: Statistics Canada 2006, 2011, 2016a, 2022b. See Appendix 13-B.
Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10.

2 Totals may not add due to rounding.

3 The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval.

4 Northern Saskatchewan (RSA) is defined as Census Division No.18.

13.2.1.4 Unemployment Rate

Unemployment rate refers to the number of people unemployed, expressed as a percentage of the labour force, in the specified reference week (Statistics Canada 2022b). Conceptually, the unemployment rate represents the proportion of people who want to work but do not have work. The definition of unemployment rate relies on the definition of the Labour Force, which includes people who are working (employed) and those who are not working, but able and available to work (unemployed). More specifically, being 'unemployed' means to be without paid work, or without self-employment, and to be available for work, actively seeking work, or having expectations of returning from lay-off or definite arrangements for new work within four weeks, during the reference period (Statistics Canada 2022b). Those who declare themselves unable, or unavailable to work are not part of the labour force, and therefore do not factor into the unemployment rate. For example, in the 2021 Census reference week of Sunday, May 2 to Saturday, May 8, 2021, those who were unemployed in the LSA totalled 160. The LSA labour force was comprised of 935 people, so the unemployment rate in the 2021 Census was 17%. In early 2022, Cameco announced plans for the McArthur River and Key Lake operations gradual return to production (Cameco 2022).

Overall, the unemployed in the LSA (160) represented 8% of the unemployed in the RSA (2,120), and 0.3% of the 48,605 unemployed in Saskatchewan overall. The unemployment rate for men

(20%) was higher than for women (17%) in the overall LSA; however, a difference existed in the unemployment rates between men and women in Pinehouse Lake, with women at 13% and men at 28%. Women may have higher employment rates in education and health services, whereas men may have higher employment rates in industries that experience fluctuations. For example, Figure 13.2-5 in Section 13.2.1.5 disaggregates employment by industry sector for the LSA by gender in 2021 and indicates that educational services (men 23% and women 77%) and health care and social assistance (men 15% and women 85%) were predominately employed by women, whereas construction (men 100% and women 0%) and the mining, quarrying, and oil and gas extraction industry (men 100% and women 0%) were predominately employed by men.

Figure 13.2-3 shows the 2021 unemployment rate in the LSA (17%) was slightly lower than the RSA (19%), and two times higher than Saskatchewan (8%) overall. Figure 13.2-3 also highlights the unemployment rates across the LSA communities, ranging from 24% in Wapachewunak to 15% in Beauval. Patuanak and the ERFN locality of La Plonge were heavily influenced by the Statistics Canada rounding procedures; given the small absolute numbers in the labour force (40 persons in the La Plonge and 25 persons in Patuanak), these figures should be treated with caution.

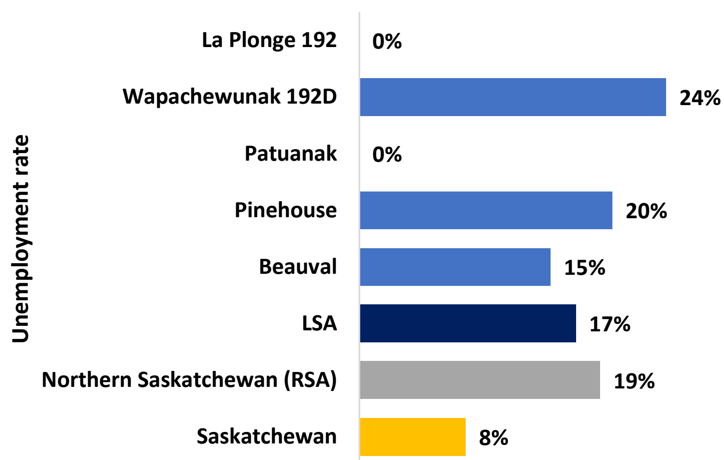

Figure 13.2-3: Unemployment Rate for the Local Study Area, Regional Study Area, and Saskatchewan, 2021[1,2,3]

Source: Statistics Canada 2022b. See Appendix 13-B.
Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10. In addition to random rounding, area and data suppression has been adopted to further protect the confidentiality of individual respondents' personal information.

2 The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval.

3 Northern Saskatchewan (RSA) is defined as Census Division No.18.

The Saskatchewan Bureau of Statistics reported for October 2021 that the overall unemployment rate for Saskatchewan was 5.2%, which was lower than the unemployment rate of 5.6% in October 2020 (Statistics Canada 2022a). Table 13.2-3 presents unemployment rates for the LSA, RSA, and

Saskatchewan in last four census periods: 2006, 2011, 2016, and 2021. Over this period, the average LSA unemployment rate was 20%, which was similar to the RSA rates, but approximately three times higher than the unemployment rate in Saskatchewan as a whole (7%).

The unemployment rate trends over time for each of the LSA communities varied. Pinehouse Lake was the most stable of the LSA communities, with the unemployment rate increasing slightly from 22% to 23% from 2006 to 2016. Beauval's unemployment rate improved by 10% from 2006 to 2021 (falling from 25% to 15%). However, the ERFN locality of Wapachewunak's unemployment rate nearly halved, improving from 41% in 2006 to 24% in 2021, and achieved a low of 13% in 2011. Patuanak and the ERFN locality of La Plonge have unreliable trends from 2006 through 2021 owing to the small labour force and Statistics Canada rounding procedures discussed above.

Relatively high unemployment rates of around 20% indicate that labour capacity is available within the LSA communities, at least in terms of people expressing a desire to work. An online survey targeted at Beauval and Pinehouse Lake sought insight into which aspects of the Project could benefit or work well for the respondents or their community. Responses related to jobs, employment, or training opportunities that could arise because of the Project[12]. Examples of comments from community engagement include:

- Potential jobs [from the Project]. All the other stuff is just for people hoping they will get work in a place where work is limited and scarce (21-EN-SUR-446.39).
- [It] would be good to bring jobs into the community (21-EN-SUR-446.42 and 22-EN-SUR-652.41).
- Create more employment opportunities[13].
- Employment for more northern people. Several people who are currently unemployed would work hard and well at the mine site (21-EN-SUR-446.54). The creation of jobs for northerners (22-EN-SUR-652.35) and the need for Denison to participate in developing qualified participants in northern communities (22-EN-SUR-652.44).
- Environmental jobs (22-EN-SUR-652.37 and 22-EN-SUR-652.38).
- More opportunities for people disabilities (22-EN-SUR-652.42).

Another online survey of ERFN members sought insight into which aspects of the Project could be challenging or cause concern for the community. Responses indicated that jobs and employment were a concern, with several specifically identifying that ERFN members should be prioritized for employment opportunities (21-EN-ERFNSUR-456.6 to 21-EN-ERFNSUR-456.14). While these survey responses represent a limited sample, they appear to show that ERFN residents view sufficient

[12] 21-EN-SUR-446.34 through 21-EN-SUR-446.42, 21-EN-SUR-446.52 through 21-EN-SUR-446.56, 21-EN-SUR-446.59, and 21-EN-SUR-446.60.
[13] 21-EN-SUR-446.40, 21-EN-SUR-446.59, and 22-EN-SUR-652.43.

attainment of employment opportunity as a challenge, whereas the residents outside of ERFN saw Project employment as a benefit and opportunity. Another comment expressed concern that crossover of worker skills from other mining projects may be limited due to the mining methods proposed for the Project (21-EN-LLRIB-392.11).

Table 13.2-3: Unemployment Rate for the Local Study Area, Regional Study Area, and Saskatchewan, 2006 to 2021

Location	2006[1]	2011[1]	2016[1]	2021[1]	Average
English River First Nation					
La Plonge 192	22%	0%	0%	0%	6%
Wapachewunak 192D	41%	13%	22%	24%	25%
Patuanak	60%	0%	50%	0%	28%
Pinehouse Lake	22%	18%	23%	20%	21%
Beauval	25%	16%	19%	15%	19%
LSA[2]	**28%**	**15%**	**21%**	**17%**	**20%**
Northern Saskatchewan (RSA)[3]	**20%**	**18%**	**24%**	**19%**	**20%**
Saskatchewan	**6%**	**6%**	**7%**	**8%**	**7%**

Source: Statistics Canada 2006, 2011, 2016a, and 2022b. See Appendix 13-B.

Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10. In addition to random rounding, area and data suppression has been adopted to further protect the confidentiality of individual respondents' personal information.

2 The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval.

3 Northern Saskatchewan (RSA) is defined as Census Division No.18.

13.2.1.5 Employment by Sector

Statistics Canada reports employment by industrial sector. Industry estimates are based on the North American Industry Classification System (NAICS), an industry classification system developed jointly by the statistical agencies of Canada, the United States, and Mexico (Statistics Canada 2017). The NAICS was developed to provide a consistent framework for the collection, analysis, and dissemination of industrial statistics. The NAICS is a comprehensive system encompassing all economic activities. It has a hierarchical structure, which at the highest level divides the economy into 20 sectors, four of which are largely goods-producing and 16 of which are entirely services-producing industries (Statistics Canada 2017). Employment by industry data are provided herein at this primary (highest) level of the NAICS hierarchy.

Employment by sector provides insight into the make up of the economy in the LSA and RSA. Insight about the types of industries, and the diversity of the industries, that comprise local and regional economies can indicate how the economy may respond to economic cycles (such as commodity price and interest rate cycles) and shocks (such as supply or demand shocks of various types).

For larger economic areas, nationally and provincially, Statistics Canada produces Gross Domestic Product (GDP) by industry, which is typically used to evaluate the constituent industries of an economy. For smaller economic areas, such as northern Saskatchewan (Census Division 18), or the communities in the LSA, GDP figures are not available. Therefore, employment by sector is used to characterize constituent industries in smaller local and regional economies.

As per Figure 13.2-4, in 2021 almost 60% of the labour force in LSA communities was employed in four major industry sectors:

- public administration (16%);
- retail trade (15%);
- health care and social assistance (14%); and
- educational services (14%).

In 2021, the key industries in the LSA and RSA were comparable, with some modest exceptions. For the dominant sectors, educational services had slightly lower rates of employment for the LSA (14%) when compared to the RSA (19%), and retail trade had slightly higher rates of employment for the LSA (15%) when compared to the RSA (11%). Mining, quarrying, and oil and gas extraction, health care and social assistance, public administration, construction, and accommodation and food services had similar rates of employment between the RSA and LSA.

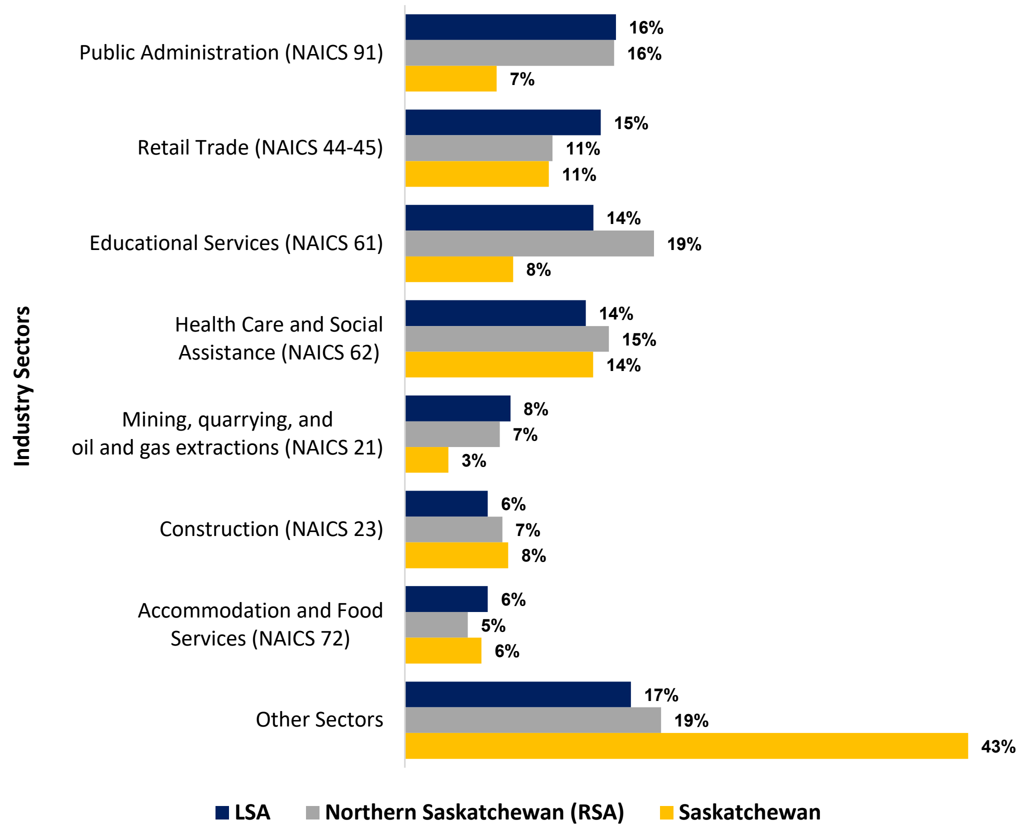

Figure 13.2-4: Employment by Industry Sector for the Local Study Area, Regional Study Area, and Saskatchewan, 2021[1,2,3]

Source: Statistics Canada 2022b. See Appendix 13-B.
Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10. In addition to random rounding, area and data suppression has been adopted to further protect the confidentiality of individual respondents' personal information.

2 The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval.

3 Northern Saskatchewan (RSA) is defined as Census Division No.18.

Table 13.2-4 presents the rank of employment by industry between the LSA and the RSA for 2016 and 2021. The ranking of sectors by percentage of employment confirms that the LSA and RSA were similar in terms of sectoral composition, information that is also evident in Figure 13.2-4. However, more differences existed between the LSA and Saskatchewan overall that are illustrated in Table 13.2-4. For instance, in 2021, the mining, quarrying, and oil and gas extraction sector was the fifth largest in the LSA, sixth largest in the RSA, but 11th largest provincially. In 2016, the mining, quarrying, and oil and gas extraction sector was the largest in the LSA and fourth largest in the RSA. The shift from first (2016) to fifth (2021) for the mining, quarrying, and oil and gas extraction sector may be a result of the Key Lake and McArthur River uranium operations moving from operation to care and maintenance status in July 2018 due to prolonged market weakness (Cameco 2021). In 2021, the public administration sector was the largest in the LSA and second largest in the RSA, but only the sixth largest provincially.

Table 13.2-4: Rank of Employment by Industry (Percentage) for the Local Study Area, Regional Study Area and Saskatchewan, 2016 and 2021

NAICS Category	Rank at 2016			Rank at 2021		
	LSA[1,2]	RSA[1,3]	Sask.[1]	LSA[1,2]	RSA[1,3]	Sask.[1]
Public administration (NAICS 91)	5	3	6	1	2	6
Retail trade (NAICS 44-45)	3	5	2	2	4	2
Educational services (NAICS 61)	2	1	5	3	1	4
Health care and social assistance (NAICS 62)	3	2	1	4	3	1
Mining, quarrying, and oil and gas extractions (NAICS 21)	1	4	12	5	6	11
Construction (NAICS 23)	6	6	4	6	5	5
Accommodation and food services (NAICS 72)	6	7	7	6	7	7

Source: Statistics Canada 2016a, 2022b. See Appendix 13-B.
Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10.

2 The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval.

3 Northern Saskatchewan (RSA) is defined as Census Division No.18.

Table 13.2-5 shows employment by industry sector for the LSA, RSA, and Saskatchewan from 2006 to 2021. Employment by sector across Saskatchewan was relatively stable between 2006 and 2021, except for health care and social assistance, which grew by 3% (from 11% to 14%). Northern Saskatchewan was similarly stable through time in most sectors, but did experience a 3% increase in educational services (16% to 19%) and a 3% decrease in mining, quarrying, and oil and gas (10% to 7%). Public administration also varied, increasing from 14% to 21% from 2006 to 2011, and then decreasing to 16% by 2021.

For the LSA communities, more variation existed than in either northern Saskatchewan or Saskatchewan overall. The LSA communities experienced changes in employment by sector amongst mining, quarrying, and oil and gas extractions; educational services; retail trade; public administration; and accommodation and food services. The most significant shifts occurred in the mining, quarrying, and oil and gas extractions sector, where employment increased from 13% to 22% from 2006 to 2011, and then decreased to 8% in 2021. For the LSA communities, Pinehouse Lake had the largest increase from 2006 to 2016, more than doubling from 13% to 32%, meaning nearly one third of those working in Pinehouse Lake were employed in the mining, quarrying, and oil and gas extractions sector. As of 2021, mining, quarrying, and oil and gas decreased to 12% in Pinehouse Lake. Wapachewunak experienced an increase in employment in the mining, quarrying, and oil and gas extractions sector from 2006 to 2016, rising 2% between 2006 and 2016, while Patuanak and the ERFN locality of La Plonge were too small to produce reliable measures due to Statistics Canada rounding procedures. As of 2021, mining, quarrying, and oil and gas decreased to 0% in Wapachewunak. Beauval employment in the mining, quarrying, and oil and gas extractions sector experienced a slight decline of 5% (15% to 10%) over the 2006 to 2021 timeframe. Retail trade also saw an increase in employment between 2006 and 2021 (increased from 5% to 15%) across the overall LSA.

Table 13.2-5: Employment by Industry Sector for the Local Study Area by Communities, Regional Study Area, and Saskatchewan, 2006 to 2021[1,2,3]

Location	Census year	Mining, quarrying, and oil and gas	Educational services	Health care and social assistance	Retail trade	Public administration	Construction	Accommodation and food services	Other sectors
English River First Nation									
La Plonge 192	2006	0%	22%	0%	0%	22%	0%	0%	22%
	2011	25%	0%	0%	0%	25%	25%	0%	0%
	2016	0%	0%	0%	29%	0%	0%	0%	29%
	2021	0%	25%	25%	25%	25%	0%	25%	0%
Wapachewunak 192D	2006	13%	13%	8%	8%	29%	13%	8%	25%
	2011	17%	10%	7%	7%	31%	7%	0%	7%
	2016	15%	18%	9%	12%	21%	9%	6%	0%
	2021	0%	20%	10%	10%	37%	7%	0%	13%
Patuanak	2006	0%	0%	0%	0%	40%	0%	0%	0%
	2011	50%	0%	0%	0%	0%	0%	0%	0%
	2016	0%	0%	40%	40%	0%	0%	0%	40%
	2021	0%	0%	0%	0%	40%	40%	0%	0%
Pinehouse Lake	2006	13%	22%	13%	11%	9%	11%	4%	11%
	2011	28%	14%	18%	8%	12%	6%	3%	6%
	2016	32%	18%	13%	7%	9%	7%	6%	6%
	2021	12%	19%	15%	15%	12%	8%	4%	8%
Beauval	2006	15%	18%	10%	5%	12%	8%	5%	27%
	2011	14%	16%	20%	0%	11%	5%	7%	11%
	2016	14%	28%	9%	12%	9%	0%	5%	19%
	2021	10%	9%	14%	16%	9%	4%	9%	28%
LSA	**2006**	**13%**	**18%**	**10%**	**5%**	**15%**	**7%**	**9%**	**20%**
	2011	**22%**	**13%**	**15%**	**5%**	**16%**	**7%**	**3%**	**7%**
	2016	**21%**	**19%**	**11%**	**11%**	**11%**	**5%**	**5%**	**10%**
	2021	**8%**	**14%**	**14%**	**15%**	**16%**	**6%**	**6%**	**17%**
Northern Saskatchewan (RSA)	**2006**	**10%**	**16%**	**14%**	**9%**	**14%**	**6%**	**7%**	**25%**
	2011	**10%**	**15%**	**13%**	**9%**	**21%**	**7%**	**5%**	**21%**
	2016	**11%**	**18%**	**15%**	**9%**	**14%**	**7%**	**5%**	**20%**
	2021	**7%**	**19%**	**15%**	**11%**	**16%**	**7%**	**5%**	**19%**
Saskatchewan	**2006**	**4%**	**8%**	**11%**	**11%**	**6%**	**6%**	**7%**	**47%**
	2011	**4%**	**8%**	**12%**	**11%**	**8%**	**8%**	**6%**	**44%**

Location	Census year	Mining, quarrying, and oil and gas	Educational services	Health care and social assistance	Retail trade	Public administration	Construction	Accommodation and food services	Other sectors
	2016	**4%**	**8%**	**13%**	**11%**	**7%**	**9%**	**7%**	**43%**
	2021	**3%**	**8%**	**14%**	**11%**	**7%**	**8%**	**6%**	**43%**

Source: Statistics Canada 2006, 2011, 2016a, and 2022b. See Appendix 13-B.

Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10.

2 The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval.

3 Northern Saskatchewan (RSA) is defined as Census Division No.18.

Figure 13.2-5 presents employment in the LSA by industry sector and by gender, for 2021, highlighting the proportion of men and women employed in each sector. Some industry sectors were heavily concentrated to one gender or the other, such as construction and mining, quarrying, and oil and gas, which was employed 100% by men, or healthcare and social assistance, which was employed 85% by women.

The Construction Sector Council (CSC 2010) noted several barriers to employment for women in the construction sector including barriers related to recruitment, access to education, training and employment opportunities, and workplace environment. A 2010 report on the status of women in the mining and exploration sector also stated that the need for flexible working arrangements was a key issue for women and that further improving work conditions and supports could help employer retention, including childcare supports, parental levels, and improved notice of travel requirements (Women in Mining Canada 2010). When supportive practices were in place, women indicated they could more easily coordinate caregiver responsivities and were subsequently more confident of their career success (Women in Mining Canada 2010).

Across NAICS categories, the employment of men and women in the LSA was nearly even, with men accounting for 46% percent of employed, and women accounting for 54% of employed. The mining, quarrying, and oil and gas extractions, construction, and public administration sectors were dominated by men, whereas the healthcare and social assistance, educational services, retail trade, and accommodation and food services sectors were dominated by women. The other industry sectors (comprising the 14 other NAICS sectors) were nearly even, but on aggregate were mostly staffed by women.

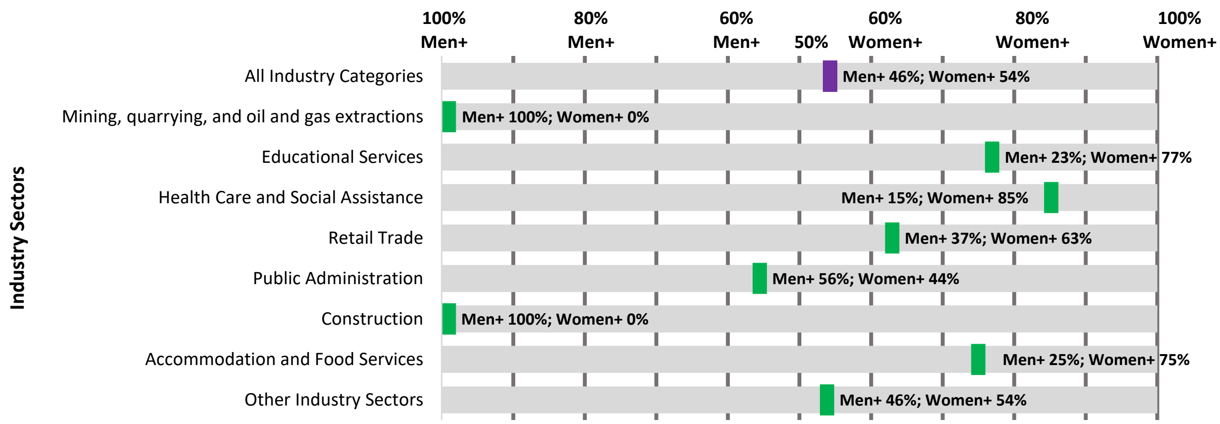

Figure 13.2-5: Employment by Industry Sectors for the Local Study Area by Gender, 2021[1,2]

Source: Statistics Canada 2022b. See Appendix 13-B.

Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10. In addition to random rounding, area and data suppression has been adopted to further protect the confidentiality of individual respondents' personal information.

2 The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval.

13.2.1.6 Educational Attainment

Educational attainment is a KI of employment and training. Educational attainment has been shown to improve employment and income opportunities as well as lead to better health (Public Health in Canada 2008). A 2013 study on the socio-economic impacts of uranium mining in northern Saskatchewan noted fewer educational programs in communities, lower levels of funding, lower rates of attendance, and higher drop-out rates as challenges to educational attainment for northern Saskatchewan residents (CVMPP 2013). Completion of high school has been found to produce benefits through lifetime income, increases in tax revenues, reductions in costs to public health, criminal justice, and public assistance, that far outweigh the program costs to achieve higher graduation rates (Belfield and Levin 2016).

Figure 13.2-6 presents educational attainment for the population 15 years of age and older for the LSA by community/locality, for the RSA, and for Saskatchewan in 2021. Educational attainment refers to the highest educational credential obtained, which is based primarily on time spent in class. The levels of educational attainment have been aggregated into four levels:

- less than high school certificate, meaning did not complete high school;
- high school certificate or equivalent, meaning did complete high school, but did not complete further training;
- post-secondary certificate or diploma below bachelor's level, meaning an apprenticeship or trades certificate, a non-university certificate or diploma, or a university certificate below the bachelor's level; and

- university degree at or above the bachelor level, meaning a bachelor, masters, or doctor of philosophy (PhD) program.

The most prevalent level of educational attainment for the majority of communities/localities in the LSA is “less than high school certificate,” although this varies by community. Beauval has the smallest percentage without high school completion at 29%, whereas Pinehouse is 52%. Overall, the LSA has a smaller share of the population aged 15 years and older without high school education than the RSA, but still more than double that of Saskatchewan overall.

For the 2019-20 school year, graduation rates for the Northern Lights School Division, which operates the kindergarten to grade 12 schools in Pinehouse Lake and Beauval among others, was 61% (59% for Indigenous students and 85% for non-Indigenous students) (Northern Lights School Division No. 113 2020).[14] English River First Nation is an independent education authority and operates the St. Louis School in Patuanak (kindergarten to grade 12) and the Mission Hill Elementary School in La Plonge (high school students in La Plonge attend the high school in Beauval). In 2012-2013, ERFN reported that approximately 80% of students entering kindergarten will graduate high school, and there is a 100% graduation rate for students entering grade 12 (NWMO 2013). Based on the most recent publicly available information, ERFN reported in 2012-2013 that approximately 20% of their students were off reserve; in those cases, ERFN has agreements with the public school system (e.g., the Northern Lights School Division for La Plonge students attending high school in Beauval) (NWMO 2013). Additional details on educational facilities and programs in the LSA are provided in Section 12.3.3.3 in Section 12 Quality of Life.

[14] Northern Lights School Division Annual Report 2019-20 reports five-year graduation rates, which reflects students completing grade 12 within 5 years of starting grade 10. Three-year Graduation rates are also reported and are lower.

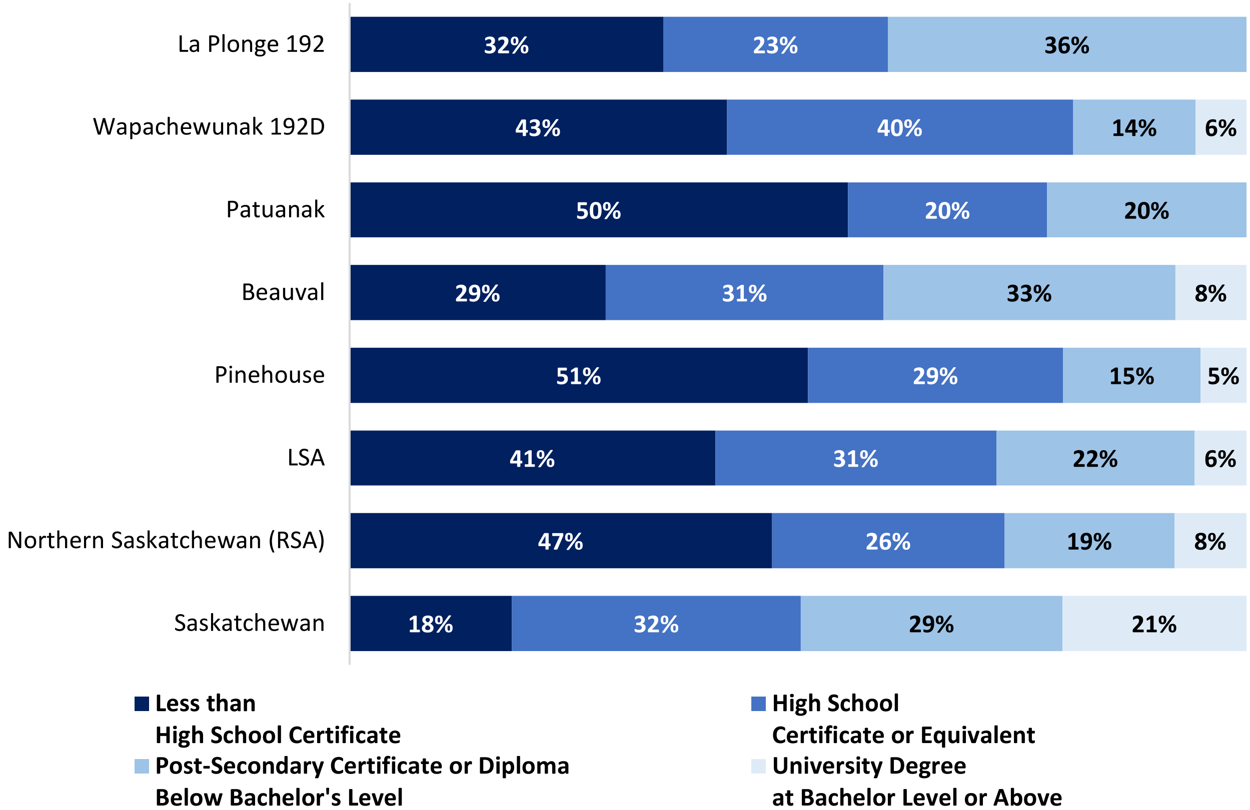

Figure 13.2-6: Educational attainment for the Population 15 Years of Age and Older for the Local Study Area, Regional Study Area, and Saskatchewan, 2021[1,2,3,4]

Source: Statistics Canada 2022b. See Appendix 13-B.

Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10.

2 The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval.

3 Northern Saskatchewan (RSA) is defined as Census Division No.18.

4 Totals may not add due to rounding.

Table 13.2-6 presents educational attainment changes from 2006 to 2021. Trends over time suggested that the level of education across the LSA was increasing. The proportion of the population who have not completed high school had fallen, from 60% to 41%, while the proportion with some form of post-secondary education had increased. Similar trends were observed across the RSA and Saskatchewan. A previous study on socio-economic impacts of the uranium industry noted the proportion of the population of northern Saskatchewan residents with apprenticeship or trades certificates or diplomas increased substantially between 1981 and 2006 (CVMPP 2013). In 2018, the Government of Saskatchewan noted education benefits from mining operations in northern Saskatchewan included contributions to scholarships for students and outreach to schools to increase career awareness and promote future opportunities in mining (Government of Saskatchewan 2018).

Regarding education and training for the Project, residents in the LSA expressed an interest in training opportunities for the Project and concern over whether training would be made available locally and regionally for residents. A resident of Beauval noted that training opportunities have been provided through collaboration with Northlands College and private sector companies in other parts of the Athabasca Basin and expressed an interest in similar opportunities (20-EN-VB-382.10). A Pinehouse Lake community member also expressed concern about training being made available locally, as well as interest in an industrial training centre in Pinehouse Lake targeting specific apprenticeship opportunities[15]. Pinehouse Lake members want to ensure that the education and training model will fit within their community structure, including a mix of western and traditional learning (22-EN-VPL/ML9-623.3). Access to training and education is an obstacle for some Métis youth in Saskatchewan. Mine training courses are often not delivered in the north, creating economic challenges for students who must leave their communities to attend training in the south (MN-S and Two Worlds Consulting 2023; Gabriel Dumont Institute of Native Studies and Applied Research Inc 2021). Regardless, training programs have supported Métis ability to obtain employment in support of resource development projects (MN-S and Two Worlds Consulting 2023). ERFN members had concern for how training for jobs will be implemented (22-EN-ERFN-618.21) and want to ensure their will be employment and training opportunities (22-EN-ERFN-621.9).

Residents in the LSA expressed an interest in capacity building for its youth and students (22-EN-ERFN-618.20 and 22-EN-SUR-652.47). An LSA resident suggested that workforce development plans be shared with educational institutions to allow for Project specific training to take place (21-EN-YOUTH-445.3). Community members of ERFN identified capacity building for elementary and middle schools to prepare students for training opportunities for the Project (18-EN-ERFN-5.21). Summer student programs were also suggested to build interest in the Project (18-EN-ERFN-5.22). English River First Nation members have observed the positive effects mining developments have brought in terms of training and employment, including that the availability of jobs in the mining industry has inspired younger generations to graduate and advance at their careers, including the need for co-op opportunities for youth and students (ERFN and SVS 2022a; 22-EN-ERFN-621.1).

Concern was also raised for the cost of associated schooling and training for the Project, as well as the time commitments required to obtain a position and progress from an entry-level position to a higher skilled/management position. A resident of ERFN inquired about the costs of schooling and training, specifically to achieve a ticketed trade related to the Project (21-EN-ERFN-447.13 and 22-EN-SUR-652.46).

[15] 21-EN-VPL-444.22, 21-EN-VPL-444.23, and 21-EN-VPL-444.21.

Table 13.2-6: Educational Attainment Proportions for the Population 15 Years of Age and Older for the Local Study Area by Communities, Regional Study Area, and Saskatchewan, 2006 to 2021

Location	Census Year	No Certificate, Diploma, or Degree[1]	High School Certificate or Equivalent[1]	Post-Secondary Certificate or Diploma Below Bachelor Level[1]	University Certificate, Diploma, or Degree[1]
English River First Nation					
La Plonge 192	2006	67%	22%	22%	11%
	2011	44%	31%	25%	13%
	2016	38%	19%	33%	10%
	2021	32%	23%	36%	0%
Wapachewunak 192D	2006	64%	14%	22%	4%
	2011	52%	33%	10%	5%
	2016	46%	29%	20%	7%
	2021	43%	40%	14%	6%
Patuanak	2006	64%	36%	0%	0%
	2011	56%	33%	0%	0%
	2016	45%	18%	36%	18%
	2021	50%	20%	40%	0%
Pinehouse Lake	2006	71%	12%	10%	6%
	2011	61%	23%	13%	5%
	2016	52%	22%	19%	7%
	2021	51%	29%	15%	5%
Beauval	2006	46%	18%	27%	7%
	2011	55%	19%	20%	6%
	2016	29%	28%	29%	11%
	2021	29%	31%	33%	8%
LSA[2]	**2006**	**60%**	**16%**	**19%**	**6%**
	2011	**56%**	**24%**	**15%**	**6%**
	2016	**44%**	**25%**	**23%**	**8%**
	2021	**41%**	**31%**	**23%**	**6%**
Northern Saskatchewan (RSA)[3]	**2006**	**58%**	**16%**	**20%**	**6%**
	2011	**55%**	**19%**	**20%**	**6%**
	2016	**51%**	**21%**	**21%**	**7%**
	2021	**47%**	**26%**	**19%**	**8%**
Saskatchewan	**2006**	**30%**	**27%**	**30%**	**13%**
	2011	**25%**	**28%**	**32%**	**15%**
	2016	**21%**	**30%**	**31%**	**18%**
	2021	**18%**	**32%**	**29%**	**21%**

Source: Statistics Canada 2006, 2011, 2016a, 2022b. See Appendix 13-B.
Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10.
2 The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval.
3 Northern Saskatchewan (RSA) is defined as Census Division No.18.

13.2.2 Key Indicator: Income

Income levels at the personal and household level are largely driven by employment. The direct, indirect, and induced employment effects of the Project can reasonably be expected to influence the level of personal and household income in the LSA. Income is an important component of the local and regional economy as it is an indicator of the economic health of a community. This section discusses the income of individuals, the income of households, and sources of income.

Due to the small populations of La Plonge and Patuanak, the income data from Statistics Canada has been suppressed to protect confidentiality. Accordingly, average income data for the LSA are not fully representative, but the effect on reported statistics is believed to be minimal at the LSA level, given the low population of those two localities.

Certain comparisons between average and median income are presented only at the level of community/locality, given the source data are not available from Statistics Canada to compute a median for the overall LSA.

13.2.2.1 Total Personal Income

Total personal income refers to monies received during the calendar year prior to the census year, from wages and salaries, net income from unincorporated business and/or professional practice, and government transfers (Statistics Canada 2016a).[16] Total Personal income does not include income tax refunds, lump sum inheritance payments, gambling revenue, lump sum insurance policy settlements, capital gains or losses, receipts from the sale of property or belongings, loan repayments, property tax rebates, or refunds of pension contributions.

Figure 13.2-7 presents the average of total personal income for the LSA, RSA, and Saskatchewan, and includes a breakdown of Indigenous identity within the LSA. On average in 2020, the total personal income of individuals in the LSA was $41,222 and 2% higher than the average of northern Saskatchewan ($40,320), but 22% lower than the average for Saskatchewan overall ($53,050).

A difference existed between the average income of Indigenous and non-Indigenous people in the LSA, as shown in the Figure 13.2-7. In 2020, Indigenous people had lower income than non-Indigenous people. Indigenous people in the LSA reported an average total income in 2020 of $39,611, which was 38% less than the $63,778 in average total personal income reported by non-Indigenous people. It is notable that most of the population in the LSA identifies as Indigenous.

[16] See Appendix 13-B for further information.

Through community engagement, local residents have commented that they could make a lot of money because of the Project and help their family (21-EN-SUR-446.53).

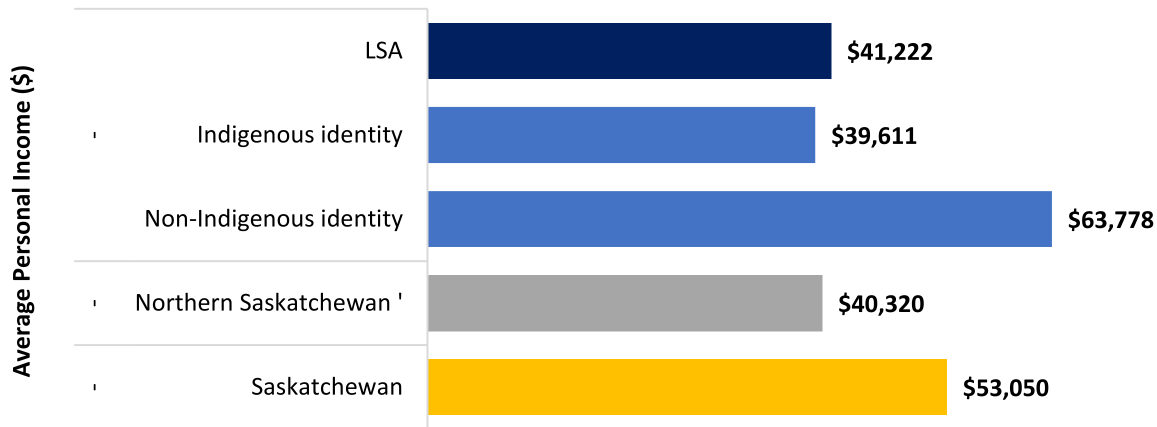

Figure 13.2-7: Average of Total Personal Income for the Local Study Area, Regional Study Area, and Saskatchewan, 2020[1,2,3]

Source: Statistics Canada 2022b. See Appendix 13-B.

Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10.

2 The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval. However, data are not available for La Plonge 192 and Patuanak.

3 Northern Saskatchewan (RSA) is defined as Census Division No.18.

A more detailed presentation of total personal income by community in the LSA is provided in Table 13.2-7. The table provides additional data on the income disparity between Indigenous and non-Indigenous populations. Within the largest community, Pinehouse Lake, the difference in average total income between Indigenous and non-Indigenous is notable (at $39,200), as is the difference in the population aged 15 years and older, with just 40 non-Indigenous people compared to 640 Indigenous people.

The examination of total personal income in the LSA reveals results consistent with broader studies, such as Raphael et al. (2020), who reported that the average income of Indigenous people was lower than non-Indigenous people in Canada, and that Indigenous people living off reserve typically earned higher incomes than Indigenous people living on-reserve. However, incomes of Indigenous people were noticeably lower than incomes of non-Indigenous Canadians, regardless of place of residence (Raphael et al. 2020).

Table 13.2-7: Average Total Personal Income for the Local Study Area by Community, Regional Study Area, and Saskatchewan, 2020

Location	Total[1]	Indigenous Identity[1]	Non-Indigenous Identity[1]
English River First Nation			
Wapachewunak 192D	$31,200	$30,700	$60,000
La Plonge 192	N/A[4]	N/A[4]	N/A[4]
Patuanak	N/A[4]	N/A[4]	N/A[4]
Pinehouse Lake	$39,400	$36,800	$76,000
Beauval	$49,600	$48,800	$56,000
LSA[2]	**$41,222**	**$39,611**	**$63,778**
Northern Saskatchewan (RSA)[3]	**$40,320**	**$35,480**	**$62,100**
Saskatchewan	**$53,050**	**$40,720**	**$55,050**

Source: Statistics Canada 2022b. See Appendix 13-B.
Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10.

2 The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval.

3 Northern Saskatchewan (RSA) is defined as Census Division No.18.

4 “N/A” means Statistics Canada did not report this information in the census.

Table 13.2-8 presents the median total personal income by community for each of the communities/localities where Statistics Canada has reported data. The median total personal income is the “middle” income, amongst the group surveyed, meaning that half of the population had a higher income and half had a lower income.

Table 13.2-8: Median Total Personal Income for the Local Study Area by Community, Regional Study Area, and Saskatchewan, 2020

Location	Total[1]	Indigenous Identity[1]	Non-Indigenous Identity[1]
Wapachewunak 192D	$23,800	$23,800	N/A[3]
Pinehouse Lake	$29,400	$28,600	$87,000
Beauval	$40,400	$40,400	$42,000
Northern Saskatchewan (RSA)[2]	**$30,600**	**$27,600**	**$51,600**
Saskatchewan	**$42,400**	**$32,000**	**$44,400**

Source: Statistics Canada 2020. See Appendix 13-B.
Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10.

2 Northern Saskatchewan (RSA) is defined as Census Division No.18.

3 “N/A” means Statistics Canada did not report this information in the census.

Comparing median and average values can provide further insight into the distribution of incomes within a population. For instance, while the median remains the middle, or centre value, an average that appears above (or below) the median suggests that the income distribution is skewed by the presence of a greater number of higher (or lower) values that draw the average away from the median.

Ratios of average to median income values from 2020 (Table 13.2-9) indicated average personal income levels were higher than median levels for all communities/regions. This result is expected as income distributions are positively skewed, meaning the range of possible incomes levels above the median is much greater than below. This is consistent with the common perspective that often a few people make materially more income than the typical person. The higher the average to median income ratio the more skewed or less symmetrical the income distribution.

The ratio of average to median incomes for the total population was reasonably consistent across the LSA communities, varying between 1.23 and 1.34. The ratio for Pinehouse Lake was the highest at 1.34, while Beauval had the lowest ratio at 1.23. Table 13.2-9 also demonstrates that Indigenous populations in all study areas had more skewed distribution than non-Indigenous populations. For the Pinehouse Lake non-Indigenous population, a very small difference was found between median and average, suggesting that income in this group was evenly distributed around the median, or at least much more so than any other community. Note, however, that in all LSA communities, the non-Indigenous population was small compared to the overall population.

Table 13.2-9: Ratio of Average to Median Income for the Local Study Area by Community, Regional Study Area, and Saskatchewan, 2020

Location	Total[1]	Indigenous Identity[1]	Non-Indigenous Identity[1]
Wapachewunak 192D	1.31	1.29	N/A[3]
Pinehouse Lake	1.34	1.29	0.87
Beauval	1.23	1.21	1.33
Northern Saskatchewan (RSA) [2]	**1.32**	**1.29**	**1.20**
Saskatchewan	**1.25**	**1.27**	**1.24**

Source: Statistics Canada 2022b. See Appendices 13-B.

Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10.

2 Northern Saskatchewan (RSA) is defined as Census Division No.18.

3 “N/A” means Statistics Canada did not report this information in the census.

13.2.2.2 Wages by Industry Sector

Statistics Canada reports wages by industrial sector and industry estimates are based on the NAICS, an industry classification system (Statistics Canada 2017). Additional information on employment by industrial sector and NAICS is provided in Section 13.2.1.5. The NAICS was developed to provide a consistent framework for the collection, analysis, and dissemination of industrial statistics.

Table 13.2-10 presents the average hourly wage in 2020 across the primary employment sectors in the LSA. Statistics Canada data indicated average hourly wage rates in Saskatchewan for the forestry, fishing, mining, quarrying, oil, and gas industries were 46% higher than for employees across all industries (Statistics Canada 2021a).[17]

Table 13.2-10: Average Hourly Wage by Sector, National, 2020

Industry Sector	Average Hourly Wage in 2020 ($)
All industries	$29.13
Forestry, fishing, mining, quarrying, and oil and gas	$42.47
Educational services	$35.15
Health care and social assistance	$30.14
Wholesale and retail trade	$22.24
Public administration	$35.38
Construction	$32.00
Accommodation and food services	$14.69

Source: Statistics Canada 2021a. Employee wages by industry, annual.

13.2.2.3 Household Income

Household income is the combined income from all sources of all members of a household aged 15 years and older. Households refer to a person or a group of persons who occupy the same dwelling and do not have a usual place of residence elsewhere in Canada. It may consist of a family group (census family) with or without other persons, of two or more families sharing a dwelling, of a group of unrelated persons, or of one person living alone.

The average household income in 2020 for the LSA, RSA, and Saskatchewan is illustrated in Figure 13.2-8. Average household income across the LSA, RSA, and Saskatchewan overall presented the same general pattern as total personal income. Average household income in the RSA ($86,800) was slightly lower than the LSA ($87,282), and for Saskatchewan overall ($99,800) the average household income was 14% greater than the LSA. Through community engagement, local residents have commented that they could make a lot of money because of the Project and help their family (21-EN-SUR-446.53).

[17] $42.47 compared to $29.13 for all industries. Both full-time and part-time employees.

Figure 13.2-8: Household Average Income for the Local Study Area, Regional Study Area, and Saskatchewan, 2020[1,2,3]

Source: Statistics Canada 2022b. See Appendix 13-B.

Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10.

2 The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval. However, data are not available for La Plonge 192 and Patuanak. Due to confidentiality procedures, the household average income for LSA non-Indigenous identity does not include Wapachewunak 192D and Beauval and only includes the household average income for Pinehouse Lake. The household average income for the LSA total and for LSA Indigenous identity includes Wapachewunak 192D, Pinehouse Lake, and Beauval.

3 Northern Saskatchewan (RSA) is defined as Census Division No.18.

A difference between household income (Figure 13.2-8) and total personal income (Figure 13.2-7) in 2020 was the parity between Indigenous and non-Indigenous household income in the LSA, which was not present between these two groups for total personal income. A plausible explanation as to why Indigenous households had levels of income on par with non-Indigenous households, while at the same time having lower individual incomes, is in the composition of Indigenous households.

Statistics Canada Census data do not report on the average number of income earners in a household, but the value can be estimated by dividing the number of people aged 15 and older in the LSA by the number of households in the LSA. The results of this calculation are presented in Table 13.2-11 for each of the LSA, RSA, Saskatchewan overall, and by Indigenous identity.[18]

Table 13.2-11 reveals that, on average, Indigenous households in 2020 had more people with income earning potential (over the age of 15), whether through employment or transfers, than non-Indigenous households. Within the LSA, the difference between Indigenous (2.4 potential income earners per household) and non-Indigenous (2.2 potential income earners per household)

[18] Statistics Canada (2022) reports on average size of census families. In 2021 the average size of census families was 2.8 for Beauval, 3.0 for La Plonge, 2.8 for Patuanak, 3.4 for Pinehouse, and 3.3 for Wapachewunak 192D.

households was similar to northern Saskatchewan, and inverted when considering all of Saskatchewan (with non-Indigenous households having more potential income earners per household). The average household size of the communities in the LSA (ranging from 2.8 persons per household in Beauval and Patuanak to 3.4 persons per household in Pinehouse Lake), which were predominately Indigenous, was similar to or larger than the average household size in Saskatchewan as a whole (average of 2.9 persons per household). Additional information on housing characteristics is available in Section 12.3.3.3 in Section 12.

Table 13.2-11: Average Number of Potential Income Earners per Household for the Local Study Area, Regional Study Area, and Saskatchewan by Indigenous Identity, 2020[1,2,3,4]

Location	Total Population Aged 15 Years and Over in Private Households	Total Number of Households with Income	Average Number of Potential Income Earners per Household
LSA, Total	1,740	745	2.3
Indigenous identity	1,630	690	2.4
Non-Indigenous identity	100	45	2.2
Northern Saskatchewan (RSA), Total	25,040	10,475	2.4
Indigenous identity	20,835	8,530	2.4
Non-Indigenous identity	4,205	1,945	2.2
Saskatchewan, Total	882,760	449,580	2.0
Indigenous identity	128,795	73,655	1.7
Non-Indigenous identity	753,965	375,925	2.0

Source: Statistics Canada 2022b. See Appendix 13-B.

Notes:

1 Rows may not add due to rounding.

2 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10.

3 The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval.

4 Northern Saskatchewan (RSA) is defined as Census Division No.18.

Table 13.2-12 presents household income for the LSA by community/locality, the RSA, and Saskatchewan as well as by Indigenous and non-Indigenous identity for the RSA and Saskatchewan in 2020. Similar to other income measures, Statistics Canada has redacted values for La Plonge and Patuanak for confidentiality related to small populations.

Across the localities in the LSA, Beauval had the highest level of average household income, similar to that of Saskatchewan overall. Wapachewunak 192D had an average household income ($67,000) that was 32% lower than Beauval.

Table 13.2-12: Average Household Income for the Local Study Area by Communities, Regional Study Area, and Saskatchewan, 2020[1,2,3,4]

Location	Total[1]	Indigenous Identity[1]	Non-Indigenous Identity[1]
English River First Nation			
Wapachewunak 192D	$67,000	$66,500	N/A[4]
La Plonge 192	N/A[4]	N/A[4]	N/A[4]
Patuanak	N/A[4]	N/A[4]	N/A[4]
Pinehouse Lake	$88,000	$87,000	$100,000
Beauval	$99,000	$100,000	95,000
LSA[2]	**$87,282**	**$86,793**	**$96,667**
Northern Saskatchewan (RSA)[3]	**$86,800**	**$82,300**	**$106,000**
Saskatchewan	**$99,800**	**$87,500**	**$102,200**

Source: Statistics Canada 2022b. See Appendix 13-B.
Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10.

2 The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval.

3 Northern Saskatchewan (RSA) is defined as Census Division No.18.

4 "N/A" means Statistics Canada did not report this information in the census.

13.2.2.4 Sources of Household Income

Figure 13.2-9 presents sources of income in 2020 for the population aged 15 years and over in private households in the LSA, RSA, and Saskatchewan. Sources of income are presented in three groups: employment income, government transfers, and other income. Other income includes net self-employment income from farm or non-farm unincorporated business and/or professional practice, investment income, private retirement income, and other income from market sources during the reference period (Statistics Canada 2022b).

The proportion of total income derived from employment across the LSA, RSA, and Saskatchewan in 2020 was comparable, ranging from 56% in the LSA to 66% in Saskatchewan as a whole. More material differences emerged in the composition of non-employment income. The LSA and RSA derived 42% and 36%, respectively, of household income from government transfers, whereas Saskatchewan overall derived only 18% of household income from government transfers. A shift in the sources of household income resulting in an increase in non-employment income may be a result of the Key Lake and McArthur River uranium operations moving from operation to care and maintenance status in July 2018 due to prolonged market weakness (Cameco 2021) and the COVID-19 pandemic and associated relief programs (e.g., the Canada Emergency Response Benefit, the Canada Recovery Benefit, and the Canada Emergency Student Benefit) (Statistics Canada 2022b).

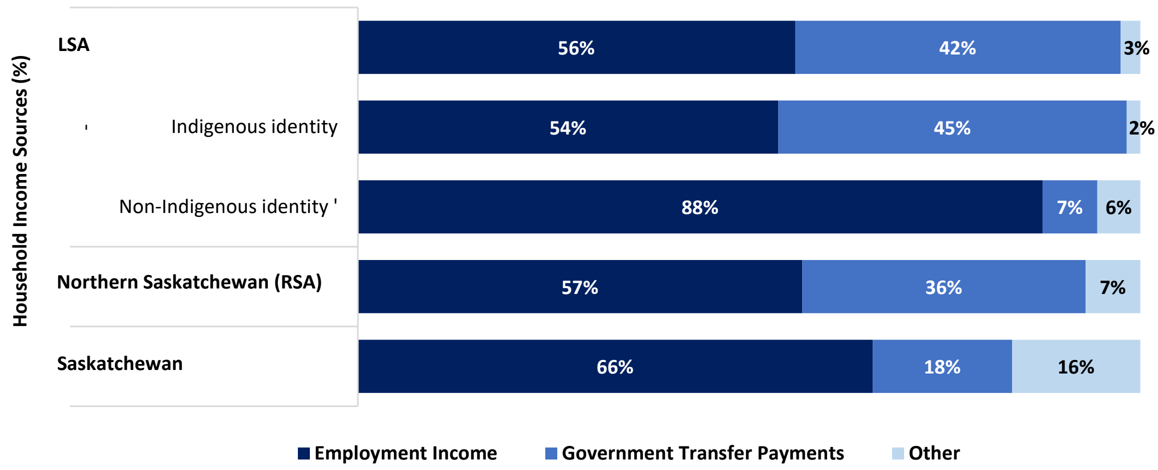

Figure 13.2-9: Total Income Sources in Local Study Area, Regional Study Area, and Saskatchewan, 2020[1,2,3,4]

Source: Statistics Canada 2022b. See Appendix 13-B.

Notes:

1 Data have been subjected to a confidentiality procedure known as random rounding whereby values are rounded either up or down to a multiple of 5, and in some cases, 10.

2 The LSA includes La Plonge 192, Wapachewunak 192D, Patuanak, Pinehouse Lake, and Beauval. However, data are not available for La Plonge 192 and Patuanak.

3 Northern Saskatchewan (RSA) is defined as Census Division No.18.

4 Totals may not add due to rounding.

13.2.3 Key Indicator: Traditional Economy

The traditional economy, or subsistence economy, refers to activities such as hunting, fishing, trapping, and crafts-making or carving that take place outside of the market or wage economy (see Section 13.2.2). These activities provide food and other necessities of life that support people and communities through personal use, giving to other members of the community for personal use, exchange, or barter, but are not purchased with cash. Participation in the traditional economy also facilitates the transmission of social norms and cultural values across generations (Usher et al. 2003).

Many northern Indigenous communities have a mixed, subsistence-based economy where the harvesting of local food for their own consumption is important in their economy and cultures (Usher et al 2003). For example, residents of the LSA described how water, land, and animals are important to their livelihood (21-EN-SUR-446.21).

In northern communities traditionally-based activities play an important role in cultural and economic support where natural resources provide an opportunity for income. Their traditional economy does not meet their total employment and income needs but holds cultural value and can assist with basic needs (further information on the relationship between cultural value and economy are found in Sections 11 and 12).

People who do not have wage-paying jobs, but practice subsistence activities, are not necessarily unemployed (Myers 1996). For many people in northern Saskatchewan, the mixed economy is important to their livelihood and culture, and they prefer to have flexible jobs that provide an opportunity to practice their traditional activities, particularly when the traditional activities are seasonal (Myers 1996). Many types of traditional economy activities are largely seasonal, although traditional economy activities can be conducted year-round with the nature of the activity changing with the season. Where traditional economic opportunities are reduced, other sources of income are required to maintain quality of life. Residents of the LSA that do not participate in the wage economy often turn to the traditional economy to meet their needs while those who have consistent employment in the wage economy may participate less frequently.

The ERFN emphasize the importance of their relationship to the land and the ways in which the land provides for them:

> *"The connection to the land, like the Elder have mentioned and I have mentioned, it's like our plate; it gives us everything. The land gives us the food we need, it gives us the clothing that we need, it gives us the heartbeat that we need. The trees in that area also provide us with shelter and also provide use with medicines in the area." (ERFN and SVS 2022b)*

The traditional economy also provides a social safety net and supports a culture of reciprocity. For the Métis in northern Saskatchewan:

> "*Extra wild meat was always shared in the community and borrowing of staple food products was a common practice. It is often said that the communal lifestyle of the Métis was disrupted by the introduction of electricity and freezers into the Métis communities. Hoarding of food was unnatural, not practical, and virtually unheard of*" (Hourie et al. 2006)";

and,

> *"The insecurity of subsistence income tends to place a high value on sharing one's good fortune with the less fortunate…poverty was explained as a lack of friends and family rather than 'lacking in material things'" (Raymond 2013).*

Fishing, hunting and trapping, gardening, gathering, and crafting were all activities that sustained physical needs and upheld spiritual and social dimensions crucial to Métis identity (MN-S and Two Worlds Consulting 2023). Historically, these activities reflected a reliance on the natural environment to sustain both family and the Métis economy, such as the fur trade (MN-S and Two Worlds Consulting 2023). Subsistence activities like fishing, trapping, and food gathering were foundational to the Métis traditional economy (MN-S and Two Worlds Consulting 2023). Today, trapping continues less for income and more so for consumption (MN-S and Two Worlds Consulting 2023).

Since 1991, Statistics Canada has conducted the Aboriginal Peoples Survey, which covers a variety of economic indicators about Indigenous peoples. The most recent available survey published by Statistics Canada is the Aboriginal Peoples Survey 2017, which was conducted from January 16 to August 15, 2017, by selecting approximately 43,000 people to participate, with a final response rate of 76% (Statistics Canada, Aboriginal Peoples Survey 2017). Approximately 60% of respondents indicated they participated in traditional activities at least once in the past year. Approximately 15% of the respondents indicated that during the hunting, fishing, or trapping seasons they did these activities every week (Statistics Canada, Aboriginal Peoples Survey 2017). In accordance with the Aboriginal Peoples Survey 2017 results, in the past 12 months from the time of the survey, 35% participated in hunting, fishing, and trapping; 29% gathered wild plants, such as berries, rice, or sweetgrass; 24% made carvings, drawings, jewellery, or other kinds of artwork; and 9% made clothing or footwear (Statistics Canada, Aboriginal Peoples Survey 2017).

Participation in both the labour force and other activities including hunting, fishing, trapping, gathering wild plants and making clothing, arts, and crafts was common, with 42% of respondents indicating they participated in both the labour force and traditional economy activities in the past 12 months. The First Nations Regional Health Survey completed by the First Nations Information Governance Centre found 23% of Indigenous adults reported fishing in the three months prior to the survey, 18% reported hunting or trapping, and 17% reported berry picking or other food gathering (FNIGC 2018).

"*In Saskatchewan, traditional food harvesting (hunting, fishing, and gathering of wild plants), is an important part of the traditional food systems and food security of First Nations communities*" (Chan et al. 2018). The First Nations Food Nutrition and Environment Study (Chan et al. 2018) found that almost all Indigenous adults in Saskatchewan (94%) reported eating traditional foods as part of their diet. Of the population included in the survey, Indigenous adults in Saskatchewan ate land mammals (83%), berries (78%), fish (51%), wild birds (46%), and wild plant foods and teas (43%) (Chan et al. 2018). Community members in the LSA noted the traditional economy makes important contributions to the economic well-being of people and communities.

English River First Nation has a high use of country foods, which provides benefits culturally and physically, as well as a healthy food source (CanNorth 2017). The ERFN Country Food Study (CanNorth 2017) provides an overall picture of the contribution of wild foods non-cash contribution to the diet of ERFN members:

- An average 38 pounds of wild meat were consumed per person annually. Moose was the top mammal consumed (76%), followed by caribou (9%), snowshoe hare (8%), and all other mammals (7%).
- An average of 97.8 portions of fish (or approximately 42 pounds) were consumed per person on an annual basis. The most consumed species were Walleye (40%), Lake Whitefish (37%), Northern Pike (9%), and all other species (14%).

- An average of 8 pounds of bird meat were consumed per person annually. Overall, Mallard was consumed most frequently (56%), followed by Canada Goose (12%), Spruce Grouse (8%), and all other species of ducks and birds (including eggs) (24%).
- An average of 57.1 grams of wild berries and edible plants were consumed by people daily. Blueberries and raspberries accounted for 67% of the wild berries and edible plants consumed, followed by bog cranberry (10%), wild mint (9%), and all other plants (14%) (CanNorth 2017).

The Project is located within the ERFN Traditional Territory, a culturally and economically significant area for ERFN and a place where fishing, hunting, and trapping occur throughout the year. English River First Nation members have stressed the importance of protecting the area noting "*forest areas that are too small, or too fragmented, do not provide the necessary support to maintain native biodiversity, including viable populations of wide-ranging species that ERFN members rely on for food*." (ERFN and SVS 2022a). Interviews with ERFN members have reported a growing desire for community members to re-engage and reconnect to these traditional activities, noting that this passion should be further supported by the band and by Denison (ERFN and SVS 2022a). Concerns were expressed about the cumulative effects of changes to the environment, how this has affected the ability to pursue traditional activities, and the associated fears about contamination (real or perceived) (ERFN and SVS 2022a).

The ERFN shared a summary of the cumulative effects that have affected their land based and associated resources, including:

- *"Impacts of past mining activity and linear developments such as roads, exploration trails and cutlines on animal movement patterns, populations and habitat, waterways, and ERFN access to harvesting areas."*
- *"The use of heavy equipment and clearing of land causing habitat disruption for wildlife species ERFN members depend upon for food."*
- *"Dumping and contamination left behind by past mining activity causing concerns about the health of waterways, fish, plants, animals and fish harvested by ERFN members."*
- *"Other development activities such as forestry, other industry, and climate change compounding the environmental change they are witnessing (ERFN and SVS 2022b)."*

Traditional activities for ERFN members are often a community affair, making the practice of hunting, fishing, trapping, and gathering key cultural events (ERFN and SVS 2022b). Although culturally significant, these traditional land-based activities are also an important economic activity to ERFN. English River First Nation members have noted that practising traditional activities such as hunting, fishing, trapping, and gathering is a crucial component of ERFN spiritual and cultural health (ERFN and SVS 2022b). The ERFN Trapper in the LSA provided some observations on trends in species population and distribution. He noted that moose were less dense in the LSA, preferring habitat further north instead (19-LK-ERFNTrap-134.172).

Kineepik Métis Local and Pinehouse Lake members have raised concern that the Project may limit their current land use practices and traditional economic activity (KML 2022). The Kineepik Métis Local and Pinehouse Lake members have indicated that one mining project will not materially affect land use practices, but substantial and growing projects in the area may limit the ability to continue practising in the area, including for moose, bear, deer, and caribou (KML 2022).

In Saskatchewan, Métis economic activities encompass a diverse range of sectors, reflecting the adaptation of traditional skills to contemporary opportunities (Raymond 2013). The arts and crafts sector continues to thrive with Métis artisans producing intricate beadwork, quillwork, and other traditional crafts (MN-S and Two Worlds Consulting 2023). Among Métis in NR1 and NR3, there is a collective understanding that moose and caribou are an important cultural food source and are supplemented with smaller game, such as mallard ducks in the summer and geese in the fall. Hunting supports harvesters, their families, Elders, and sometimes whole communities. Quantity depends on the abundance of resources available, how challenging the resources are to harvest, and the need for additional food (MN-S and Two Worlds Consulting 2023). Métis harvesters hunt what is necessary (i.e., not for sport) and save resources for future need. Hunting and reciprocity are closely tied among Métis; Métis harvesters may share their game if another harvester is unsuccessful during a hunt. These practices reflect the foundational understanding of wahkotowin (kinship roles and responsibilities) and the importance of taking care of each other through food sharing and make sure enough resources are leftover to avoid overconsumption (Flaminio, Gaudet, and Dorion 2020).

Despite the introduction of the wage economy in Indigenous communities, customary social relationships of sharing and reciprocity continue (Natcher 2009). Wage earnings have allowed for the continuation of harvesting activities by enabling the purchase of hunting and trapping equipment (Natcher 2009). Rather than choosing to participate in only one activity, many households derive income from multiple sources including the subsistence economy, giving and receiving food and medicines, selling or bartering goods produced from natural products, and by participation in the wage economy (Natcher 2009). Subsistence economies continue to demonstrate their resilience and remain integral to the health and well-being of northern Indigenous communities.

Additional information on the traditional activities contributions to cultural continuity is provided in Section 12. Participation in the traditional economy often occurs concurrently with activities related to Indigenous Land and Resource Use and Other Land and Resource Use (Section 11).

13.2.4 Key Indicator: Business Opportunities

Several business opportunities that exist in the LSA could be affected by the uranium sector. The business opportunities that could be affected by the Project include local businesses.

13.2.4.1 Local Businesses

The number and diversity of business opportunities and businesses providing goods and services to the LSA communities is limited, which is reflective of the population size of the communities and the structure of their economies. Business opportunities that are fulfilled by locally owned and/or locally staffed companies will produce employment income, business revenues, and profits that may be spent or re-invested locally. Economic leakage (i.e., money leaving the local economy) is a relevant concern, particularly for small, concentrated economies. Economic leakage can occur at various points through the cascade of spending in an economy, but the closer that leakage occurs to the point source of investment, the more potential economic benefit that is lost.

In response to the demand for northern Saskatchewan based services, businesses have grown to meet various needs over the past three decades. The Joint Federal-Provincial Panel on Uranium Mining in Northern Saskatchewan (Joint Panel), in its 1997 cumulative observations report, noted that "*The first business opportunities for northerners typically came in areas requiring little capital investment and minimal technical expertise – security services, catering, and light construction work. Later opportunities included heavier construction projects and transportation-related activities including the transport of employees... the distribution of fuel and supplies, the movement of ore from mine to mill and the delivery of yellowcake to customers*" (Joint Panel 1997).

A variety of sophisticated business enterprises provide a broad range of supplies and services in the LSA. The following include the local businesses known to exist within ERFN and Patuanak, Pinehouse Lake, and Beauval.

<u>Local Businesses within English River First Nation and Patuanak</u>

Local businesses within ERFN (La Plonge, and Wapachewunak) and Patuanak include (Northern Business Directory 2020; NWMO 2013):

- business and travel centre (Grasswood Business Centre and English River Travel Centre);
- communication station and radio broadcasting (Patuanak Communication Society);
- community arena and recreation (English River Recreation and Area);
- construction and engineering (AllTron Electric, Cameco Northern Affairs Office, Des Nedhe Development Inc./Tron Power, JV Driver, March Consulting and Engineering, MineTex Sales, and Mudjatik Enterprises);
  - Des Nedhe Development Inc. was established in 1991 by ERFN (ERFN and SVS 2022a). Des Nedhe holds an interest in a variety of construction, repair and maintenance, mining construction, development and production work, heavy civil and roadbuilding construction, retail, property management, and communications firms, as well as holds investments in catering (Athabasca Catering), trucking (Northern Resource Trucking), welding (JNE Welding), and cannabis grower operations. Relevant Des Nedhe divisions, companies, and partnerships to the uranium mining industry include Tron Construction and Mining, Tron

Industrial, GGDL-Tron, Iron Trail Industrial, Makwa-Tron, MTM Mining, and Neetah Construction (Des Nedhe Group 2022; ERFN and SVS 2022a).

- fish packing and wholesale distribution (English River Fish Plant);
- groceries, general merchandise, and/or gasoline (English River Gas Bar and Northern Store);
- hair salon (Michelle's Hair Design);
- insurance services (Canadian Shield Insurance Services Ltd.);
- outfitters (Golden Wally Outfitters, Mawdsley Lake Fishing Lodge, and Mudjatik River Outfitters);
- public services and administration (ERFN); and
- taxi services (J & Son's Taxi and Patuanak Taxi).

<u>Local Businesses in Pinehouse Lake</u>

Local businesses in Pinehouse Lake include (Northern Business Directory 2020; NWMO 2013):

- accommodations and/or seasonal camps (Jonlaw Development Corporation and Kamkota Lodge);
- commercial fishing and wholesale (Pinehouse Local Fisherman's Co-op);
- construction and engineering (PBN Construction (formerly Pinehouse Business North) and Snake Lake Construction Ltd.);
    - PBN Construction, established in 2007, is a northern contractor focused on civil earthworks, road maintenance, and site services. Since its inception, PBN has experienced extensive organizational growth, moving from a seasonal labour service provider to a midsize contracting company with the assets, people, and management team required to execute complex projects (PBN Construction 2022).
- grocery, general merchandise, and/or gasoline (Minahik Café and Gas Bar and Pinehouse Lake Co-operative Limited); and
- pharmacy (Medi-Cross Pharmasave).

<u>Local Businesses in Beauval</u>

Local businesses in Beauval include (Village of Beauval n.d.; Northern Business Directory 2020):

- accommodations and/or outfitters (Amyott Inn, Amy's Bar and Motel, Angler's Trail Resort, Keeley Lake Lodge 1989, and Sandy Beach Resort);
- business support (Northern Enterprise Fund);
- career services and counselling (Gabriel Dumont Institute Training and Employment and Saskatchewan Indian Institute of Technology (SIIT) - Industrial Career Centre);
- communication station and radio broadcasting (Sipisishk Communications – CIPI 96.5 FM);

- construction (Butt and Top Construction);
- economic development (Beauval Development Inc. and Primrose Lake Economic Development Corporation);
- groceries, general merchandise, and/or gasoline (Beauval General Store, MDeez Confectionary and Gas Bar Ltd., and Northern Store);
- health services (Beauval Health Centre);
- taxi service (Beauval Taxi); and
- other businesses (Beauval Marine and Small Engine Repair, Blueberry Hills Natural Spring Water, English River Travel Centre, Pine Ridge Bible Camp, Pineridge Ford, and Polar Oils Ltd.).

Community members in Beauval inquired about investment opportunities for First Nations, development corporations, or individuals (16-EN-VB-107.12), and if Denison currently conducts business or employs locals. Similarly, ERFN indicated that it is interested in future business opportunities associated with the Project and expressed concern about missing out on opportunities[19]. English River First Nation operates businesses it believes are suited to support the Project and can supply the mining industry and associated camps (16-EN-ERFN-99.2).

Community members in Pinehouse Lake have also indicated that PBN Construction was formed to contribute to and benefit from these types of projects (16-EN-VPL-105.7) and expressed interest in procurement opportunities for impacted/rights bearing communities for the life of the mine (21-EN-VPL-444.1). A community member in Beauval expressed the desire to see a positive legacy developed as a result of the Project, be it through infrastructure or a fund to benefit the region (16-EN-VB-107.12). Another community member of Beauval indicated that the COI have an onus to deliver the 'assets and human resources, equipment capacities and capabilities' in exchange for a 'piece of the action' (16-EN-VB-107.15). The municipal government in Beauval indicated that the community is interested in maximizing its involvement in the Project, and to work with Denison to prepare the community to do so (19-EN-VB-132.1).

13.2.5 Key Indicator: Government Revenues

Several provincial and federal revenue sources could be affected by the Project, including:

- current status of the provincial economy;
- uranium royalties;
- resource surcharges;
- mineral surface lease agreements (MSLAs); and
- corporate and personal income tax.

[19] 16-EN-DesNd-101.1, 21-EN-ERFN-447.3, and 21-EN-ERFN-447.4.

13.2.5.1 Provincial Economy

Saskatchewan's economy ranks fifth largest in Canada, with an annual GDP of $77 billion in 2020 (Statistics Canada 2021b). Over the past 5 years, GDP has fluctuated modestly between a low of $77 billion in 2020 and a high of $82 billion in 2018. Saskatchewan was the only province to experience a decline in GDP in 2019 prior to the pandemic, and suffered a 5.2% decline in 2020, making it one of the provinces most impacted by the pandemic.

Based on 2020 reported data, Saskatchewan's economy is somewhat concentrated and noticeably weighted toward resource production. The four largest sectors of the Saskatchewan economy account for nearly 60% of economic output:

- mining and petroleum – 26%;
- finance, insurance, and real estate – 14%;
- education and healthcare – 10%; and
- agriculture, forestry, fishing and hunting – 9%.

Figure 13.2-10 presents the complete composition of Saskatchewan's GDP for 2020 by sector. Owing to the concentration in mining, petroleum, and agriculture, Saskatchewan's GDP is influenced by global commodity prices. The Saskatchewan mining sector was notably concentrated in potash (producing roughly one third of global potash output annually) and primary uranium production (13% of global production) in 2019 (Government of Saskatchewan 2020b).

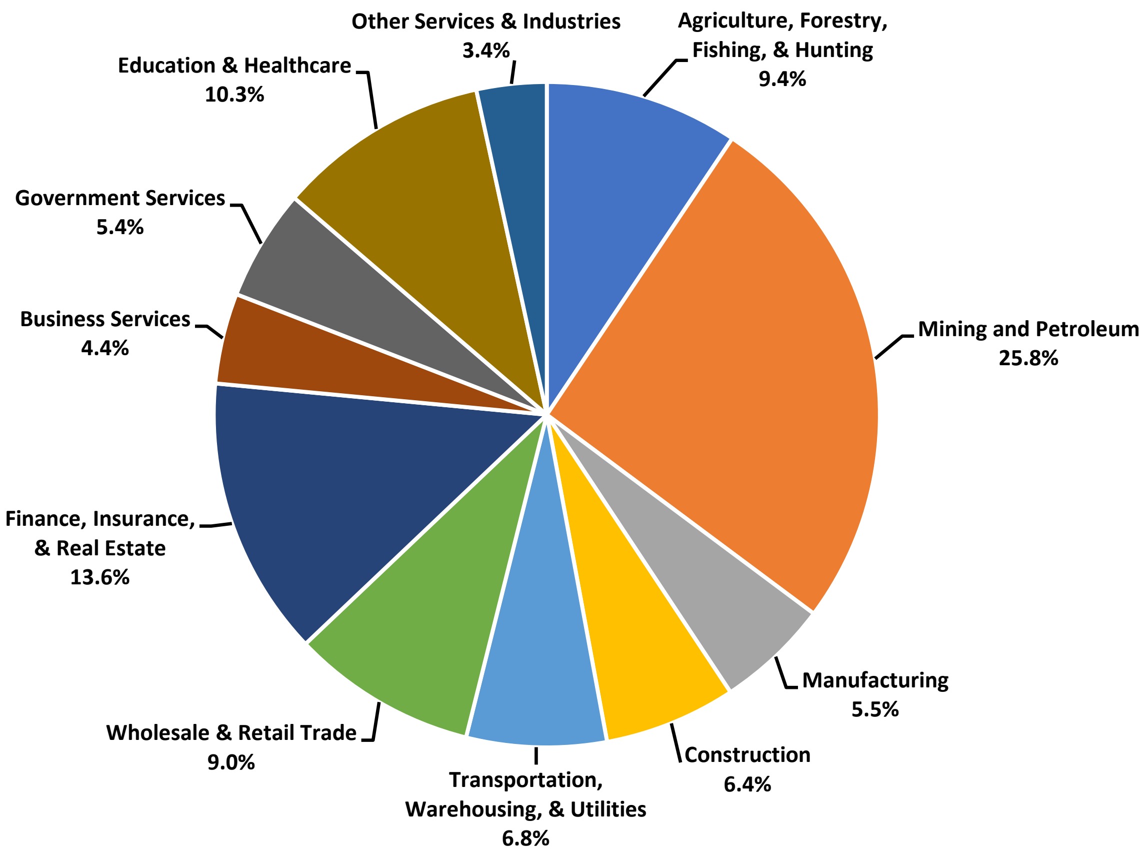

Figure 13.2-10: Saskatchewan Gross Domestic Product by Sector, 2020

Source: Government of Saskatchewan 2020a. Figure recreated by InterGroup Consultants Ltd.

13.2.5.2 Uranium Royalties

Uranium royalties in Saskatchewan are payable in accordance with The Crown Mineral Royalty Regulations, 2013 (Government of Saskatchewan 2013) pursuant to *The Crown Minerals Act, 1985* (Government of Saskatchewan 1985). The Saskatchewan uranium royalty system has three components: (1) a basic royalty, (2) a Saskatchewan Resource Credit, and (3) a profit royalty. The basic royalty is 5% of gross revenue. The Saskatchewan Resource Credit is typically applied as a 0.75% credit against the basic royalty such that the effective basic royalty is 4.25% of gross revenue. The profit royalty has tiers that increase from 10% to 15% as net profit increases.

The Government of Saskatchewan reported total non-renewable resource revenues from all sources (including oil and gas, potash, and other non-renewable resources) for Saskatchewan of $1.735 billion in 2018–2019 and $1.750 billion in 2019–2020. The Saskatchewan Ministry of Energy reported uranium resource revenues, inclusive of both basic royalty and profit royalty, (inclusive of interest, penalty, or other amounts) of $28 million in 2018-2019 and $53 million in 2019-2020 (Saskatchewan Ministry of Energy and Resources 2019 and 2020).

13.2.5.3 Resource Surcharges

Large resource corporations in Saskatchewan are subject to the Corporation Capital Tax Resource Surcharge pursuant to *The Corporation Capital Tax Act*. As a result, a tax rate of 3.0% is applied to the value of resource sales (Ministry of Finance 2021). Total resource surcharge revenues, inclusive of the 3.0% tax on the value of sales of uranium produced in Saskatchewan, reported by the provincial government were $394 million in 2019 and $413 million in 2020 (Government of Saskatchewan 2020b).

13.2.5.4 Mineral Surface Lease Agreements

The Crown Resource Land Regulations, 2017 (Section 5-16, Government of Saskatchewan 2017) under *The Provincial Lands Act, 2016* (Government of Saskatchewan 2016) enables the minister responsible for the administration of *The Forest Resources Management Act, 1996* (Government of Saskatchewan 1996) to issue a mineral surface lease to access Crown resource land for mineral extraction. Mineral surface lease agreements apply to mines operating on Crown Land in the Northern Saskatchewan Administration District. The ministries of Government Relations and Environment administer MSLAs to provide long-term land rental (Government of Saskatchewan 2021). Fees associated with MSLAs are set out The Crown Resource Land Regulations, 2017 (Section 6-3, Government of Saskatchewan 2017).

13.2.5.5 Individual Income Tax

Federal individual income taxes are payable to the Government of Canada pursuant to the *Income Tax Act, 1985* (Government of Canada 1985). The 2021 individual income tax rates ranged from 15% to 33% depending on an individual's tax bracket. The Government of Canada (2019; 2021) reported individual income tax revenues of $163.881 billion in 2018-2019 and $167.576 billion in 2019-2020. Provincial personal income taxes are payable to the Government of Saskatchewan pursuant to *The Income Tax Act, 2000* (Government of Saskatchewan 2001). The 2021 personal income tax rates in Saskatchewan ranged from 10.5% to 14.5% depending on the individual's tax bracket. The Government of Saskatchewan (2020a) reported individual income tax revenues of $2.340 billion in 2019 and $2.629 billion in 2020.

13.2.5.6 Corporate Income Tax

Federal corporate income taxes are payable to the Government of Canada pursuant to the *Income Tax Act, 1985* (Government of Canada 1985). The 2021 corporate tax rate after the general tax reduction was 15%. The Government of Canada reported corporate income tax revenues of $50.368 billion in 2018–2019 and $50.060 billion in 2019–2020. Provincial corporate income taxes are payable to the Government of Saskatchewan pursuant to *The Income Tax Act, 2000* (Government of Saskatchewan 2001). The 2021 corporate income tax rate in Saskatchewan was 12% (as per Section 56(1) of *The Income Tax Act, 2000* [Government of Saskatchewan 2001]). The

Government of Saskatchewan (2020a) reported corporate income tax revenues of $586 million in 2019 and $787 million in 2020.

13.3 Assessment of Project-related Effects

13.3.1 Potential Interactions Between the Project and Valued Component / Key Indicators

Potential interactions between Project components and activities and the Economy VC and their associated KIs are summarized by Project phase and activity in Table 13.3-1. The Project will create employment and business opportunities and increase income for workers and businesses. Communities and residents in the LSA will be given first priority for employment and training and business opportunities followed by RSA communities and residents. The Project will also positively affect the governments of Saskatchewan and Canada mainly through the government payments (e.g., uranium royalties paid to the Government of Saskatchewan, corporation income tax, payroll taxes). Changes associated with Project employment may also affect the traditional economy of communities in the LSA.

The identification of Project activities and their potential interactions is based on IK; LK; discussions with Indigenous groups, government agencies, and the public; KPIs for the Project; the professional judgment of members of the Project team; and a review of existing conditions in the study areas for the Economy VC and its associated KIs. Potential interactions in Table 13.3-1 are ranked as:

- **Primary Interaction** (✓): Project activity is expected to interact with the VC/KI, which may result in an adverse effect on the VC (i.e., a measurable or detectable change in the MP) and is further considered in the effects assessment as the primary contributor to potential adverse effects.
- **Other Interaction (✓):** Project activity is expected to interact with the VC/KI. While the interaction is further considered in the effects assessment, it is not expected to be a primary contributor to potential adverse effects.
- **No Interaction:** Project activity is not expected to interact with the VC/KI, no adverse effects are expected, and a rationale is provided for not considering this potential interaction further.

As noted in Table 13.3-1, Project employment and expenditures are generated by most Project activities and components throughout the phases of the Project, although to varying degrees. Hence, all KIs for the Economy VC are assessed for the Project.

Table 13.3-1: Potential Project Interactions for Economy

Project Phase/Activity	Economy				
	Employment and Training	Income	Traditional Economy	Government Revenues	Business Opportunities
Construction Activities					
Development of access roads and air strip					
Site preparation and earthworks; clearing, levelling, and grading of the Project area					
Generators					
Installation of main substation and distribution of power around site					
Wellfield and freeze hole drilling					
Ground freezing					
Batch plant operation (concrete); crusher at borrow area					
Development of surface infrastructure (camp, operations centre plants, ponds, pads, and support facilities)					
Waste management (composting, domestic and industrial landfill operation, recycling)					
Water management (including treatment and site runoff)					
Groundwater supply					
Surface water withdrawal					
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)					
On-site and off-site operation of vehicles and transport of materials					
Air transportation for workers					
Regulatory site inspections					
Engagement - Site visit from Interested Parties					
Employment and Expenditures[1]	✓	✓	✓	✓	✓
Operation Activities					
Operation of the in situ recovery (ISR) wellfield					
Wellfield and freeze wall drilling					
Operation and expansion of freeze wall					
Batch plant operation (grout and cement); crusher at borrow area					
Expansion of pond and pads					

Project Phase/Activity	Economy				
	Employment and Training	Income	Traditional Economy	Government Revenues	Business Opportunities
Operation of the processing plant and production of uranium concentrate					
Water withdrawal from groundwater or surface water body					
Management of surface water (including seepage and site runoff)					
Water treatment, both domestic and industrial					
Water release to surface water body					
Waste management (composting, domestic and industrial landfill operation, recycling)					
Hazardous waste management (temporary storage, handling, and off-site transportation)					
Storage and disposal of drill waste rock, process precipitates, and industrial wastewater treatment plant precipitates					
On-site and off-site operation of vehicles and transport of materials					
Power supply – primarily power from the grid, also generators and back-up generators					
Package and transport of nuclear substances					
Fuel management (e.g., propane for comfort heating; vehicle and aircraft fuel)					
Air transportation for workers					
Progressive decommissioning and reclamation					
Regulatory site inspections					
Engagement – site visit from Interested Parties					
Employment and Expenditures[1]	✓	✓	✓	✓	✓
Decommissioning Activities					
Site water management, treatment, and release					
Mining horizon remediation and thawing of freeze wall					
Process water treatment and release					
Closure of ISR and freeze wells and related infrastructure					
Decontamination of surface facilities and injection, recovery, and monitoring wells					

Project Phase/Activity	Economy				
	Employment and Training	Income	Traditional Economy	Government Revenues	Business Opportunities
Asset removal (including site power transmission lines and electrical infrastructure)					
Demolition and disposal of non-salvageable surface infrastructure and materials					
Remediation of contaminated areas (wellfield, pads, ponds, domestic wastewater treatment location, and process plant area)					
Power generation – generators					
Waste management (composting, and landfill operation)					
Decommissioning of landfills; hazardous materials management (temporary storage and off-site disposal)					
On-site and off-site operation of vehicles and transport of materials					
Reclamation of disturbed areas (site, roads, camp, and airstrip)					
Regulatory site inspections					
Engagement – site visit from Interested Parties					
Employment and Expenditures[1]	✓	✓	✓	✓	✓
Post-Decommissioning Activities					
Environmental monitoring					
Regulatory site inspections					
Engagement – Site visit from Interested Parties					
Employment and Expenditures[1]	✓	✓	✓	✓	✓

Notes:

1 Project employment and expenditures are generated by most Project activities and components throughout the phases of the Project. Hence, Project employment and expenditures have been added into the table as a separate row for each Project phase instead of acknowledging these individually by component or activity.

13.3.2 Potential Project-related Effects

The various phases of the Project will have different effects on the Economy VC and its KIs. Project demand for labour can affect the labour force in the LSA, RSA, and beyond the RSA positively and negatively. Positive effects include increases to employment and income during Construction, Operation, and Decommissioning, while negative effects can occur once the Project has been decommissioned (e.g., loss of income). Similarly, the potential exists for positive and negative effects for business opportunities in the LSA and RSA. The pathways to effects include:

- employment and training opportunities from the Project;
- Project labour affecting wage and salary income levels;
- Project labour and changes in income affecting participation in traditional economy activities;
- changes to lands, waters, and the resources therein, along with the perceived suitability of the area for traditional land and resource use may further affect participation in the traditional economy;
- potential business opportunities for communities in the LSA and RSA; and
- provincial and federal government revenues from the Project.

Five KIs were identified for the Economy VC—employment and training, income, traditional economy, business opportunities, and government revenues. The engagement process identified an interest in income and employment rates, including that they may increase (21-EN-SUR-446.52 and 21-EN-SUR-446.53); an interest in employment and training opportunities, including that they may create jobs for local communities and residents (21-EN-SUR-446.34 and 21-EN-SUR-446.42); an interest in the types of opportunities that would arise from the Project and Denison[20], such as agreements for hiring and working with northern peoples and companies; and that Indigenous land use should be integrated into the economic assessment and its importance to the traditional economy (21-EN-ERFN-474.5). Additional information is also found in Section 4.

Additional information on potential effects prior to mitigation for each KI are outlined in subsequent text. Mitigation measures are outlined in Section 13.4 and residual effects following mitigation measures are described in Section 13.5.

13.3.2.1 Potential Effect 1 – Employment and Training

Employment opportunities will be of benefit to the LSA where unemployment is typically high. Training opportunities are expected to begin prior to Construction and continue until Operation. Training programming will be determined in consultation with COI and are anticipated to involve existing training facilities and programs (Process Operation Technical [SIIT] Meadow Lake, Chemical Technology [Saskatchewan Polytechnic]) as well as specific ISR training, where required. Denison will initially prioritize Indigenous and non-Indigenous communities in the LSA in terms of employment and training opportunities.

Denison has estimated a workforce of 300 people for the two-year Construction period**.** Each component of Construction will require workers with different types of skills and training

[20] 21-EN-SUR-446.34, 21-EN-SUR-446.40, and 21-EN-SUR-446.42.

depending on the task (e.g., road construction, wellfield drilling, erection of buildings, connection to services).

During Operation, over 180 people are expected to be employed to operate the ISR wellfield and processing plant, as well as provide various supporting activities such as security, camp operations, operation of the water treatment, sewage and potable water plants, environmental monitoring, and maintenance of roads, equipment, and buildings. Total employment level of over 180 people is estimated to include 155 employees and 29 contracted. Workforce requirements for these positions have been identified and characterized into the following categories: Foundational (commonly referred to as Entry Level), Trades, Professional/Technical, and Supervisory. The Project, in identifying employment requirements, will use this information to inform future training program and recruitment activities. To date, uranium mining companies in Saskatchewan have made best efforts to maximize opportunities for employment and training for residents of Saskatchewan's North, owing to various mechanisms in place at the time such as SLAs. Residents of Saskatchewan's North are prioritized for employment, and this will make sure employment opportunities are available for Indigenous people in the LSA and RSA. Eighty-six percent of the total population in northern Saskatchewan and 95% of the LSA identify as Indigenous (Figure 12.2-10 in Section 12.2.3.1 in Section 12). Since 1992, other uranium operations have maintained a high rate of northern employment (47%), with 39% of the workforce identifying as Indigenous (Government of Saskatchewan 2018).

The anticipated workforce breakdown for Operation of the Project includes the following types of positions:

- Foundational positions (i.e., Entry Level) (82 jobs) require Grade 12 education and in-house training programs, although a combination of skills and experience may be considered. These positions would include process plant operators, site services, drillers, and catering/janitorial staff.
- Trades positions (35 jobs) require specific trade certification. These positions would include well field maintenance, mechanical, electrical, and instrumentation staff.
- Professional/Technical positions (46 jobs) require specific post-secondary education. These positions would include laboratory technicians, health and safety technicians, security/emergency medical technicians, and human resources staff.
- Supervisory positions (21 jobs) require supervisory/management education and experience. These positions would include operations management, maintenance supervisors, technical management, and process plant supervisory staff.

Currently, Denison has identified areas where there are likely synergies with labour demand and availability within the LSA, particularly as the LSA communities have existing relationships with the industry that lend themselves well to future opportunities. Denison, like other uranium operations, will give preferential consideration across all job openings to residents of Saskatchewan's North (i.e., the RSA), and particularly those from the COI in the LSA. This will include working with the Indigenous COI to advertise jobs broadly (e.g., websites, social media, local radio, northern publications), and assisting northern employees in applying for career advancement opportunities. Members of ERFN have observed the positive impacts mining developments have brought in terms of training and employment (including through Des Nedhe), including that the availability of jobs in the mining industry has inspired younger generations to graduate and advance at their careers (ERFN and SVS 2022a). Engagement with residents of Pinehouse Lake indicated that there is a consensus among community members that development of the Project will benefit the community, including ongoing work between Denison and Pinehouse Lake leadership to provide and understand preliminary opportunities in working on the Project and that community owned businesses (for example PBN Construction) are part of and will be prioritized in the procurement processes (KML 2022). However, residents of Pinehouse Lake have provided that they may not have the capacity to capture much of the economic activity on the Project and may lose substantial opportunities through economic leakage (KML 2022).

Access to training and education is an obstacle for some Métis youth in Saskatchewan. Mine training courses are often not delivered in the north, creating economic challenges for students who must leave their communities to attend training in the south (MN-S and Two Worlds Consulting 2023; Gabriel Dumont Institute of Native Studies and Applied Research Inc 2021). Regardless, training programs have supported Métis ability to obtain employment in support of resource development projects (MN-S and Two Worlds Consulting 2023). Métis citizens have worked on industrial development projects in northern Saskatchewan and, as a result, bring a range of knowledge on uranium mining processes (MN-S and Two Worlds Consulting 2023). Employment numbers during Decommissioning are expected to be similar to those during Operation.

As outlined in Section 13.2.1.2, in 2021, the overall participation rate in the LSA (49%) was lower than Saskatchewan as a whole (65%), but higher than northern Saskatchewan (44%). Participation rates within LSA communities vary considerably, with ERFN localities and Pinehouse having materially lower participation rates (between 36% and 40%) compared to the other LSA communities, which range from 50% to 69%. The ERFN participation rates are also materially lower than northern Saskatchewan overall.

For the four census periods of 2006, 2011, 2016, and 2021, the average LSA employment rate was 39% compared to 38% in the RSA and 63% in Saskatchewan as a whole. Communities in the LSA had similar levels of engagement in the labour market compared to the overall RSA, but both the LSA and RSA materially lagged behind the province as a whole (Section 13.2.1.3). Employment rates within the LSA communities also varied, with ERFN communities having generally lower employment rates than other LSA communities. However, between 2006 and 2021, Wapachewunak and Patuanak employment rates increased 8% and 15%, respectively. The small populations in Patuanak and La Plonge warrant the caveat that trends and point estimates should be interpreted with caution due to Statistics Canada rounding procedures. The employment rate in Pinehouse Lake decreased 4% (from 37% to 33%) over the 2006 to 2021 period. Beauval employment rates varied, dropping 8% (from 43% to 35%) between 2006 and 2011, and then increasing to 58% in 2021.

Employment opportunities will occur at the Project. Employment opportunities pursued by those from the COI will be prioritized (see Section 4), and Denison will concentrate initial and sustained efforts for employment and training initiatives for the Project with these communities. Training opportunities are anticipated to be delivered by institutions in northern Saskatchewan or Saskatchewan more broadly, and will be determined in consultation with LSA communities. Training delivery may involve development partnerships with Northern Career Quest or other relevant entities such as they may exist during the life of the Project, and may include things such as scholarships, summer student opportunities, career counselling or other on-the-job training. These opportunities will be extended to other Indigenous communities and the general public in the RSA after discussions with LSA communities.

13.3.2.2 Potential Effect 2 – Income

Income would be generated in the LSA, RSA, and beyond the RSA during Construction, Operation, and Decommissioning of the Project. The effect of a change in income will begin during Construction and continue until Post-Decommissioning, although Post-Decommissioning will have limited effects in terms of income. Income would be generated through direct demand for labour (i.e., Project employment), indirect demand for goods and services, and induced demand (i.e., additional income and profits earned by workers). Induced income is difficult to track.

As outlined in Section 13.2.2, LSA and RSA communities have lower personal and household income than Saskatchewan as a whole. In addition, LSA and RSA communities are more reliant on government transfers. On average in 2020, the total personal income of individuals in the LSA was $41,222 and 2% higher than the average of northern Saskatchewan ($40,320), but 22% lower than the average for Saskatchewan overall ($53,050). In 2020, Indigenous people had lower income than non-Indigenous people. Indigenous people in the LSA reported an average total income of $39,611 in 2020, which is 38% less than the $63,778 in average total personal income reported by non-Indigenous people. Average household income across the LSA, RSA, and Saskatchewan overall present the same general pattern as total personal income. Average household income in the RSA ($86,800) was slightly lower than the LSA ($87,282), and for Saskatchewan overall ($99,800) the average household income was 14% greater than the LSA.

The proportion of total income derived from employment across the LSA, RSA, and Saskatchewan is comparable, ranging from 56% in the LSA to 66% in Saskatchewan as a whole. More material differences emerge in the composition of non-employment income, where the LSA and RSA derived 42% and 36% of household income from government transfers, whereas Saskatchewan overall derived only 18%.

Mineral sector positions are considered to be higher paying than many industrial positions. In February 2022, estimated median weekly wages within the mining sector were approximately $1,800 compared to $1,000 for all Canadian industry. In Saskatchewan, median weekly income was approximately $1,900 (MiHR 2022). In northern and remote locations in Canada, mineral sector jobs and the associated income has even greater importance compared to other wage/salary opportunities.

Employment and, hence, opportunities to increase income will be provided first to communities in the LSA. Denison will initially prioritize Indigenous and non-Indigenous communities in the LSA in terms of employment and will work with the leadership of these communities to assist in determining hiring practices during all phases of the Project. Priority for hiring will then focus on Indigenous and non-Indigenous residents of the RSA and then beyond the RSA.

13.3.2.3 Potential Effect 3 – Traditional Economy

The traditional economy in the LSA provides important non-cash income to citizens and contributes to the overall sense of well-being for communities. For many people in northern communities, the mixed economy is important and allows for participation in both the wage economy and in traditional activities that contribute to non-cash income (Myers 1996). Rather than choosing to participate in only the wage or traditional economies, many households derive income from multiple sources including the subsistence economy, giving and receiving food and medicines, selling or bartering goods produced from natural products, and by participation in the wage economy (Natcher 2009). Subsistence activities like fishing, trapping, and food gathering are foundational to the traditional economy (MN-S and Two Worlds Consulting 2023). Subsistence economies continue to demonstrate their resilience and remain integral to the health and well-being of northern Indigenous communities.

Where traditional economic opportunities are reduced, other sources of income are required to maintain quality of life. Residents of the LSA that do not participate in the wage economy often turn to the traditional economy to meet their needs while those who have consistent employment in the wage economy may participate less frequently. Community members in the LSA noted the traditional economy makes important contributions to the economic well-being of people and communities (21-EN-ERFN-474.5).

Several factors contribute to where, how, and when people participate in the traditional economy relative to Construction, Operation, and Decommissioning of the Project. The first considerations relate to the physical presence of the Project and its associated activities and how these may interact with traditional activities. The second set of considerations relate to participation in the wage economy, and how this can contribute to an individual's ability to partake in traditional activities. Each of these pathways are explored in the context of potential effects to potential changes to the non-cash income provided by the traditional economy.

The traditional economy is closely associated with activities related to Indigenous land and resource use, and other land and resource use (e.g., commercial trapping and fishing). Changes to land and resource use associated with the physical presence of the Project and its activities are assessed in Section 11 and consider:

- availability of resources for harvesting purposes (distribution and abundance of animals, plants and wildlife for harvest and suitability, animals, plants and wildlife for consumption);
- land availability to practice traditional land use; and
- perceived suitability of lands and resources therein.

The assessment of changes to land and resource use determined considered these pathways to both commercial land uses (i.e., trapping and commercial fishing), along with subsistence harvesting that occurs as part of Indigenous land and resource use.

With respect to commercial trapping and commercial fishing, the individual active in proximity to the Project (i.e., the ERFN Trapper) passed away prior to the filing of this EIS. Although his activities were not expected to be altered meaningfully by the Project, a trappers compensation agreement had been contemplated to offset any nuisance factors. It is anticipated that if the individual's trapping allocations are passed along to other individuals, a similar relationship would be entered into with Denison. With respect to commercial fishing, the Project is not expected to interact with any of the lakes allocated for such purposes, so no change in activities is expected.

With respect to subsistence harvesting in proximity to the Project, it was similarly the same individual who actively and regularly harvested in the area. Although ERFN, the Kineepik Métis Local, the MN-S, and the Athabasca Denesųłiné have indicated some use and harvest in proximity to the Project site over time, the concentration of community use tends to occur in other areas. English River First Nation, the Kineepik Métis Local, and the MN-S (NR1 and NR3) tend to be most active in areas south of the Key Lake Gate, although access beyond the gate is often facilitated by uses along the Fox Lake Road. The Athabasca Denesųłiné and MN-S (NR1 and NR3) also have demonstrated uses more proximal to their home communities, with the Athabasca Denesųłiné in particular having reliance on barren ground caribou. This means that the access limitations created by the Project (i.e., 169.9 ha restricted for use) are not anticipated to overlap with areas frequented by most resource harvesters.

Further to this, Project effects to fish and wildlife are not anticipated to result in any population level changes – meaning the availability of resources to support subsistence use will not be altered by the Project. Notwithstanding these predictions, the ERFN Trapper in the LSA provided some observations on trends in species population and distribution. He noted that moose are less dense in the LSA, preferring habitat north of the Project instead (19-LK-ERFNTrap-134.172). Similarly, ERFN Elders have reflected on the changes to the landscape proximal to the Project, noting;

> *"I would say the early 1980s, there was an abundance of moose, an abundance of caribou, on the Haultain area, but with the road (Highway 914) coming in, there has been more people taking the moose, taking the caribou" (ERFN and SVS 2022b).*

The cumulative changes that have occurred in the Project area have been observed by Indigenous communities, and there is continued concerned that future changes will contribute to their ability to successfully undertake their traditional harvests in the area, as reflected in comments such as.

> *"The whole area is sensitive now, with all the things that are going on. It's disturbing the environment; the environment has been disrupted. So the animals, the birds, and the fish are all affected, especially when there's mining activity. Because of that, animals tend to move away" (ERFN and SVS 2022b).*
>
> and,
>
> *"While one project or mining operation does not materially affect our land use practices. The substantial and growing projects and mineral exploration activity severely limits our ability to practice continued and use for the region north of Haultain River. KML land users' limitation are leading to complete exclusion of the area for food sovereignty. As an example of this our hunting practices currently use high powered rifles to engage with big game including moose, bear, deer, and caribou in the area. With the significant and growing numbers of projects we do not know how we can continue to practice this method of food gathering in a safe method"* (KML 2022).

Communities have expressed some uncertainty regarding the ISR mining method, as it is a new approach relative to other uranium operations in the region. Despite the low use of the area by resource harvesters, this uncertainty may result in some hesitance to use areas in proximity to the Project site. Denison is committed to continued engagement within the LSA to increase the familiarity and comfort with the ISR method. *The Wheeler River Project: Métis Knowledge Study Report* (MN-S and Two Worlds Consulting 2023) notes that Métis Elders are now more reluctant to harvest proximal to uranium mines. The report describes key factors affecting Métis land and resource use over time, including imposed government programs and policies, changes to wildlife behavior as a result of habitat loss and climate change, and development activities (for further details see Section 11.1.3.2.5).

The Indigenous communities acknowledge the challenges associated with balancing participation in the wage economy versus the traditional economies which have sustained them. There is acknowledgement that employment and business income associated with the uranium industry has been of benefit, but that connections to culture are critical to the communities' well-being. (ERFN and SVS 2022a; KML 2022; MN-S and Two Worlds Consulting 2023)

Employment on the Project and associated participation in the commuter-rotation system may result in some individuals having less time to participate in the traditional economy, which may reduce the overall contribution of non-cash income to an individual and his/her family. This effect could be experienced by individuals or families throughout the RSA, but may be more discernable within the LSA where employment is prioritized. A study on the effects of the worker rotation in northern Saskatchewan found that some people felt there was not enough time during their free time to allow them to go out on the land for traditional purposes. However, some participants in the study felt there was still sufficient time for traditional pursuits, and that the income associated with employment contributed to their ability to purchase supplies and equipment needed for traditional pursuits (CVMPP 2005). The Project's commuter-rotation schedule (2 weeks on/2 weeks off) is also anticipated to provide participants with the flexibility and sufficient time to participate in traditional activities. Overall, the extent of effects is dependent on personal preferences of individuals and is likely to be balanced out through the income received by employment.

Measures to mitigate potential changes to land and resource use (Sections 11.1.5 and 11.2.5 in Section 11) would similarly be protective of the activities that support the traditional economy. Given that there are limited changes associated with land and resource use activities, it is unlikely that the Project would have any discernable effect on the traditional economy through this pathway.

13.3.2.4 Potential Effect 4 – Business Opportunities

The number and diversity of business opportunities and businesses providing goods and services to the LSA communities is limited, reflective of the population size of the communities and the structure of their economies. Business opportunities that are fulfilled by locally owned, and/or locally staffed companies will produce employment income, business revenues, and profits that may be spent or re-invested locally. Economic leakage (i.e., money leaving the local economy) is a concern particularly for small, concentrated economies. Economic leakage can occur at various points through the cascade of spending in an economy, but the closer that leakage occurs to the point source of investment, the more potential economic benefit that is lost.

In response to the demand for northern Saskatchewan based services, businesses have grown to meet various needs over the past three decades. A variety of sophisticated business enterprises provided a broad range of supplies and services required by the mining industry in the LSA in 2021 (Section 13.2.4.1).

The need for goods and services during Construction, Operation, and Decommissioning will generate business opportunities throughout the life of the Project. Northern Saskatchewan based services and local businesses have grown to meet a broad range of supplies and services required by the mining industry. Examples of anticipated goods and services needed at the Project site may include catering, housekeeping, food, freight, and bulk materials such as fuel, propane, and reagents. The total direct and sustaining capital costs for the Project are expected to be approximately $387 million. The total annual operating costs for the Project are expected to be approximately $39 million per year to cover administration, camp operations, labour, and maintenance costs. In 2018, the northern mining industry in Saskatchewan reported that it purchased 45% of its total goods and services from northern Saskatchewan businesses and joint ventures and has continued to maintain a long-term trend of high levels of northern purchases (Government of Saskatchewan 2018). Denison will strive to sustain similar participation targets for the Project as experienced across other mining industries in northern Saskatchewan.

Denison has established an internal procurement approach that requires the procurement of all goods and services for the Project to first consider businesses based within the LSA communities prior to looking elsewhere in northern Saskatchewan, southern Saskatchewan, and/or outside of Saskatchewan throughout all phases of the Project. As a first priority, Denison will consider the capacity and capabilities of businesses in the LSA and work with business owners to increase their potential for successfully bidding on Project. Contracts would provide LSA and possibly other communities business with substantial amounts of contract work during Project Construction, Operation, and Decommissioning**,** and would be their predominant source of business opportunities for the Project.

13.3.2.5 Potential Effect 5 – Government Revenues

Construction of the Project will generate revenues for the federal and provincial governments. The Government of Saskatchewan has a uranium royalty regime that consists of three components as follows:

- basic royalty of 5% of gross revenues from uranium extracted from ore bodies in the province;
- a reduction in the basic royalty of 0.75% of gross revenues; and
- a profit royalty between 10% and 15% of net profits from the mining and processing of uranium extracted from ore bodies in the province.

In addition, Denison expects to enter into an SLA with the Province of Saskatchewan that provides the province with long-term revenue from the rental of the land the operation is situated on.

In 2018, taxable income of a Canadian resource company with a project in the Province of Saskatchewan was subject to federal tax at a rate of 15% and provincial tax in Saskatchewan at a rate of 12% for a combined tax rate of 27%. This combined tax rate is applied to a company’s taxable income for the year, which is calculated on a net basis after claiming certain allowable deductions. In 2018, the Province of Saskatchewan was estimated to receive between $400 million (base case) and $592 million in revenue royalties. Profit royalties for the Saskatchewan Government are estimated to range between $422 million (base case) and $777 million. Federal and provincial income taxes were expected to range from $685 million (base case) to $1,254 million.

Both the federal and provincial governments are expected to benefit from personal income taxes resulting from the Project. Individual income tax rates in 2021 ranged from 15% to 33% depending on an individual's tax bracket for the Canadian Government and ranged from 10.5% to 14.5% depending on the individual's tax bracket.

Federal and provincial governments are expected to benefit from reductions in social assistance and employment insurance payments where jobs are filled by people who would otherwise be unemployed.

13.4 Mitigation and Enhancement Measures

The Project will have positive effects on government revenues and, as such, no mitigation measures are required. However, the following mitigation measures will be implemented to enhance the positive effects of the Project on employment and training, income, Traditional economy, and business opportunities, and minimize adverse effects:

- Denison, through a Human Resource Development Plan, will initially prioritize Indigenous and non-Indigenous communities in the LSA in terms of employment and training opportunities (anticipated to be in institutions in northern Saskatchewan) and will work with the leadership of these communities to assist in determining hiring and training practices during all phases of the Project, which could include such items as on-the-job training and career counselling to help with advancement from foundational positions, advance sharing of job qualification requirements, clearly identifying training requirements and working with various training institutions to make sure such appropriate training is available, and creation of scholarship and support programs. Priority for employment and training will then focus on Indigenous and non-Indigenous residents of the RSA and then beyond the RSA.
- Denison will establish a procurement approach throughout all phases of the Project, prioritizing the procurement of goods and services for the Project toward businesses based within the LSA communities prior to looking elsewhere in northern Saskatchewan, southern Saskatchewan, and/or outside of Saskatchewan. This procurement approach may consider advance sharing of purchasing requirements of goods and services throughout all phases of the Project, efforts to increase the capacity and capabilities of businesses to increase successful bidding outcomes, and the development of a business registry.
- Denison will plan a workforce transition plan prior to Decommissioning of the mine.
- Denison has previously compensated a trapper potentially affected by exploration activities in and around the Project based on the potential for commercial loss, who has since passed away. This will be assessed going forward based on the potential for the Project to negatively effect commercial loss, and where appropriate, Denison will compensate accordingly.

- Denison will negotiate with the Province of Saskatchewan to develop the Project's SLA and the Human Resource Development Agreement, which will outline measures in relation to socio-economic parameters related to the Project.

13.5 Residual Effects Evaluation

13.5.1 Residual Effects Characterization

General definitions of the Residual Effects Characteristics are provided in Table 5.8-1 in Section 5. Residual Effects Characteristics specific to Economy are defined in Table 13.5-1**.**

Table 13.5-1: Economy – Definitions of Effect Characteristics Considered When Determining the Significance of Residual Effects

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive.	**Adverse** – Negative effect or effect is not desirable. **Positive** – Beneficial effect or effect is desirable.
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	**Negligible** – no measurable change on Economy over baseline conditions. **Low** – Minimal amount of change on Economy relative to baseline conditions and within the range of existing variation. **Moderate** – Moderate amount of change on Economy relative to the baseline conditions and within the range of existing variation. **High** – High amount of change to Economy relative to baseline conditions and the range of existing variation.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area** – Effect is limited to the Project area. **Local** – Effect is limited to the LSA for the Economy VC. **Regional** – Effect extends beyond the LSA into the RSA. **Beyond Regional** – Effect extends beyond the RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term** – Less than 3 years (i.e., effect happens during the Construction Phase only). **Medium-term** – 3 years to 38 years (i.e., effect happens from the Construction Phase through to the end of the Post-Decommissioning Phase). **Long-term** – More than 38 years (i.e., effect extends beyond the Post-Decommissioning Phase).
Frequency	How often the residual effect is expected to occur.	**Infrequent** – Effect occurs several times at sporadic intervals. **Frequent** – Effect occurs many times on a regular basis. **Continuous** – Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible** – A residual effect that diminishes to baseline conditions. **Partially Reversible** – A residual effect that partially diminishes to baseline conditions. **Irreversible** – A residual effect that will not diminish to baseline conditions.
Context	The extent to which the Economy VC or associated KIs have been affected by past and present environmental and socio-	**Low –** Economy VC/KI has high resilience to stress and is able to accommodate change. **Moderate –** Economy VC/KI has moderate resilience to stress and is able to accommodate some change.

Residual Effect Characteristic	Definition	Rating
	economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its ability to recover from that effect (i.e., resilience).	**High –** Economy VC/KI has weak resilience to stress and is unable to accommodate change.
Likelihood	Likelihood that the residual effect will occur including consideration of the likelihood that the mitigation will be successful.	**Likely** – A moderate to high probability that the residual effect will occur. **Unlikely** – A low probability that the residual effect will occur.

The characterization of residual effects is based on the review of the existing environment (Section 13.2), the assessment of Project-related effects and proposed mitigation measures, IK, KPIs, and professional judgment. All residual effects (independent of their significance rating) are carried forward to the CEA.

Effects on Economy are expected to be mostly positive, although the residual effects assessment considers both positive and negative effects after mitigation. The determination of significance is based only on adverse effects. A significant adverse residual effect on Economy is defined as an adverse effect that is highly distinguishable from current conditions and cannot be mitigated through adjustments to programs, policies, plans, or through other mitigations.

In terms of confidence, a low level is assigned when the VC/KI and/or the Project interaction is not well understood, and/or the mitigation measures have not been proven effective. A moderate level is assigned where the VC/KI is understood and/or the mitigation measures have been proven effective elsewhere. A high level is assigned when the VC/KI and Project interactions are well understood, and the mitigation measures have been proven effective.

13.5.1.1 Employment and Training

A summary of residual environmental effects on employment and training is found in Table 13.5-2. Employment opportunities represent direct and indirect benefits associated with construction and operation of projects, particularly in the vicinity of communities where unemployment is typically high.

The residual effect on employment during Construction, Operation, and Decommissioning is expected to be positive. Although the number of jobs will be fewer during Operation than Construction, it will be over a much longer period (i.e., two years for Construction and 15 years for Operation). Decommissioning is also expected to occur over a five-year timeframe with a similar number of jobs available as during Operation. With the implementation of mitigation and enhancement measures in place, residual effects are expected to be low to moderate in magnitude.

Positive effects are expected to occur primarily in the LSA and RSA but are also expected to extend beyond the RSA as the labour demands of the Project are unlikely to be met with local resources only. Effects associated with employment are expected to occur continuously through each Project phase, while it is anticipated that training efforts will be focused largely during the operational phase (although some initiatives may be in place prior to the onset of Operation to maximize opportunities). Effects will be reversed after Decommissioning is completed; however, individuals who benefits from employment and training will have skills to carry forward to future opportunities.

Table 13.5-2: Economy – Summary of the Characteristics Ratings for Employment and Training

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Positive	Employment opportunities will occur during Construction, Operation, and Decommissioning and will benefit people particularly in the LSA and RSA. The Project will provide training opportunities prior to Construction and during Construction and Operation. Closure of the mine will end employment and training opportunities for the Project; however, the direction of effects is assessed relative to the existing environment.
Magnitude	Low to moderate	Given the size and scale of the operation, Project employment and training opportunities will be low to moderate, in part due to the important contribution of the Project in the context of a current lack of opportunities in the region. The magnitude of effects may vary among the communities in both the LSA and RSA.
Geographic Extent	Local, Regional, and Beyond Regional	Employment and training opportunities will initially be prioritized on communities in the LSA, followed by the RSA.
Duration	Medium-term	Employment will occur through Construction (two years), Operation (15 years), and Decommissioning (five years), while training is anticipated to focus largely on the Operation phase.
Frequency	Continuous	Effects on employment opportunities will occur throughout Construction, Operation, and Decommissioning.
Reversibility	Fully Reversible/Irreversible (following mine closure)	Employment and training opportunities from the Project will not occur following Decommissioning.
Context	Moderate	People in the LSA and RSA will benefit from employment and training opportunities and are expected to adapt following closure of the mine.
Likelihood	Likely	The Project will result in employment and training opportunities.

13.5.1.2 Income

A summary of residual environmental effects on income is provided in Table 13.5-3. The residual effect on income during Construction, Operation, and Decommissioning is expected to be positive. Although the number of jobs will be fewer during Operation than Construction, it will be over a much longer period of time (i.e., two years for Construction and 15 years for Operation). As jobs are expected to be similar during Operation and Decommissioning, effects in terms of income are expected to be similar. With the implementation of mitigation and enhancement measures, residual effects are expected to be moderate in magnitude during Construction, Operation, and Decommissioning, although will be reserved after Decommissioning of the Project. This is due in part to the higher-than-average wages associated with mining income (Section 13.2.2.2).

Positive effects are expected to occur primarily in the LSA and RSA, but are also expected to extend beyond the RSA as the labour demands of the Project may not be achieved solely locally. Continuous effects will occur throughout Construction, Operation, and Decommissioning and are considered medium-term in duration.

Table 13.5-3: Economy – Summary of the Characteristics Ratings for Income

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Positive	The Project will increase income in the LSA and RSA through employment and business opportunities.
Magnitude	Moderate	Given Project employment and business opportunities, and the current lack of opportunities in the region, effects on income are expected to be moderate. Following closure of the mine, the loss of income will result in a low adverse effect.
Geographic Extent	Local, Regional, and Beyond Regional	Effects will occur primarily in the LSA and RSA, but some benefits will likely extend beyond.
Duration	Medium-term	The duration of Construction is short-term (two years) while the duration of Operation and Decommissioning is medium-term (15 and five years respectively).
Frequency	Continuous	Effects on income through employment and business opportunities will occur throughout Construction, Operation, and Decommissioning.
Reversibility	Fully Reversible	Income will decline following Decommissioning as job and business opportunities on the Project will no longer exist.
Context	Moderate	People in the LSA and RSA will benefit from increased income and are expected to adapt following closure of the mine.
Likelihood	Likely	The Project will have effects on income through employment and business opportunities.

13.5.1.3 Traditional Economy

A summary of residual environmental effects on traditional economy is provided in Table 13.5-4. The residual effect during Construction, Operation, and Decommissioning is expected to be adverse. With the implementation of mitigation and enhancement measures, including those described relative to land and resource use (Sections 11.1.5 and 11.2.5 in Section 11), residual effects are expected to be negligible to low during Construction, Operation, and Decommissioning (i.e., medium-term). Effects are expected to occur in the LSA, although this will vary by pathway to the KI. In the instance of the physical presence of the Project and its activities, it is anticipated most effects will occur near the Project site, although they could displace some individual activities within land and resource use LSAs. In the instance of participation in the wage economy limiting the ability to participate in the traditional economy, effects may be more widespread to communities in the LSA. Effects will occur frequently and are expected to be fully reversible after the closure of the mine. The traditional economy is considered resilient, and current efforts in communities to revitalize cultural practices and activities will continue to support this KI.

Table 13.5-4: Economy – Summary of the Characteristics Ratings for Traditional Economy

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Adverse	The physical presence of the Project and its activities, including participation in the commuter rotation may limit some traditional land and resource activity.
Magnitude	Negligible to Low	The presence of the Project and its activities are unlikely to have a discernable effect on the traditional economy, as activities can persist in other locations in proximity (i.e., negligible in magnitude); however, they may displace some individual resource use. The extent of effects associated with participation in the workforce/commuter rotation may affect individuals' abilities to partake in the traditional economy, but on the balance is expected to be minimal relative to existing practices (i.e., low in magnitude).
Geographic Extent	Local	Effects stem primarily through participation in the workforce/commuter rotation and thus will be experienced by individuals across the LSA.
Duration	Medium-term	Effects will occur during Construction, Operation, and Decommissioning.
Frequency	Frequent	Effects would occur on a regular basis but will vary by individual and by season.
Reversibility	Fully Reversible	Effects on the traditional economy are expected to be reversible following after Decommissioning as resource users will likely return to traditional activities in proximity to the site or will no longer be employed on the Project.
Context	Moderate	The traditional economy has adjusted to many changes over centuries of influence and is considered resilient.
Likelihood	Likely	The Project will have effects on resource users in the vicinity of the Project area.

13.5.1.4 Business Opportunities

A summary of residual effects on business opportunities is found in Table 13.5-5. With the implementation of mitigation and management measures, residual effects are expected to be positive due to spending on goods and services and employment effects for businesses, although the effect will be reversible after Decommissioning of the Project. A proportion of effects are anticipated to be met by businesses in the LSA; however, it is likely that the contracting demands of the Project will exceed local capacity requiring businesses from the RSA and beyond. These continuous effects are medium-term and will extend from Construction, through Operation and Decommissioning. Through experience with the uranium industry in northern Saskatchewan, ERFN (through its Des Nedhe Group of businesses), and Kineepik Métis Local and Pinehouse Lake (through PBN Construction) are well positioned to participate in some of the sizable business opportunities associated with the Project.

Table 13.5-5: Economy – Summary of the Characteristics Ratings for Business Opportunities

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Positive	The Project will increase income in the LSA and RSA through business opportunities. Following closure of the mine, there will be a loss in direct business.
Magnitude	Moderate	Given Project business opportunities, and the current lack of opportunities in the region, effects are expected to be moderate. Following closure of the mine, the loss of business opportunities will result in a low adverse effect.
Geographic Extent	Local and Regional	Effects will occur primarily in the LSA and RSA.
Duration	Short-term (Construction)/Medium-term (Operation and Decommissioning)	The duration of Construction is short-term (two years) while the duration of Operation and Decommissioning is medium-term (15 and five years respectively).
Frequency	Continuous	Effects on businesses will occur throughout Construction, Operation, and Decommissioning.
Reversibility	Fully Reversible (Construction, Operation, and Decommissioning)/ Irreversible (following mine closure)	Business opportunities will decline following Decommissioning as these opportunities on the Project will no longer exist.
Context	Moderate	People in the LSA and RSA will benefit from increased business opportunities and are expected to adapt following closure of the mine.
Likelihood	Likely	The Project will have effects on businesses in the LSA and RSA.

13.5.1.5 Provincial and Federal Government Revenues

A summary of residual environmental effects on provincial and federal government revenues is found in Table 13.5-6. Overall, Project residual effects are predicted to be positive and will be higher due to the payment of royalties to the Province of Saskatchewan during Operation. Given the estimated royalties the Province of Saskatchewan is estimated to receive, as well federal and provincial income tax effects are expected to moderate in magnitude during Construction, Operation, and Decommissioning and negligible following mine closure. Effects will extend beyond the RSA and will be medium-term, with income tax revenues expected across Construction, Operation, and Decommissioning, and royalties during the Operation phase. Effects will occur frequently through each Project phase. Although the provincial and federal government revenues will cease following Decommissioning, effects are expected to be reversible as governments have a high level of resilience.

Table 13.5-6: Economy – Summary of the Characteristics Ratings for Provincial and Federal Government Revenues

Residual Effects Characteristic	Rating	Summary Rationale for Rating
Direction	Positive	The Project will result in the payment of royalties to the Province of Saskatchewan, and corporate income taxes to both the provincial and federal governments.
Magnitude	Moderate	The Project will provide revenue to the Province of Saskatchewan. Based on 2020 data, mining and petroleum account for 26% of revenue.
Geographic Extent	Beyond Regional	Both the provincial and federal governments will obtain increased revenue from the Project.
Duration	Medium-term	Revenue will occur throughout the duration of the Project but will be highest during Operation of the mine.
Frequency	Frequent	The revenue stream will occur throughout the duration of the Project.
Reversibility	Fully Reversible	Revenue to the provincial and federal governments will cease once the mine is no longer operational.
Context	Low	The Project is one among many that generate government revenues and will be distributed across a broad scale.
Likelihood	Likely	The Project once operational will increase revenues for the provincial and federal governments.

13.5.2 Summary of Project-related Residual Adverse Effects on Economy

For the most part, effects of the Project are expected to be positive to the Economy VC and have the potential to contribute to both the LSA and RSA and beyond. Although the effects to Economy KIs have been assessed for illustrative purposes, positive effects associated with employment and training, income, business opportunities, and federal and provincial revenues have been characterized, but are not carried through to the discussion of significance.

As such, the only potential residual adverse effects relate to the traditional economy. Many of these residual effects will benefit from mitigation in relation to potential changes to land and resource use (Sections 11.1.5 and 11.2.5 in Section 11), combined with any measures as determined with Indigenous COI through the agreement negotiation process. These residual adverse effects will occur in the LSA, are expected to be negligible to low in magnitude, medium-term in duration, frequent, and reversible after Decommissioning.

13.5.3 Significance and Confidence

Given the mitigation measures stemming from potential changes to land and resource use (Sections 11.1.5 and 11.2.5 in Section 11), the effects to Economy are **not significant**.

The level of confidence of this prediction is low to moderate as the ERFN Trapper, who had established relationships with other mine sites relative to compensation and access, passed away prior to the filing of the EIS. Effects associated with changes related to these uses are assessed more fully in Section 11.1.4 in Section 11.

With respect to traditional resource users in the LSA, certainty exists as to the extent of how participation in the workforce may affect individual traditional resource use behaviours in the LSA. It is likely to vary by individual, and in many instances traditional resource use may be supported by the income gained through employment. Based on evidence from other uranium operations in northern Saskatchewan, it is anticipated that there a balance of positive and adverse outcomes relative to participation in the traditional economy (CVMPP 2005).

13.6 Cumulative Effects

Consideration of cumulative effects is based only on residual adverse effects. As most changes to the Economy VC are positive, the CEA is only applied to changes to the traditional economy. Projects considered in the CEA (Section 5.9 in Section 5) were systematically examined for temporal and spatial overlap. Temporal overlap occurs when a project is a reasonably foreseeable development, meaning that the project is fairly certain and the development will take place within the planning horizon and expected life cycle of the Project (i.e., 38 years) (IAA 2018). The only project carried through to the CEA relative to land and resource use was the Highway 914 All Weather Road Extension Project.

Two pathways were considered assessing changes to the traditional economy: changes associated with biophysical effects and Project activities in proximity to the site, along with changes associated with pathways through employment that require individuals to participate in a commuter-rotation system (i.e., fly-in/fly-out two-week rotation). The CEA deals only with pathways associated with changes to land and resource use in proximity to the Project, as the Highway 914 All Weather Road Extension Project did not introduce potential changes associated with participation in employment and a commuter-rotation system, and would potentially draw on a different labour pool during Construction.

The Highway 914 All Weather Road Extension Project EIS is described as follows by Stantec (2021):

> *"Saskatchewan Ministry of Highways (MOH or the Ministry) is proposing a highway extension project consisting of the construction of 50.7 kilometres (km) of all-weather highway that will extend the existing Highway 914 starting near the McArthur River mine site to an existing road near the Cigar Lake mine site… The purpose [of] the Project is to create an alternate travel route for residents of Saskatchewan's northernmost communities. Several communities have one road option to access the southern areas of the province (Provincial Highway 905). Development of the Project would provide a secondary route for vehicles travelling to and from the north (p. vii)."*

With respect to cumulative effects to the traditional economy, the nature of effects is likely to vary by individual resource users, ranging from no anticipated effect to the perception that areas in proximity to the Project footprint are no longer suitable for traditional purposes. The ERFN Trapper predicted that "*If the gate at Key Lake is removed or the road is redesigned to go around Key Lake allowing unimpeded access to the north, there would be lots of concerns about the increase in the number of people coming north into this area*" (19-LK-ERFNTrap-134.224). Increased access to the area was identified as a concern by the Kineepik Métis Local #9 particularly with respect to hunting and fishing for food as an "*increase in human traffic will affect our ability to practice*" subsistence harvesting (KML 2022). The timing of overlap would begin in the Project Operation phase and continue until Post-Decommissioning is complete when temporal overlap ceases.

Although offering an alternative route south, the Highway 914 extension will not considerably shorten travel to the south by Athabasca Denesųłiné communities to southern population centres, and decisions on which route to take would remain influenced by the final destination of any travellers. It is possible that the previous route south via Highway 905 will remain the preferred route for through traffic. It is also possible that travel down Highway 914 may be pursued for destinations on the west side of Saskatchewan, or to explore parts of the province that were otherwise difficult to reach by road. Similarly, recreational land use may increase due to resource users arriving from the south. Commercial uses, such as trapping and fishing, were excluded from the analysis as these are provincially regulated activities and the associated allocations would not present the same sort of competition as the number of users would remain consistent with existing conditions.

An influx of new users is likely to affect competition for resources and contribute to increasing traffic volumes and associated noise and dust. Although ERFN, the Kineepik Métis Local, and the Athabasca Denesųłiné have indicated some use and harvest in proximity to the Project site over time, the concentration of community use tends to occur in other areas. Further to this, Project effects to fish and wildlife are not anticipated to result in any population level changes—meaning the availability of resources to support subsistence use will not be altered by the Project.

Measures to mitigate potential changes to land and resource use (Sections 11.1.5 and 11.2.5 in Section 11) would similarly be protective of the activities that support the traditional economy. When considered in the context of the perceived suitability of the area for resource use relative to the extension of Highway 914, the changes to the traditional economy are summarized in Table 13.6-1.

The magnitude of changes to traditional economy was considered moderate, as easing access would result in an increase of users in the area, particularly relative to existing conditions in which access restrictions are in place. The geographic extent is considered regional and could introduce resource users from communities that would otherwise have to travel further distances to access the area by road. These changes are considered continuous and would be fully reversible upon

Decommissioning. Effects to the traditional economy are likely and would occur in a social context where communities are considered highly resilient and adaptive to changes. Consideration of the cumulative effects of the Highway 914 All Weather Road Extension Project to the traditional economy does not alter the determination of significance, although Denison and the Province of Saskatchewan should continue to engage with potentially affected Indigenous communities relative to their concerns of the two combined projects. It is expected that areas of other more intensive community use will remain central to participation in the traditional economy, and that the non-monetary contribution of these activities to communities will be sustained.

Table 13.6-1: Summary of Cumulative Effects for Traditional Economy

Cumulative Effects	Project Phases	Cumulative Effects Characterization[1]								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Perception of reduced suitability of land and resources therein, including increased competition for resources	Operation – Post-Decommissioning	M	RSA	MT	CF	FR	L	L	NS	M

Notes:

1 Magnitude Low (L), Moderate (M), High (H).
Geographic extent Local (LSA), Regional (RSA), Beyond Regional (Beyond RSA).
Duration Short-term (ST), Medium-term (MT), Long-term (LT).
Frequency Infrequent (IF), Frequent (FF), Continuous (CF).
Reversibility Fully reversible (FR), Partially Reversible (PR), Irreversible (IR).
Context Low (L), Moderate (M), High (H).
Likelihood Unlikely (U), Likely (L).
Significance Not Significant (NS), Significant (S).
Level of Confidence High (H), Moderate (M), Low (L).

13.6.1 Climate Change Considerations

The Project is considered in the context of climate change. The sensitivities of the Project to severe weather (e.g., extreme temperatures and excessive precipitation) and forest fires have been examined as they have the potential to adversely affect the Project. Events including flooding, tornadoes, and forest fires, which are likely to become more frequent and/or more severe under climate change, have been considered in the Accidents and Malfunctions report, although the risk for these events has been determined as low, very low, or not expected (Ecometrix 2022). Detailed plans and procedures would be developed for the Project that are site specific including:

- process monitoring and operational procedures;
- mine development and control procedures;
- radiation protection plan;
- spill and emergency response plan;
- traffic and transportation plan;

- security procedures;
- travel management plan;
- environmental monitoring procedures;
- personnel training procedures;
- regular and preventive inspection and testing procedures; and
- surface water and flood management procedures.

Based on a consideration of the mitigation strategies to be applied, past experience, and application of best management practices, effects of a changing climate on the Project are expected to be **not significant**.

13.7 Monitoring and Follow-up

Monitoring and follow-up are required to confirm the residual and cumulative effects and any uncertainties identified in Sections 13.5 and 13.6.

Denison will work with the Province of Saskatchewan to develop the Project's SLA, which typically includes commitments related to an overall and Human Resource Development Agreement, along with annual human resources development plans. Annual reporting may include metrics such as total employment and employment of residents in the LSA and RSA, disaggregated employment by sex or gender and Indigenous identity (self-identified), total wages in dollars, northern procurement volumes in dollars and percentage of total procurement, any details on training partnerships and employee development, and community involvement such as scholarships, outreach, and information sharing with northern residents (Government of Saskatchewan 2018).

13.8 Economy Summary

The various phases of the Project will have different effects on Economy and its KIs: employment and training, income, the traditional economy, government revenues, and business opportunities. The Project will create employment and business opportunities and increase income for workers and businesses in the LSA, RSA, and beyond the RSA during all phases of the Project. Denison has estimated a workforce during the two-year Construction period of 300 people and during the Operation phase 180 people are expected to be employed to operate the ISR wellfield and processing plant, including supporting activities. Mineral sector positions are typically considered to be higher paying than many other industrial positions.

Residents and communities in the LSA will be given first priority for employment and training and business opportunities, followed by Indigenous and / or other communities in the RSA. The Project will also positively affect the governments of Saskatchewan and Canada through payments (e.g., uranium royalties, corporation income tax, personal income tax).

Changes associated with Project employment may also affect the traditional economy of residents in the LSA through: (1) the physical presence of the Project and its associated activities and how these may interact with traditional activities and (2) participation in the wage economy and how this can contribute to an individual's ability to partake in traditional activities, including that the commuter-rotation system may result in some individuals having less time to participate in the traditional economy.

As outlined in Denison's Indigenous Peoples Policy, Denison recognizes the critical necessity of advancing reconciliation with Indigenous peoples in Canada and the important role of Canadian business in the reconciliation process. Denison is committed to providing Indigenous people and businesses with sustainable economic opportunities and benefits and sharing the economic benefits of Denison's business activities.

Mitigation and enhancement measures will be therefore implemented by Denison to enhance the positive effects of the Project on employment and training, income, traditional economy, and business opportunities and minimize adverse effects including:

- a Human Resource Development Plan to initially prioritize Indigenous and non-Indigenous communities in the LSA in terms of employment and training opportunities;
- establishment of a procurement approach through all phases of the Project, focusing on businesses based within the LSA communities, followed by Indigenous and / or businesses in the RSA;
- continued assessment of future need for a trapper compensation agreement if/when an existing trapline is passed to another individual; and
- negotiation with the Province of Saskatchewan to develop the Project's Surface Lease Agreement and Human Resource Development Agreement.

Residual effects of the Project are expected to be positive for the Economic KIs of employment and training, income, business opportunities, and federal and provincial revenues and were not carried through to the discussion of significance.

The only potential residual adverse effect relates to the traditional economy. Many of the residual effects will benefit from mitigation in relation to potential changes to land and resource use (Sections 11.1.5 and 11.2.5 in Section 11) combined with any measures as determined with Indigenous COI through the agreement negotiation process. With respect to traditional resource users in the LSA, less certainty exists as to the extent of how participation in the workforce may affect individual traditional resource use behaviours in the LSA. It is likely to vary by individual, and in many instances traditional resource use may be supported by the income gained through employment. These residual adverse effects will occur in the LSA, are expected to be negligible to low in magnitude, medium-term in duration, frequent, and reversible after Decommissioning. As a result, the effects are considered to be **not significant**. The level of confidence in this prediction is low to moderate as the ERFN Trapper, who had established relationships with other mine sites relative to compensation and access, passed away prior to the filing of the EIS. The determination of significance (**not significant**) does not change with the consideration of the Highway 914 All Weather Road Extension Project in the assessment of cumulative effects.

Monitoring and follow-up would be used to (1) monitor progress on achieving employment and contracting targets and identify opportunities to improve employment and procurement, (2) continue and maintain communication with Indigenous and non-Indigenous COI, and (3) contribute to the overall and continual improvement of the Project. It is anticipated that the Project's SLAs and Human Resource Development Agreements will shape measures for socio-economic monitoring and reporting relative to key socio-economic indicators.

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Appendix 13-A Engagement Database Summary – Economics

See file “S13_App 13-A Economics Engagement_Wheeler River.pdf”

Appendix 13-B Economic Indicators

See file "S13_App 13-B Economic Indicators_Wheeler River.pdf"

Denison Mines

Wheeler River Project

Final Environmental Impact Statement

November 2024

Powering
PEOPLE, PARTNERSHIPS AND PASSION.

Wheeler River Project

Final Environmental Impact Statement

Section 14 – Accidents and Malfunctions

November 2024

Denison Mines

Denison Mines Corp.

345 4th Avenue South

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Roadmap

This roadmap of the Wheeler River Project Environmental Impact Statement (EIS) has been provided to summarize the main document sections and appendices of the EIS.

**Wheeler River Project
Environmental Impact Statement**

Executive Summary

Part I: Introduction and Context

- Section 1: Project Introduction and Overview
- Section 2: Project Description
- Section 3: Indigenous and Local Knowledge
- Section 4: Engagement
- Section 5: Approach and Methodology of the Assessment

Part II: Biophysical Environmental Assessments

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Part III: Human Environment Assessments

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Abbreviations, Acronyms, and Units

Abbreviation / Acronym	Definition
ALARP	As low as reasonably practicable
ARF	Airborne release fraction (or airborne release rate for continuous release)
CNSC	Canadian Nuclear Safety Commission
Denison	Denison Mines Corp.
DR	Damage ratio
EIS	Environmental Impact Statement
LPF	Leak path factor
MAR	Material at risk
Project	Wheeler River Project
RF	Respirable fraction
SGI	Saskatchewan Government Insurance
SI	Screening index
TDG	Transportation of Dangerous Goods
TRV	Toxicity reference values
TSD	Technical Supporting Document
UOC	Calcined uranium concentrate
US DOE	United States Department of Energy
VC	Valued component

Units	Definition
%	percent
Bq/d	becquerel per day
Bq/L	becquerel per litre
cm	centimetre
cm/s	centimetre per second
d	day
d/kg	day per kilogram
g	gram
g/cm^3	gram per cubic metre
g/L	gram per litre
g/s	gram per second
gal	gallon
h	hour

Units	Definition
ha	hectare
kg	kilogram
km	kilometre
km/h	kilometre per hour
L	litre
L/s	litre per second
lbs	pounds
m	metre
m/s	metre per second
m^2	square metre
m^3	cubic metre
m^3/kg	cubic metre per kilogram
m^3/s	cubic metre per second
mg/d	milligram per day
mg/kg	milligram per kilogram
mg/kg.d	milligram per kilogram day
mGy/d	milligray per day
min	minute
mL	millilitre
mSv	millisievert
µg/g	microgram per gram
µg/L	microgram per liter
µm	micrometre
yr	year

Glossary

Term	Definition
Accident	Any unintended event, including operating errors, equipment failures or other mishaps, the consequences or potential consequences of which are significant from the point of view of protection or safety.
Accident scenario	A conceptual / theoretical representation of any unintended event, including operating errors, equipment failures or other mishaps, the consequences or potential consequences of which are significant from the point of view of protection or safety.
Bounding scenarios	A conceptual / theoretical representation of any unintended event, including operating errors, equipment failures or other mishaps, the consequences or potential consequences of which are significant from the point of view of protection or safety, whose potential effects are equal to or exceed the severity of other possible scenario s that may occur in association with a given project component or activity.
Calcined uranium	Uranium that is heated to remove impurities.
Dangerous goods	A product is considered to be a dangerous good when one of the following conditions is met: • it is listed in Schedule 1 or Schedule 3 of the Transportation of Dangerous Goods (TDG) Regulations, • or if it is not listed in Schedule 1 or 3, it meets one or more of the classification criteria in Part 2 of the TDG Regulations.
Decay products	Also called "daughter products" - radionuclides that are formed by the radioactive decay of parent radionuclides.
Emergency or incident response	The integrated set of equipment, procedures and personnel necessary for performing a specified function or task required for preventing, mitigating or controlling the effects of an accidental release.
Emergency Response Plan	The documented measures required of applicants and licensees under the Class I Nuclear Facilities Regulations and Uranium Mines and Mills Regulations. Accordingly, an emergency plan for a Class I nuclear facility or a uranium mine or mill consists of a proposed or actual program to cope with accidental releases. This program encompasses both emergency preparedness and emergency response measures.
Hazard Assessment	The process used to systematically identify and assess hazards to evaluate the potential internal, external, human-made and natural events that can cause the identified hazards to initiate faults that develop into accidents.
Hazardous materials / substances	A substance, other than a nuclear substance, that is used or produced in the course of carrying on a licensed activity and that may pose a risk to the environment or the health and safety of persons.
Hydraulic gradient	The ratio of hydraulic head (water elevation) difference and the distance between two points.
Indigenous Knowledge	The unique and collective knowledge of Indigenous peoples that may include, but is not limited to, the environmental, cultural, economic, political, and spiritual conditions of a community or region.
Lixiviant	Liquid medium used in hydrometallurgy to selectively extract the desired metal from the ore or mineral.
Local Knowledge	Specialized knowledge developed through long-term association, interaction, and cumulative experience.
Malfunction	See Accident

Term	Definition
Mitigation	The elimination, reduction or control of the adverse effects of the Project and includes restitution for any damage to the VC caused by such effects through replacement, reclamation, compensation or any other means.
Project component	A physical system or activity with the potential to present a risk to the human health or biophysical environment.
Residual effects	Potential effects that cannot be fully mitigated.
Risk assessment	An assessment of the risks, including consequence assessment and associated probabilities, associated with normal operation and potential accidents involving a nuclear substance or licensed activity.
Risk matrix	A matrix that is used during risk assessment to define the level of risk by considering the category of probability or likelihood against the category of consequence severity.
Solubility	The maximum amount of a substance that will dissolve in a given amount of solvent at a specified temperature.
Specific gravity	The ratio of the density (mass of a unit volume) of a substance to the density of a given reference material.
Toxicity reference values	means a maximal estimate of exposure to a substance which would not elicit an unacceptable adverse toxicological effect in an organism
Valued Components	Aspects of the biophysical and human environments that will likely be affected (adversely or positively) by the Project.

14 Accidents and Malfunctions

14.1 Introduction

This subsection of the Environmental Impact Statement (EIS) for the Wheeler River Project (the Project) outlines the potential accidents and malfunctions that could occur in association with the Project and describes the potential effects on human health or the biophysical environment, considering environmental design features and mitigation measures that would be implemented to reduce such effects. The information presented in this section summarizes the results of the detailed technical assessment of accidents and malfunctions risks related to the Project that are presented in the accidents and malfunctions Technical Supporting Document (TSD) (see Appendix 14-A; Ecometrix 2022).

For the purpose of this assessment, accidents and malfunctions refer to events or conditions that are not part of any activity or normal operation of the Project as proposed by Denison Mines Corp. (Denison). This is consistent with the definition of an accident as described in REGDOC 3.6, "… *any unintended event, including operating errors, equipment failures, and other mishaps, the consequences, or potential consequences of which are significant from the point of view of protection or safety*" (CNSC 2022). Despite rigorous planning and the implementation of best practices and preventative measures, the potential exists for accidents and malfunctions to occur during any Project phase. If such unplanned events or conditions occur, adverse effects on human health or the biophysical environmental could result if not addressed or responded to in an appropriate manner.

14.2 Scope, Scale, and Objectives of the Assessment

The overall scope of this assessment includes consideration of potential accidents and malfunctions within the context of the key Project components that define the Project scope for the purposes of the Environmental Assessment.

As it concerns the temporal and spatial scales of the assessment the following is noted:

- The temporal scale of the assessment includes all Project phases: Construction, Operation, Decommissioning, and Post-Decommissioning.
- The spatial scale of the assessment includes the Project site and associated access road to its junction with Highway 914, as well as locations of interest to Interested Parties along the mine-related transportation route. It is noted that the primary transportation route for the Project includes approximately 380 km of publicly accessible gravel highway (110 km of Highway 165 and 270 km of Highway 914). Focussing the assessment on the locations of interest to Interested Parties along the route is a practical means by which to conduct the assessment. The accident and malfunctions scenarios described herein related to transportation of Project-

related goods and services at the locations of interest can generally be interpreted as being representative of similar location along the transport route.

The overall objective of the assessment is to evaluate the potential effects to human health or the biophysical environment resulting from radiological and conventional accidents and malfunctions in consideration of proposed environmental protection measures.

It is noted that some hazards related to worker safety were identified; however, worker safety (i.e., risks and consequences) is beyond the scope of this assessment. Consistent with Canadian Standards Association (CSA) N288.6-12 (CSA Group 2012), potential risks to nuclear energy workers will be addressed as part of the licence application and will include the results of occupational hazard and exposure assessments and the Radiation Protection Program and Health and Safety Program. Specifically, as it pertains to the consideration of accidents and malfunctions as presented herein, Denison will assess radiological dose to workers that may result from Bounding Scenarios (see definition in Section 14.5.6) involving vehicular accidents resulting in releases of radioactivity to the aquatic (see Section 14.6.1) and terrestrial (see Section 14.6.7) environments.

14.3 Regulatory Context

Federal guidance concerning the assessment of accidents and malfunctions is provided in Canadian Nuclear Safety Commission (CNSC) REGDOC-2.9.1: Environmental Protection: Environmental Principles, Assessments and Protection Measures (CNSC 2020). Specific considerations regarding the scope of such assessments are described in REGDOC-2.9.1, which indicates that the EIS should provide an assessment of potential health and environmental effects resulting from postulated radiological and conventional malfunctions and/or accidents. The EIS should also include any mitigation measures such as monitoring, contingency, clean up, or restoration work in the surrounding environment that would be required during or immediately following the postulated malfunction and accident scenarios (CNCS 2020).

Section 5.4 of the Transportation of Dangerous Goods Regulations (Government of Canada 2021) sets out the requirements for the loading and securing of dangerous goods to prevent damage to the container or to the means of transport that could lead to an accidental release. Section 8 of the Transportation of Dangerous Goods Regulations (Government of Canada 2021) is relevant to accidental release and accidental release reporting requirements.

The mandate associated with the province of Saskatchewan is less specific than that provided within CNSC REGDOC-2.9.1. Both the technical proposal guidelines (Government of Saskatchewan 2014a) and the guidelines for the preparation of the terms of reference (Government of Saskatchewan 2014b) reference addressing effects associated with accidents and malfunctions that may occur during all Project phases within the EIS. Denison has included these commitments in the Project's Terms of Reference (Denison 2019).

14.4 Influence of Indigenous Knowledge, Local Knowledge, and Engagement on the Assessment

The accidents and malfunctions assessment considered, and integrated information provided by Indigenous Knowledge and Local Knowledge and information obtained through engagement activities. Indigenous communities expressed their connection to the land and water and both general and specific concerns regarding how the implementation of the Project could affect historical and current land and resources uses and that there is fear within the communities for environmental contamination. Several examples are provided below that highlight the concerns raised.

The Ya'Th'Néné Lands and Resources Traditional Knowledge, Land Use and Occupancy Information study (2022) indicated the following:

> *"The areas considered in the duty to consult responses indicate that the surrounding land is used for activities such as hunting, fishing (including commercial) and the gathering of berries and medicines. The land is also used for therapeutic purposes, youth gatherings, fish camps and general camping. Accessible areas were utilized year-round for hunting, trapping and fishing, with activities such as berry picking occurring in summer.*
>
> *Concerns raised by the interviewees include damage to the lands and water, how wildlife will be affected, disruption to traditional activities and accessibility to the areas while projects are ongoing. Line cutting was raised as an issue that affects both land and wildlife."*

The Kineepik Metis Local #9 (KML and NVP 2022) in their value ecosystem components report to Denison expressed concerns regarding the management of potential incidents and emergency response:

> "*The community will also require confidence that any environmental incidents are managed in a way that is understood by the community. Ideally the community would have capacity to manage the incidents and monitor any environmental cleanup processes. We must be assured that the standards being followed and that as a community we are able to action a response are able to mitigate and potential environmental impact. This knowledge must become an integral part of the community capacity for this project.*"
>
> "*The community residents of Pinehouse and the current first responder for emergency and medical personnel will absorb many issues and incidents arising from increased traffic and future development. KML requests an emergency planning process that increase the Emergency response for Pinehouse to manage increased requirements for emergency response.*"

The English River First Nation Traditional Knowledge Study (SVS 2002) outlines general context to the community's connection to land and propensity for traditional land uses:

> "*Fear of contamination: The overarching fear of contamination from the mine is woven in to almost every other concern noted by participants in the TK study. It is worth acknowledging this concern separately given the potential for mental health impacts related to people's experiences of fear and anxiety.*"

The English River First Nation Country Food Study (CanNorth 2017) highlights the importance of their culture camp that is located in the area:

> "*One important location is the seasonal culture camp held along Highway 914 approximately 50 km south of the Key Lake Uranium Mining and Milling Operation. The culture camp is a place where the elders and young people gather to share stories and teachings. The youth who participate in the culture camp are taught by elders how to hunt, fish, and harvest traditional foods that are important to the ERFN people. The culture camp remains an important gathering location for young and old to share and learn these traditions and the ERFN would like to ensure that the country foods they are consuming are safe for future generations.*"

The former three examples helped to frame the accidents and malfunctions assessment in a general way as the confirm the approach taken that took a broad perspective considering how all facets of the proposed Project could interact with the environment over all mien life phases. These examples also point specifically to emergency or incident response as a key concern and commensurate with this concern emergency response planning is a key mitigation that Denison is committed as described in the accidents and malfunctions assessment.

The latter example of the specific concern of the English River First Nation for their culture camp influenced the accidents and malfunction assessment directly. An accident scenario was specifically included in the assessment (see Section 14.6.7.1) that considers the risks of a release of hazardous material due to a vehicle accident at this location, as well as at a second location of importance to the Kineepik Metis Local #9.

Direct engagement activities highlighted concerns with regards to accidents and malfunctions (see Appendix 14-B for details). These engagement records are summarized below in Table 14.4-1. The table also indicates how these records were considered in the accidents and malfunctions assessment.

Table 14.4-1: Summary of Engagement Records related to Accidents and Malfunctions

Unique Engagement Record ID	Comment	Accident and Malfunction Assessment Consideration
19-EN-ML82-62.21	If one of the pipes breaks, what would happen?	The assessment considers a scenario involving a piping system failure in the processing plant.
21-EN-VPL-444.14	Would Denison partner with Pinehouse to create	Emergency response planning and the development of an Emergency Response Pan is a key mitigation in the accidents and malfunctions assessment and a commitment to develop the plan is included in the EIS.
21-EN-SUR-446.65	Non transparency in regards to spills	The accidents and malfunctions assessment considers all project activities and phases to ensure a comprehensive evaluation has been completed. The EIS provides a summary of the Technical Supporting Document (TSD). The TSD includes a detail that Denison believes facilitates a transparent accounting of potential accidents and malfunction scenarios.
21-EN-SUR-446.66	Just pollutions	The accidents and malfunctions assessment considers all project activities and phases to ensure a comprehensive evaluation has been completed. The EIS provides a summary of the TSD. The TSD includes a detail that Denison believes facilitates a transparent accounting of potential accidents and malfunction scenarios.
21-EN-SUR-446.67	Contamination	The accidents and malfunctions assessment considers all project activities and phases to ensure a comprehensive evaluation has been completed. The EIS provides a summary of the TSD. The TSD includes a detail that Denison believes facilitates a transparent accounting of potential accidents and malfunction scenarios.
21-EN-SUR-446.91	Water contamination	The accidents and malfunctions assessment considers all project activities and phases to ensure a comprehensive evaluation has been completed. The EIS provides a summary of the TSD. The TSD includes a detail that Denison believes facilitates a transparent accounting of potential accidents and malfunction scenarios. Specific releases to water are considered I the assessment.
21-EN-SUR-446.92	The quality of the water if something were to leak. Ile a la crosse is a basin where all the rivers meet, so if something were to spill into the water system it would be concerning for our community.	The accidents and malfunctions assessment considers all project activities and phases to ensure a comprehensive evaluation has been completed. The EIS provides a summary of the TSD. The TSD includes a detail that Denison believes facilitates a transparent accounting of potential accidents and malfunction scenarios. Specific releases to water are considered I the assessment.
21-EN-YOUTH-448.2	Any chance of the wells blowing and contaminating the ground around it?	Two bounding scenarios that consider the potential loss of control of the freeze wall and containment of the mining solutions are included in the assessment.
21-EN-ERFN-474.1	Any difference in spill management for ISR operation relative to from other standard mining operations?	Emergency response planning and the development of an Emergency Response Pan is a key mitigation in the accidents and malfunctions assessment and a commitment to develop the plan is included in the EIS. The plan will be specific to the proposed operation.
18-EN-VILX-3.35	Need a stormwater management plan and a spill response plan.	Emergency response planning and the development of an Emergency Response Pan is a key mitigation in the accidents and malfunctions assessment and a commitment to develop

Unique Engagement Record ID	Comment	Accident and Malfunction Assessment Consideration
		the plan is included in the EIS. The plan will be specific to the proposed operation.
21-EN-VPL-444.25	If the chemicals are dangerous will Denison have an emergency response team to respond? Are there preventative measures in place to prevent the chemicals from entering the environment?	The accidents and malfunctions assessment considers as potential scenarios the release of hazardous substances that will be associated with the implementation of the Project. Various mitigation measures (i.e., preventative actions) are described as part of the assessment to prevent and lessen the likelihood of the occurrence of such accidents and malfunctions. Emergency response planning and the development of an Emergency Response Pan is a key mitigation in the accidents and malfunctions assessment and a commitment to develop the plan is included in the EIS. The plan will be specific to the proposed operation.
18-EN-VILX-3.33	Need a stormwater management plan and a spill response plan.	Emergency response planning and the development of an Emergency Response Pan is a key mitigation in the accidents and malfunctions assessment and a commitment to develop the plan is included in the EIS. The plan will be specific to the proposed operation.
21-EN-ERFN-447.37	Ice lander river is close to the project if a spill would happen would it reach or contaminate the river?	The accidents and malfunctions assessment considers as potential scenarios the release of hazardous substances that will be associated with the implementation of the Project. Various mitigation measures (i.e., preventative actions) are described as part of the assessment to prevent and lessen the likelihood of the occurrence of such accidents and malfunctions. Specific releases to water are considered I the assessment. Emergency response planning and the development of an Emergency Response Pan is a key mitigation in the accidents and malfunctions assessment and a commitment to develop the plan is included in the EIS. The plan will be specific to the proposed operation.

14.5 Assessment Methodology

14.5.1 Overview

The assessment of accidents and malfunctions employed a risk assessment approach to characterize the potential effects of non-routine events on human health or the biophysical environment. Residual effects (i.e., effects that cannot be mitigated) for accidents and malfunctions and transportation-related events were defined in terms of risk, which can be characterized based on the likelihood of the postulated event and the effect or severity of the potential effects on human health or the biophysical environment. This approach differs somewhat from that used in effects assessments completed for biophysical, cultural, and socio-economic Valued Components (VCs), where the assessment presents predictions that consider the effects from normal operating conditions and/or activities over the lifespan of the proposed Project. The potential effects on human health or the biophysical environment from accidents and malfunctions and transportation-related events are considered to be an estimate of the residual risk to VCs and intermediate components.

An overview of the risk analysis approach for the accidents and malfunctions assessment is provided in Figure 14.5-1. The assessment involved initially identifying a comprehensive list of hazard scenarios, which represent physical situations with the potential to harm human health or the biophysical environment. This initial list was then screened qualitatively based on likelihood and consequence to determine overall risk level using a risk matrix approach. Bounding scenarios were then selected from this initial list of hazard scenarios. The subsequent analysis focused on evaluating the hypothetical effects associated with each bounding scenario. A revised risk evaluation that considered the results of the detailed assessment was then completed for each bounding scenario.

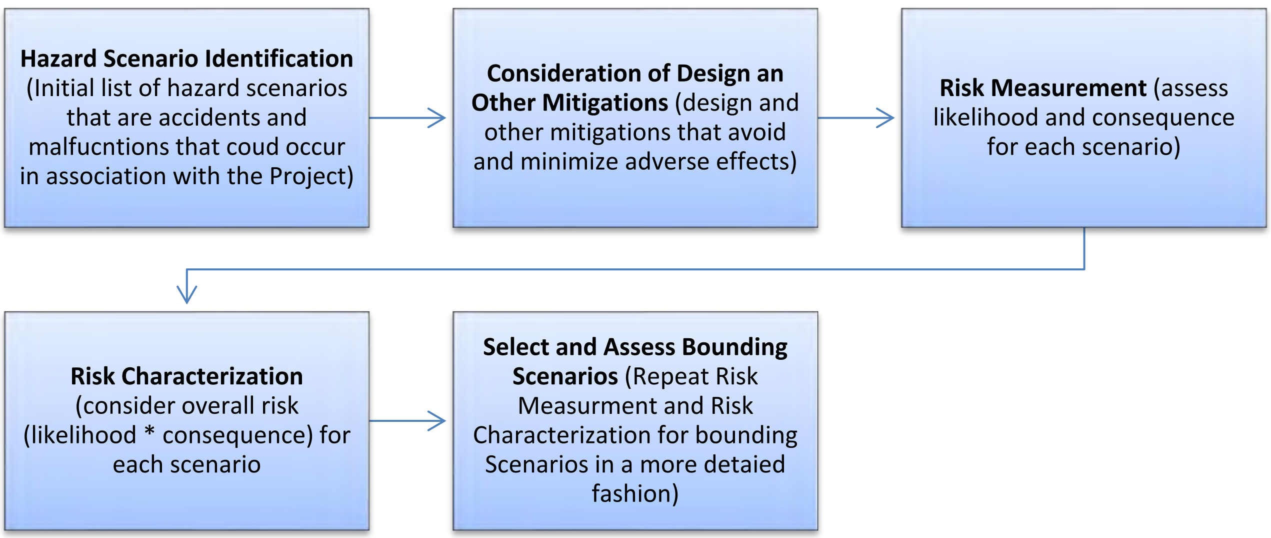


Figure 14.5-1: Risk Analysis Approach Applied in the Accidents and Malfunctions Assessment

14.5.2 Process Hazards Analysis

The hazard identification process is a systematic approach to identify possible hazards in a work process. A hazard can be defined as a physical condition that has the potential for causing damage to people, property, or the environment (e.g., fire, explosion, release of chemicals, or radioactivity). Potential nodes for hazard identification are selected through the review of the Project-related components. A node is a Project component that represents a physical system or activity with the potential to present a risk to the human health or biophysical environment. Hazard scenarios are developed by considering these nodes.

The hazard identification for each node involves the consideration of the sources of hazard (e.g., presence of hazardous materials), hazardous situations (e.g., height or extreme heat), and initiating events (e.g., natural causes, technical failure, or human error) that, in combination, present a risk to the human health or biophysical environment. A screening evaluation is applied to a given scenario by qualitatively evaluating consequence severity and probability to determine a risk level.

While standards and regulatory documents (e.g., REGDOC-2.4.2, *Safety Analysis – Probabilistic Safety Assessment [PSA] for Reactor Facilities* [CNSC 2014]) govern the assessment of the probability of the hazard scenarios for nuclear reactors, no such documents exist for non-reactor facilities. The focus of these documents is design-basis and beyond design-basis accidents that affect the integrity of the reactor core. The annual probability of releases from these accidents can be 1×10^{-6} and lower, while the consequence of these accidents could be very severe. In contrast, the probability of accidents and malfunctions at non-reactor facilities, such as mines and process plants, can be higher, as derived from the operating experience of similar installations. The International Atomic Energy Agency's TECDOC-1267 (IAEA 2002) states that while a plant-specific qualitative risk analysis should be conducted for a nuclear reactor facility, for non-nuclear facilities hazard identification and screening, evaluation of selected accident scenarios, and a combination of qualitative and quantitative analysis should be conducted. This document does not prescribe what probabilities should be considered.

On a scale of increasing likelihood, scenarios are categorized as highly unlikely, unlikely, likely, very likely, and almost certain as follows:

1. highly unlikely: ≤1 occurrence in 1,000 years;
2. unlikely: ≤1 occurrence in 100 years and >1 occurrence in 1,000 years;
3. likely: ≤1 occurrence in 10 years and >1 occurrence in 100 years;
4. very likely: ≤1 occurrence in 1 year and >1 occurrence in 10 years; and
5. almost certain: >1 occurrence in 1 year.

On a scale of increasing severity, scenarios are categorized as none, minor, moderate, major, and catastrophic as follows:

1. none: no human health or biophysical environmental consequences;
2. minor: short-term (less than one month) effect on small area, or injuries that require first-aid but not medical treatment and/or that result in no lost work time (for workers);
3. moderate: reversible or repairable effect (less than one year) off site, or reversible injuries with lost worm time (for workers);
4. major: extended-range, long-term effect off site (e.g., 10 years) or severe injuries with long lasting effects and/or disability; and
5. catastrophic: long-lasting with long-lasting or irreversible environmental effects, fatalities or multiple disabilities.

The resulting risk levels, i.e., low, moderate, and high, are defined according to these definitions and are illustrated in the matrix shown in Figure 14.5-2.

Likelihood		Consequence Severity				
		1	2	3	4	5
		None	Minor	Moderate	Major	Catastrophic
5	Almost certain	Low	Moderate	Moderate	High	High
4	Very likely	Low	Low	Moderate	High	High
3	Likely	Low	Low	Moderate	Moderate	High
2	Unlikely	Low	Low	Low	Moderate	High
1	Highly unlikely	Low	Low	Low	Moderate	Moderate

Figure 14.5-2: Hazard Analysis Risk Matrix

Risks were identified as low (i.e., coloured green in Figure 14.5-2) where the screening evaluation considers the risk as generally being acceptable, as the likelihood of these scenarios can be effectively managed through application of planned controls and/or the consequence would be low in magnitude. Low-risk scenarios have a severity of none to moderate with the likelihood ranging from highly unlikely to almost certain.

Risks were identified as being moderate (i.e., coloured yellow in Figure 14.5-2) where the screening evaluation considers the risk as generally being tolerable. In some cases, a moderate-risk scenario can encompass the risk of several screened scenarios for each effect category (e.g., toxic release, fire). In these cases, a moderate-risk scenario can be carried forward as a bounding scenario for more detailed analysis. Moderate-risk scenarios have a consequence of minor to catastrophic, with the likelihood ranging from highly unlikely to almost certain. In many cases, risk-reduction activities would reduce the risk associated with these scenarios to as low as reasonably practicable (ALARP).

Risks were identified as being high (i.e., coloured red in Figure 14.5-2) where the screening evaluation considers the risk as generally being unacceptable. High-risk scenarios have major to catastrophic severity with the likelihood ranging from unlikely to almost certain. As the evaluation of the risk at this hazard identification stage is qualitative and is associated with some uncertainty, the hazard scenarios identified as high risk were advanced for additional detailed assessment so that a more fulsome evaluation of risk and potential management activities can be considered.

14.5.3 Accident and Malfunction Scenario Identification – Project Activities and Components

The assessment of accidents and malfunctions began with the initial identification of hazard scenarios. Hazard scenarios were identified using a systematic approach that considered the existence of sources of hazards and initiating events for the Project in consideration of Project activities and components.

Based on a review of Project-related information, the following key Project components and activities were identified that form the basis of consideration for the identification of potential hazard scenarios:

- site works;
- drilling of wells;
- access road/land transportation;
- air strip/air transportation;
- operation of the freeze plant;
- maintenance of the freeze wall;
- production facility (operation of the processing plant);
- clean waste rock pads;
- special and mineralized waste rock pads;
- precipitates disposal area;
- wastewater treatment system;
- ponds and retention berms;
- electrical system and power plant;
- fire protection system; and
- hazardous waste management system.

A total of 70 hazard scenarios were identified. A summary of initial scenarios, relative to Project components and activities listed above, is provided in Table 14.5-1. Additional details for how each of these Project components and activities were considered in the initial hazard scenario identification process are provided in the accidents and malfunctions TSD (see Appendix 14-A; Ecometrix 2022).

Table 14.5-1: Summary of Hazard Scenario Identification Process

Project Component / Activity	Number of Hazard Scenarios	Comments
Site works	9	Fall / slip, refuelling accident, fuel storage failure, fuel storage and transfer fire and explosion, vehicle, and construction equipment accident
Drilling of wells	4	Drilling mud spill, piping failure in the well field, surface flood, well casing yield or damage
Access road/land transportation	8	Vehicle accident including rollover, collision, run off road, vehicle fire, vehicle-wildlife collision

Project Component / Activity	Number of Hazard Scenarios	Comments
Air strip/air transportation	5	Fuel storage failure, refuelling accident, plane de-icing chemical release, airplane crash, ground vehicle – airplane collision
Operation of the freeze plant	5	Ammonia storage and piping failure, loss of freeze capacity, cooling line break, pumps failure
Maintenance of the freeze wall	1	Failure of freeze wall due to seismic event / geotechnical instability
Production facility (operation of the processing plant)	8	Process vessel and piping system failure, thickener overflow, facility fire / explosion, process containment and gas cleaning and filtration system failure
Clean waste rock pads	4	Stockpile slope failure / erosion, uncontrolled leachate / seepage losses
Special and mineralized waste rock pads	2	Loss of storage containment
Precipitates disposal areas	10	Water and wind erosion derived releases, uncontrolled leachate / seepage losses
Wastewater treatment system	3	Infrastructure failure, equipment, and control system failure
Ponds and retention berms	5	Pond overtopping, containment failure, leakage, and flooding
Electrical system and power plant	3	Transformer leak, infrastructure fire/explosion
Fire protection system; and	2	Loss of firefighting capacity through pumping or supply failure
Hazardous waste management system	1	Spill with loss to water/ground

14.5.4 General Design and Mitigation Considerations

Over the past four decades of global commercial nuclear facility operation, the probability and severity of accidents has been markedly lower than those in related industrial operations (OECD 2010). This can be attributed to the rigorous regulatory framework and well-developed plans and procedures for safe operation of nuclear facilities, including uranium mining and milling operations. The experience gained from the accidents that have occurred has resulted in improved engineered safety features and operating procedures, and the probability that similar accidents might occur in the future is considered low.

Denison intends to develop and operate the Project in a manner that mitigates potential adverse effects on human health and the biophysical environment to the extent possible. Denison plans to verify that all work completed during the Project meets or exceeds the regulatory requirements stipulated by the CNSC and other regulatory authorities. Denison is committed to setting high standards for various aspects of its operations, which will serve to mitigate potential Project-related effects, including those that may be associated with postulated accident and malfunction scenarios. In practice, these standards would be upheld through adherence to corporate health, safety, environmental, and quality policies as manifested in various Project-related programs, including:

- a quality management program;
- an occupational health and safety program;
- a radiation protection program;
- an environmental protection program;
- an emergency preparedness and response program;
- a fire safety program;
- a maintenance program; and
- a wellfield and surface water program.

Within the aforementioned programs, detailed plans and procedures would be developed for the Project that would be site specific and in accordance with corporate policies, including:

- a radiation protection plan;
- a spill response plan;
- an emergency response plan;
- a traffic and transportation plan;
- a travel management plan;
- process monitoring and operational procedures;
- wellfield development and control procedures;
- security procedures;
- environmental monitoring procedures;
- personnel training procedures;
- regular and preventive inspection and testing procedures; and
- surface water and flood management procedures.

Together, these plans and procedures, and the work instructions that they contain, would be implemented throughout the life of the Project and would help to mitigate the likelihood of occurrence of accident and malfunction scenarios. Project design features and considerations are the first line of defence in this regard. Examples of proposed design features and considerations are summarized in the following bullets.

- The processing plant will be designed with expert consideration of potential environmental and health and safety effects to mitigate interactions to the extent possible.
- The floor of the process plant will be graded as required and sumps will be installed to collect any spills.
- Ventilation in the processing plant will be designed with the ALARP principle in mind to provide sufficient worker protection, and monitoring systems will be installed to safeguard worker health and safety.

- Dust control measures and good housekeeping practices throughout the processing plant will form a critical component of the radiation protection management plan developed for the Project.
- Processing plant exhaust, mainly from drying and packaging areas, will be directed through a stack and released outside the building.
- The stack height will be designed to an appropriate height for optimal dispersion based on the results of air dispersion modelling.
- Bulk storage tanks for processing chemicals (e.g., sulphuric and/or hydrochloric acid, sodium hydroxide, and hydrogen peroxide) will be located outside the processing plant.
- Storage tanks will sit inside appropriately designed and sized secondary containment basins. The secondary containment basin for each chemical system will be physically separated from the containment basins for other chemical systems.
- Each material will be stored, handled, recycled, and/or disposed of in an appropriate manner that meets the requirements of The Hazardous Substances and Waste Dangerous Goods Regulations (Government of Saskatchewan 2000).
- No fuels, oils, or other hazardous substances will be stored within 100 m of any waterbody, and no equipment maintenance or re-fuelling will be conducted within 100 m of a waterbody.
- Denison will maintain an up-to-date record of the various hazardous substances on site and will maintain Safety Data Sheets and appropriate procedures for spill management, handling, and clean up in an accessible location.
- Fuel storage and distribution infrastructure will be constructed in accordance with applicable legislation requirements (e.g., The Hazardous Substances and Waste Dangerous Goods Regulations; Government of Saskatchewan 2000). Stationary and mobile equipment will be fueled with a fuel-dispensing truck.
- Ventilation in the pumphouses will be designed with the ALARP principle in mind to provide sufficient worker protection from potential radon and radon progeny exposure. Monitoring systems will be in place to confirm that these mitigation measures are meeting design specifications.
- Double-walled, high-density polyethylene piping, or equivalent, will be used in the wellfields to meet design operation and environmental conditions.
- The lines from the processing plant, pumphouses, and individual well lines will be freeze protected and secured to minimize pipe movement.
- Groundwater monitoring wells will be installed at various locations and depths in and around the wellfield. The monitoring wells will allow for both groundwater sample collection and measurement of groundwater level.

- After an injection, recovery, or monitoring well has been completed, and before it is made operational, mechanical integrity testing of the well casing will be completed to confirm the installation has been successful and the well is functioning as designed. Well casings that fail integrity tests will be repaired before the well is placed into service.
- The very low permeability basement rock below the uranium deposit at the Project serves as a natural aquitard.
- The site access route was selected with consideration of distance from waterbodies.
- Water will be collected from the waste pond (which will collect runoff from the waste pad) and the processing plant terrace and then directed to the water treatment plant.
- Ponds or pads designed to temporarily or permanently store potentially radioactive materials will be double lined, with leak detection capabilities and an associated monitoring program to facilitate containment.
- Fuels will be stored in approved, above-ground, double-walled storage tank(s) equipped with secondary containment in accordance with provincial regulations and standards.
- Fuel storage and fueling activities will be located at least 100 m from waterbodies.

14.5.5 Results of the Initial Screening of Accident and Malfunction Scenarios

A summary outlining the results of the initial risk screening of accident and malfunction scenarios is provided in this subsection and summarized in Figure 14.5-3.

Three of the hazard scenarios characterized as high risk were recommended for further assessment. An additional four moderate/ALARP-moderate scenarios were identified as requiring further detailed assessment for more accurate characterization of risk.

Twenty-one of the scenarios evaluated were characterized as moderate-risk scenarios. Generally, the moderate-risk scenarios were deemed to represent a tolerable level of risk in consideration of proposed safeguards and design features that reduce the risk level to ALARP. As previously mentioned, four moderate/ALARP-moderate scenarios require additional detailed assessment for more accurate characterization of risk. The four moderate-risk scenarios that are subsequently assessed in more detail are associated with a contaminant release to the environment, which may have potential effects that are more far reaching than can adequately be assessed by the screening assessment. As such, a more quantitative evaluation was deemed appropriate.

The remaining scenarios evaluated (44) were characterized as low-risk scenarios based on low likelihood of occurrence and/or low consequence in consideration of planned existing safeguards and design features. Low-risk scenarios were not carried forward for more detailed analysis as they were considered to be adequately characterized by the screening process.

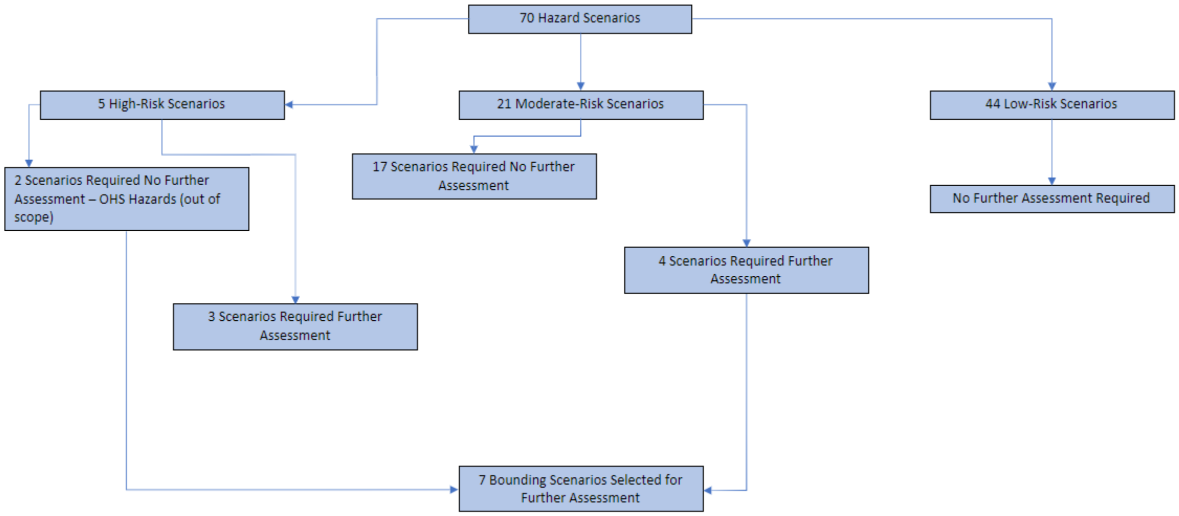


Figure 14.5-3: Summary – Initial Screening of Accident and Malfunction Scenarios

14.5.6 Definition of Bounding Scenarios

The results of the initial screening process identified a subset of scenarios for which more detailed risk analysis was determined to be appropriate (i.e., bounding scenarios). In this context, the term 'bounding scenario' is used to describe an event where the potential consequences are considered to represent those associated with other accident and malfunction scenarios. Alternatively, the term is used to describe the potential consequences of scenarios that are bounded by another and are expected to fit within the envelope of those associated with the bounding scenario. Utilizing the bounding scenario approach makes it possible to avoid duplication in the evaluation process, while at the same time making sure the evaluation is completed in a conservative manner. The bounding scenarios are shown in Table 14.5-2 for reference.

Table 14.5-2: Bounding Scenarios Identified for Further Assessment by the Hazard Identification Screening Process

Potential Accident or Malfunction	Project Phase	Potential Effect Pathway	Environmental Interactions	Initial Risk Characterization
Vehicle accident, including rollover, collision, run off road	O	Aquatic release of radioactivity	Potential effects on surface water quality, aquatic environment VCs, wildlife VCs and human health	High Risk
Vehicle accident, including rollover, collision, run off road	C/O/D	Aquatic release of fuel, hazardous chemicals, and reagents	Potential effects on surface water quality, aquatic environment VCs, wildlife VCs and human health	High Risk
Loss of freeze capacity	O	Loss of freeze wall and secondary underground containment	Potential effects on the groundwater VCs	High Risk
Failure of freeze wall	O	Loss of secondary underground containment and groundwater contamination	Potential effects on the groundwater VCs	Moderate Risk
Process vessel and piping system failure	O	Release of radon from storage tank	Potential effects on groundwater, soils, vegetation, wildlife VCs and human health	Moderate Risk
Facility fire/explosion	O	Release of radioactivity and uranium concentrate powder to atmosphere	Potential effects on air quality and human health	Moderate Risk
Vehicle accident, including rollover, collision, run off road	C/ O/D	Terrestrial release of radioactivity and chemicals	Potential effects on groundwater, soils, vegetation, wildlife VCs and human health	Moderate Risk

Notes:

C = Construction, O = Operation, and D = Decommissioning.

Red and yellow shading indicates high and moderate risk scenarios, respectively.

“Effect Pathway” describes the nature of the event and, therefore, the nature of the assessment of consequence.

14.6 Assessment of Bounding Scenarios

As indicated in Section 14.5.6, several accident and malfunction scenarios were identified during the initial risk screening as requiring further detailed assessment to assess potential effects more adequately on human health and the biophysical environment. The detailed assessment of each bounding scenario resulted in a more in-depth, quantitative, and representative characterization of the risk associated with each scenario.

The assessment undertaken for each of the bounding scenarios, as detailed in the following subsections, consisted of a general description of the hypothetical event, characterization of the resulting release (e.g., contaminants, quantities), an assessment of probability (i.e., frequency of occurrence), and a description of the resulting potential effects on the human health and biophysical environment VCs. Based on the results of the detailed risk analysis for each bounding scenario, a revised risk evaluation that considered the results of the detailed assessment was then completed for each bounding scenario. The revised risk evaluation is provided for each bounding scenarios as per the risk measurement and evaluation matrices outlined in Section 14.5.2. The information provided in the following subsections is at a summary level; details regarding how each of the Project components and activities were considered in the initial hazard scenario identification process are provided in the accidents and malfunctions TSD (see Appendix 14-A; Ecometrix 2022).

14.6.1 Bounding Scenario 1 – Vehicle Accident and Aquatic Release of Radioactivity

14.6.1.1 Scenario Description

Vehicular access to the Project would be via an access road from Highway 914 that leads to the Project site. The access road would be used primarily to transport equipment and supplies to and from the Project, as well as trucking of uranium concentrate. Personnel would typically be flown to and from the site.

The access road would be approximately 12 km long, with 5 km between Highway 914 and the Project site and 7 km between the Project site and the airstrip. Additional site roads would include a service loop to the camp and short service roads to other site features to facilitate access. Denison anticipates the need for installation of two water crossings in the Icelander River drainage upstream of Whitefish Lake along the section of the road from the Project site to the airstrip. Figure 14.6-1 shows the location of the water crossings along the access road.

Figure 14.6-1: Location of the Water Crossings Along the Access Road to Airstrip

No trucks transporting uranium concentrate are expected to travel along the portion of the access road between the Project site and the airstrip; however, Jet Fuel A would be transported to the airstrip along this portion of the road.

The portion of the access road between Highway 914 and the Project site is not within 100 m of any waterbody at any location; therefore, an accidental release of hazardous substances, including uranium concentrate, to surface water is not expected along this portion of the road. Highway 914 crosses the Wheeler River 10 km southwest of the access road junction. Figure 14.6-2 shows the location of the water crossings along Highway 914. The length of the bridge over the river at this crossing is approximately 100 m. The width of the river at the crossing is approximately 20 m. The crossing is equipped with guardrails along the entire length of the bridge. A vehicle accident, including a rollover, collision, or run off road, at or near the bridge could potentially result in a release of uranium concentrate into the surface water at this location. This location was the focus of the evaluation as it represents an important location to resource users in the study area. The scenario provides an example of the consequences of such releases to local receptors, the results of the assessment of the releases at this location would be expected to be generally representative of crossings along the transport route since the key endpoint in the assessment is overall risk, as defined for the assessment process as probability multiplied by consequence. Appendix C to this report describes water crossings along the Project-related transportation route on Highway 914 south from the Project site to its junction with Highway 165 and Highway 165 east to Hwy 2 and west to Hwy 155. While the specific conditions at these crossings may differ in size or nature, the results of the analysis presented can generally be applied more broadly as indicated above. The approach used is consistent with past practice for comparable assessments for uranium projects in the province.

The flow direction at the Wheeler River water crossing is towards the northeast and Russell Lake. The flow rates for the stream crossings and Wheeler River south of Russell Lake are provided in Table 14.6-1.

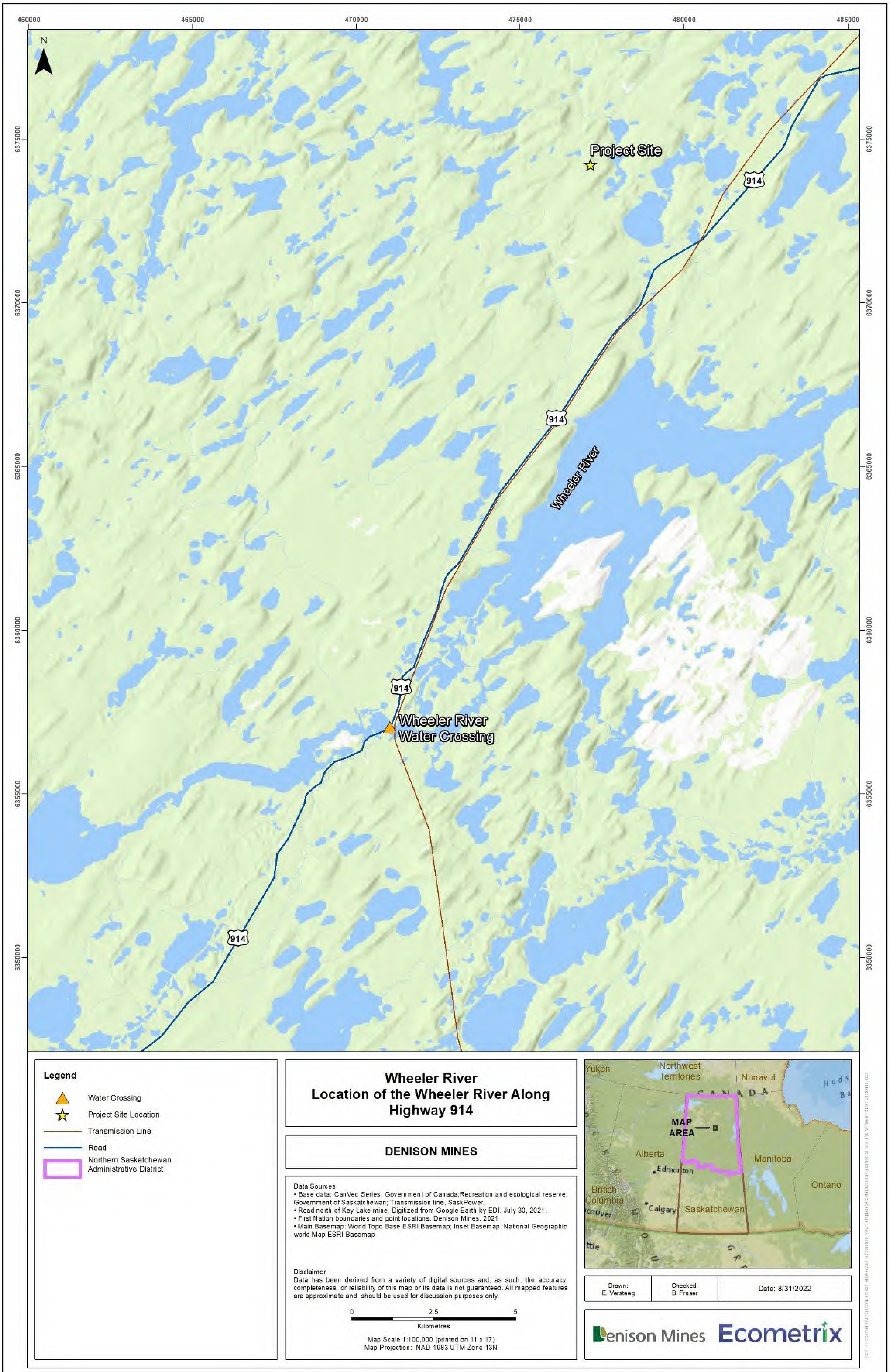


Figure 14.6-2: Location of the Wheeler River Along Highway 914

Table 14.6-1: Flow Rates for the stream crossings and Wheeler River south of Russell Lake

Location	Minimum Flow (L/s)	Average Flow (L/s)	Maximum Flow (L/s)
Water Crossing 1 – Inflow to Whitefish Lake from Kratchkowsky Lake	204	357	769
Water Crossing 2 - Inflow to Whitefish Lake from LA-9	494	917	2,132
Hydrometric Station 06DA005 - Wheeler River South of Russell Lake (https://wateroffice.ec.gc.ca/index_e.html)	10,900	17,340	24,670

For reference, the calcined or dried (heated to remove impurities) uranium concentrate would be packed into standard 205 L (55 gal) steel drums for shipping. The gross weight of each drum would be between 430 and 450 kg. It is projected that there would be 35 to 40 drums packaged per mill operating day, requiring an average number of one trip per day. In uranium concentrate, the short-lived decay products of uranium-238 (i.e., thorium-234; protactinium-234m; protactinium-234, which has a relative concentration of 0.16% of uranium-238; and uranium-234) and uranium-235 (i.e., thorium-231) are assumed to be in equilibrium with their respective parents considering both uranium and its decay products. The radioactive equilibrium exists when a radionuclide decays at the same rate at which it is being produced by its parent decay. The activities of these radionuclides in uranium concentrate can be derived using the branching ratios as shown in Table 14.6-2. The branching ratio for decay is the fraction of particles that decay by an individual decay mode with respect to the total number of particles that decay. These fractions are used to calculate the activity concentration of radionuclides in uranium concentrate.

Table 14.6-2: Radionuclides in Uranium Concentrate

Radionuclide	Half-Life	Branch Percentage
Uranium-238	$4.47 \times 10^{+09}$ yr	NA
Thorium-234	24.1 d	100% uranium-238
Protactinium-234m	1.16 min	100% uranium-238
Protactinium-234	6.7 h	0.16% uranium-238
Uranium-234	$2.45 \times 10^{+05}$ yr	100% uranium-238
Uranium-235 (4.6% of uranium-238)	$7.04 \times 10^{+08}$ yr	NA
Thorium-231	1.063 d	100% uranium-235

From other studies conducted for uranium mills in northern Saskatchewan, the particle size distribution for three uranium concentrate calcined samples was measured using a Beckman Coulter LS Particle Size Analyzer. Table 14.6-3 provides a summary of the particle size distribution information for these studies.

Table 14.6-3: Uranium Concentrate Particle Size Distribution in Three Calcined Samples[1]

Size Category (µm)	Average Size (µm)	Percentage
<5	2.5	4.0
5–15	8.6	14.7
15–25	19	46.1
25–35	30	32.8
35–55	44	2.5

1 This information was obtained from Cameco Corporation during the assessment of accidents and malfunctions for the Millennium Mine Project.

The solubility of the calcined uranium used herein is based on testing of samples from the McClean Lake Operation that were analyzed over 24- or 72-hour periods. The flask method detailed in the *OECD Guideline for the Testing of Chemicals – Water Solubility* (OECD 1995) was followed for these tests. The results are shown in Table 14.6-4. Bulk and particle densities of calcined uranium concentrate (UOC) were considered at 2.1 and 9.6 g/cm^3. Based on the solubility data from the McClean Lake Operation samples, a solution of 0.125 g of UOC in 250 mL of water would result in a uranium concentration of 4,800 µg/L.

Table 14.6-4: Solubility of Calcined Uranium Concentrate

Sample Source	Sample No.	Estimated Solubility (g/L) by Test Duration		
		24 h	48 h	72 h
McClean Lake (calcined)[1]	1	0.0035	0.0045	0.0046
	2	0.0060	0.0071	0.0067
	3	0.0053	0.0062	0.0090
	4	0.0038	0.0036	0.0039
	5	0.0070	0.0068	0.0064
	16 to 20 (average)	0.003 to 0.008 (0.005)	NA	NA

1 This information was obtained from Cameco Corporation during the assessment of accidents and malfunctions for the Millennium Mine Project.

14.6.1.1.1 Release Characterization

The performance of drums, similar to those proposed to be used for uranium concentrate shipment during transportation accident scenarios for the Project, was analyzed by McSweeney et al. (2004). Based on drum deformations performed in a previous analysis, the authors concluded that if a drum experienced a crush force of 100,000 lbs, the deformation of the drum would cause the lid to detach from the drum. Using this drum failure mechanism, and assuming the drums weigh 450 kg and are arranged four across in the truck, the front 25% of the drums would fail at a speed of 48 km/h, the front 55% would fail at 60 to 97 km/h, the front 75% would fail at 145 km/h, and all drums would fail at ≥193 km/h.

Given that truck speeds for the Project will likely be between 60 to 97 km/h, it was concluded that less than 55% of the drums would fail in a vehicle accident scenario. Assuming 40 drums in one shipment per day, each shipment would have approximately 40,000 lb of uranium concentrate:

$$40 \text{ drums} \times 450 \text{ kg/drum} = 18{,}000 \text{ kg uranium concentrate} = 40{,}000 \text{ lb.}$$

If 55% of this amount was released, the total release weight would be approximately 22,000 lb of uranium concentrate. The short-term dissolved release rate was estimated using solubility data. Solubility of calcined UOC was considered at an average value of 4,800 µg/L over the first 72 hours, which was the average solubility of McClean Lake Operation samples. It was assumed that such concentrations applied to a cross section of water defined by the lateral footprint of the spill (i.e., the total 20 m of the Wheeler River crossing) and a water column depth of 10 cm.

The water velocity in the Wheeler River was assumed to be 0.72 m/s. At an average depth of 1.2 m, the total flow rate would be 17.3 m^3/s:

$$20 \text{ m} \times 1.2 \text{ m} \times 0.72 \text{ m/s} = 17.3 \text{ m}^3\text{/s.}$$

The dissolution rate was calculated as 6.9 g/s:

$$20 \text{ m} \times 0.1 \text{ m} \times 0.72 \text{ m/s} \times 4.8 \text{ g/m}^3 = 6.9 \text{ g/s.}$$

Long-term concentrations were also estimated to account for transfer of the settled uranium from sediment to water. The long-term release rate is based on the concentration estimated for sediment porewater quality. It was assumed that such concentrations applied to a cross section of water defined by the lateral footprint of the spill and a water column depth of 10 cm.

14.6.1.2 Design and Mitigation Considerations

Principal traffic risk mitigation measures include:

- traffic control measures such as speed limits;
- travel management plans;
- spill and emergency response planning; and
- driver training.

14.6.1.3 Evaluation of Probability

Despite risk control measures, a residual probability of accidents occurring remains. The probability of occurrence of a transportation accident and subsequent sequence of events resulting in a release of hazardous materials is the key factor for quantifying the transportation risk. Statistical data for transportation accidents are available for general transportation and the transportation of hazardous materials. General transportation accident statistics are commonly presented as the number of accidents per million kilometres or million miles of transport vehicle travelled. Specific hazardous materials transportation accident statistics are commonly presented as the number of accidents per million tonne-kilometres or million ton-miles of materials transported.

Hazardous material transportation accident statistics are generally more relevant for risk assessment studies such as this; however, the statistical datasets for hazardous material transportation are less reliable. Data regarding the total volume and mass transported by various modes of transportation are maintained by shipping companies, and in most cases are only available to regulatory agencies such as Transport Canada. Publicly available information is reported on a lump sum basis. In addition, the statistical breakdown for transportation routes is not readily available and the route data, particularly for road transportation, are maintained by road transport companies and are not publicly available. With this in mind, general transportation accident statistics have been used herein to characterize accident probability.

In Canada, statistics related to transportation and road accidents are primarily collected and maintained by federal and provincial government agencies, including Transport Canada (2019) and its branches (e.g., Canada Transportation Safety Board), the Saskatchewan Ministry of Highways and Infrastructure, and Saskatchewan Government Insurance (SGI) (SGI 2018). These statistics indicate that the average accident rates for Canada and Saskatchewan were 1.2 and 0.89 accidents per one million kilometres travelled, respectively. Statistics more localized to the Project site indicate that the average accident rate was 1.75 accidents per one million kilometres travelled for Highway 914. This value was used for the calculations.

In the case of the accident scenario envisioned, UOC would be packed into standard 205 L (45 gal) steel drums for shipping. It is projected that there would be approximately 40 drums packaged per mill operating day (Denison 2019). It was also assumed that a traffic accident on the bridge, or within 40 m of either side of the bridge, would have the potential for release to the Wheeler River.

Using the transportation route lengths and the transportation accident rates estimated above, and assuming one trip per day for 330 days per year, the annual probability of traffic accidents involving uranium concentrate along Highway 914 and in the vicinity of the Wheeler River crossing (i.e., considering a 40 m buffer at each side of the bridge, total of 40 + 40 + 20 = 100 m = 0.1 km) was estimated as:

for release to water: $330 \times 1.75 \times 0.1 / 1{,}000{,}000 = 5.78 \times 10^{-05}$.

The above probabilities were calculated using SGI statistics for Highway 914.

According to the probability ratings described in Section 14.5.2, the probability that this accident and malfunction scenario may occur is predicted to be highly unlikely.

14.6.1.4 Evaluation of Consequence

The Wheeler River runs approximately 10 km south of the Project site from the southwest towards the northeast and drains to Russell Lake. Highway 914 crosses the Wheeler River 10 km southwest of the site access road junction. This is the crossing where it is assumed that a hypothetical vehicle accident could occur (Figure 14.6-3). The river width at the crossing measures approximately 20 m. The closest hydrometric gauging station is station 06DA005 (at Wheeler River south of Russell

Lake). The flow rates considered for this assessment were 5th percentile annual flows of 10.9 m^3/s (minimum flow), the average annual flow of 17.3 m^3/s (average flow), and the 95th percentile annual flow of 24.67 m^3/s (maximum flow). Corresponding water depths for these flow conditions were 0.8, 1.2, and 1.7 m, respectively.

Figure 14.6-3: Wheeler River Crossing Location

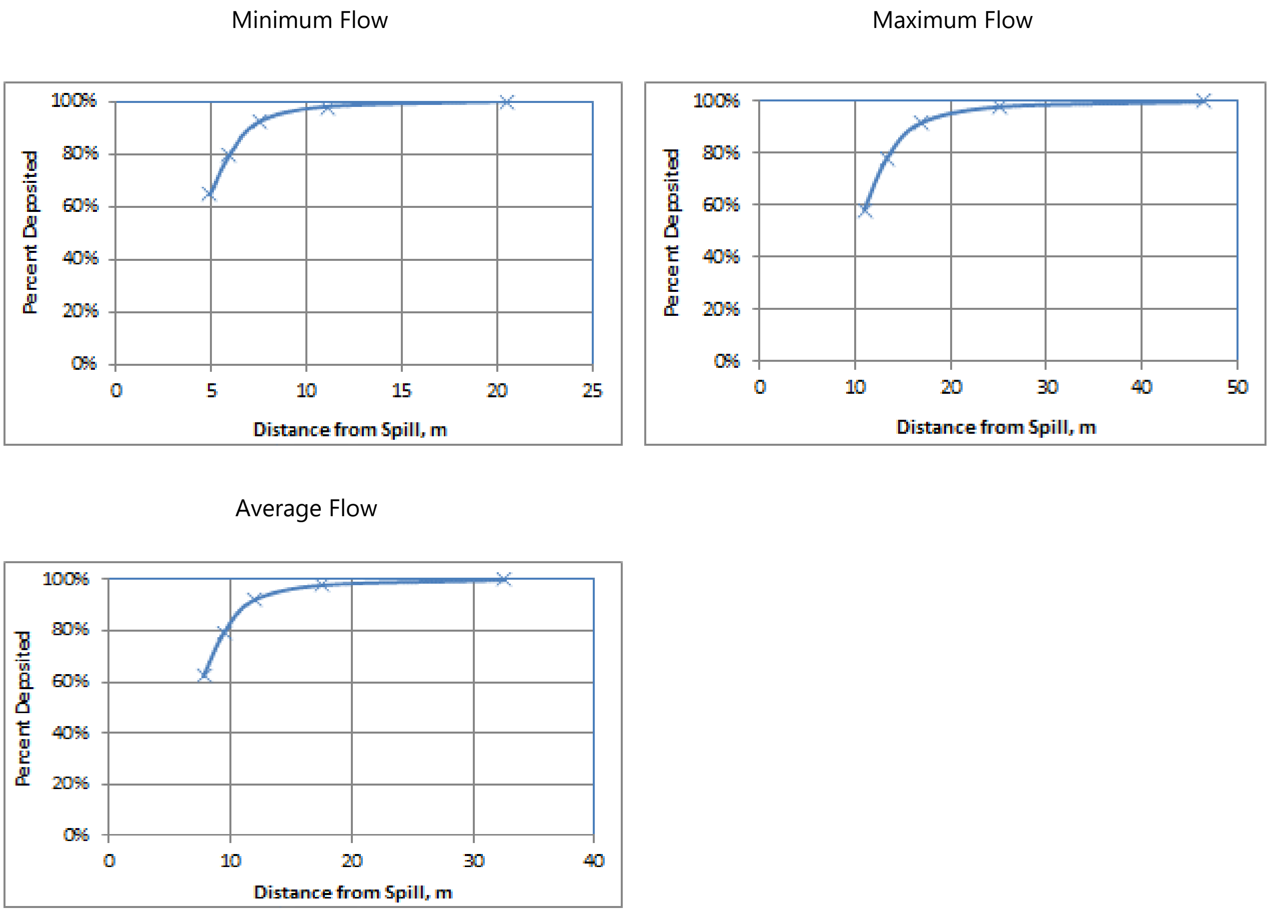
14.6.1.4.1 Uranium Concentrates Fate and Transport Results

Sediment concentrations were estimated through calculation of the distance travelled by uranium concentrate after a spill plus the area affected.

Figure 14.6-4 illustrates the implication of this distribution of uranium concentrate mass for any clean-up planning. The results indicated that most (98% of the mass) of the uranium concentrate is expected to settle within a short distance of the release (i.e., within approximately 20 m of the release point), even under high flow conditions in the Wheeler River due to a relatively slow water velocity (<0.8 m/s). This suggests that the hypothetical release would be confined to a small area; therefore, it is expected that the spill could be effectively recovered. Under high flow conditions (i.e., the worst-case scenario), the maximum estimated distance for the deposition of particulates <5 µm was approximately 46 m from the crossing.

For the purposes of the current assessment, it was assumed that 95% of the solids that settle within 15 m of the spill site would be potentially recoverable through remedial activities. Sediment quality results are shown in Table 14.6-5 for post-remediation conditions. The results presented in this table are a summary of the three flow conditions for predicted sediment concentrations in the Wheeler River. In general, using the results of the assessment, the minimum predicted uranium concentrate concentrations in the river sediments occurred under high flow conditions, with smaller particles (<5 µm) being deposited over a larger area.

Porewater quality within the affected sediment of the Wheeler River was estimated based on weighted-average sediment concentrations using a sediment-to-water partition coefficient of 3.5 m^3/kg. The results are shown in Table 14.6-5. During minimum flow conditions, the affected volume is expected to be smaller, resulting in a higher sediment concentration. In comparison, higher flow conditions are expected to result in a greater footprint and lower concentrations. Concentrations post clean up may not follow the same trend since clean up will be limited to a distance of 15 m of the release. While higher concentrated sediment in the vicinity of spill will be cleaned, sediments with lower concentrations further downstream will not, resulting in a higher overall concentration under high flow conditions.



Note: The horizontal scale is not the same for all figures.

Figure 14.6-4: Distribution of Deposited Uranium Concentrate by Distance Downstream of the Wheeler River Crossing

Table 14.6-5: Estimated Post-Remediation Sediment and Porewater Quality Downstream of the Wheeler River Crossing

Flow	Affected Distance (m)	Average Sediment Concentration (µg/g)	Porewater Concentration (µg/L)
Minimum	21	3,461	12
Average	33	3,309	12
Maximum	47	2,535	9

Water concentrations for the three flows were estimated for short- and long-term concentrations using information on uranium solubility and porewater concentrations, respectively. The results are shown in Table 14.6-6. The short-term period for the Wheeler River was estimated at one week regardless of whether settling was considered.

Table 14.6-6: Estimated Water Quality Downstream of the Wheeler River Crossing (µg/L)

Duration	Mixing in 5% of River Flow			Mixing in 25% of River Flow			Mixing in 100% of River Flow		
	Min Q	Mean Q	Max Q	Min Q	Mean Q	Max Q	Min Q	Mean Q	Max Q
Short term[1]	56,747	37,831	26,705	11,349	7,566	5,341	2,837	1,892	1,335
Long term[2]	NA	NA	NA	NA	NA	NA	0.39	0.188	0.173

Notes:

1 Estimated at one week.

2 Post remediation.

Q is flow.

NA – mixing in 5% and 25% is not relevant for long-term concentrations.

14.6.1.4.2 Exposure Assessment

The assessment of effects on ecological receptors was completed by comparing exposure estimates to relevant toxicological/radiological benchmarks. For example, intake (or dose) estimates were compared to non-radiological toxicity reference values (TRVs) and to dose rate guidelines for radionuclides to assess the risks of adverse health effects for each of the ecological receptors. For humans, the estimated exposure was compared to the drinking water quality guidelines. The adverse effects on water quality were transient, and the accumulation of contaminants through the food chain is not expected for the accident scenarios. Therefore, the only credible exposure pathway for the human receptor is drinking water.

It should be noted that ecological health effects were considered at the population level as opposed to the individual level. Estimation of population-level effects is a complex issue and involves some level of scientific judgement.

The results of water and sediment quality predictions were used to assess exposures of ecological species to uranium.

In general, the approach taken for estimating the exposure of radiological and non-radiological contaminants to non-human biota is to model the intake of a contaminant by the biota (in mg/d or Bq/d) and then use a transfer factor (d/kg) to obtain a body or flesh concentration where necessary. Many toxicity values for non-radiological contaminants are expressed as intake rates rather than tissue residues. Therefore, the assessment of radiological and non-radiological contaminants can be carried out in parallel with the flesh concentrations that are important for estimating internal radiological doses. Intakes are used for assessment of non-radiological contaminants. Detailed methodology and example calculations are provided in the accidents and malfunctions TSD (see Appendix 14-A; Ecometrix 2022).

The comparison of intake (or dose) estimates to TRVs or dose rate guidelines is usually undertaken by the calculation of screening index (SI) values, also referred to as hazard quotients. The SI values provide an integrated description of the potential hazard, the exposure (or dose) response relationship, and the exposure evaluation. This approach is widely used as a key line of evidence in ecological assessments, particularly in screening-type assessments (EC 2012).

Acute exposure to all aquatic species, except for benthic invertebrates, was assessed. Since an acute TRV is not available for benthic invertebrates and they are exposed to both sediments and water, benthic invertebrate exposure was considered to be chronic.

In the assessment of population-level effects on benthic invertebrates, one of the key considerations in this predictive assessment was the scale of the effect. As discussed by US EPA (2003), if the area is large, the effects will be diluted. However, if the area is small, the affected population or community may be too insignificant to prompt stakeholder concern or action. For this assessment, population-level effects were expected to occur if more than 5% of a lake or 0.2 ha of a river system were affected.

The results of the water quality predictions were used to assess exposures of a human receptor to chemical uranium and radionuclides. For a short-term assessment, the estimated uranium concentration in water was compared to the appropriate water quality benchmark and the estimated radiological dose was compared to the reference dose.

For the assessment of the exposure following a spill in a river, the focus was placed on the estimated concentration following mixing in the entire river flow under average conditions.

Table 14.6-7 summarizes estimated concentrations and intake related to uranium and calculated SI values for each receptor selected for assessment in the Wheeler River during average flow conditions and exposure to a spill of uranium concentrate. The SI values for short-term water and sediment concentrations were above the reference value of 1; these values are examined further in the following bullets. The results of the ecological risk assessment indicated short-term ingestion of contaminated water resulting from an accident would not result in potential risks to grouse, vole, or deer. No additional exceedance was observed under low or high flow conditions.

- **Sediment:** Concentrations in post-remediation conditions (95% clean up within 15 m of a spill) are expected to exceed the benchmark. Spilled uranium concentrate would spread approximately 10.3 m under average flow conditions, covering an area of approximately 824 m^2 (10.3 x 80 = 824 m^2 = 0.084 ha). These results indicate that a spill of uranium concentrate could potentially affect benthic invertebrate populations following a spill, but the spatial extent would be limited.
- **Water:** When evaluating the potential effect, a comparison was made between the results of the estimated short-term water quality and the guideline. The concentration of 1,892 µg/L (1.892 mg/kg) is greater than 33 µg/L. This indicates that there may be some aquatic species that could be affected, but the effects are expected to be transient as the water concertation quickly drops to a long-term level of 0.19 µg/L.

Table 14.6-7: Consequences on Ecological Receptors for Average Flow in the Wheeler River

Receptor	Exposure					Screening Index (based on Conc., Intake, Dose as indicated))		
	Conc. (mg/kg)	Intake (mg/kg.d)	Internal Dose	External Dose	Equiv. Dose, (mGy/d)	Conc. (mg/kg)	Intake (mg/kg)	Dose (mGy/d)
Water – short term	1.892	-	-	-	-	57.3	-	-
Water – long term	0.00019	-	-	-	-	0.005	-	-
Sediment – dw	8449	-	-	-	-	4	-	-
Grouse	0.076	457	1.95E-05	-	1.95E-05	-	0.86	<0.001
Vole	3.97E-06	0.38	1.88E-06	-	1.88E-06	-	0.033	<0.001
Deer	2.55E-03	0.113	0.0012	-	0.001	-	0.01	0.018

Notes:

Benchmark for water: 0.033 mg/L (short-term).

Toxicity reference values: 0.043, 0.17, and 0.73 (95th, 90th, and 80th protection levels).

Sediment: 2,296 mg/kg dw (benthic invertebrates).

Intake: 160 mg/kg.d (grouse), 11.4 mg/kg.d (vole, deer).

Dose: 2.4 mGy/d.

Grey shading exceeds benchmark.

dw is dry weight.

Based on this assessment, and in consideration of the consequence scale described in Section 14.5.2, the severity of the consequences of this accident and malfunction scenario is expected to be moderate.

14.6.1.5 Evaluation of Risk

In consideration of both probability and consequence, and based on the risk matrix described in Figure 14.5-2, the overall risk related to Scenario 1 is predicted to be low.

14.6.2 Bounding Scenario 2 – Vehicle Accident and Aquatic Release of Fuel and Hazardous Chemicals

14.6.2.1 Scenario Description

Bounding Scenario 2 is similar to Bounding Scenario 1 except it potentially results in the release of fuels or chemicals (e.g., diesel, gasoline, propane, hydrogen peroxide, sulphuric acid, or sodium hydroxide) at the bridge over the Wheeler River. As with Scenario 1, this location was also the focus the evaluation as it represents an important location to resource users in the study area but the results of the analysis presented can generally be applied more broadly to water crossings along the transport route from an overall risk perspective.

Information regarding the fuels and chemicals that may be transported to the Project site is summarized in Table 14.6-8.

It was conservatively assumed that a volume equivalent to the entire cargo of a shipment would be released during an event. Based on available Project information, the following was assumed:

- **Diesel and Jet Fuel A (30 m^3 or 30,000 L release):** The released diesel would form a sheen on top of the water with a thickness of approximately 1 µm. While as much as 15% of the diesel would dissolve in the water column (NOAA 2006), up to 30% would evaporate from the surface of the water (Silver and Mackay 1984). The rest of the fuel, which consists of predominantly heavier components, would stay afloat or be adsorbed into shallow sediments along the riverbank and downstream near-shore lake areas.
- **Gasoline (30 m^3 release):** The released gasoline would form a sheen on top of the water with a thickness of approximately 1 µm. While as much as 25% of the gasoline would dissolve in the water column (NOAA 2006), up to 70% would evaporate from the surface of the water (Silver and Mackay 1984). The rest of the fuel, which consists of predominantly heavier components, would stay afloat or be adsorbed into shallow sediments along the riverbank and downstream near-shore lake areas.
- **Propane (41.58 m^3 or 11,000 gal release):** The released propane would evaporate quickly and be released to the atmosphere with no measurable residue.
- **Sulphuric acid (25 m^3 release):** The released sulphuric acid would be completely dissolved in water, resulting in low pH in affected waterbodies. It was assumed that the entire volume of sulphuric acid would mix with water.
- **Sodium hydroxide (25 m^3 release):** The released sodium hydroxide would be completely dissolved in water, resulting in high pH in affected waterbodies. It was assumed that the entire volume of sodium hydroxide would mix with water.
- **Hydrogen peroxide (approximately 18 m^3 release):** Hydrogen peroxide and water are miscible liquids. Upon release, the entire volume of hydrogen peroxide would mix with water.

Table 14.6-8: Chemicals Transported to the Site

Item	Annual Consumption (m^3)	Truck Travel per Year
Diesel	7,991	266
Jet A Fuel	195	10
Gasoline	163	6
Propane	4,740	114
Sulphuric acid	15,417	617
Sodium hydroxide 50%	21	1
Hydrogen peroxide 70%	0.97 to 1.61	216
Total	-	**1,220**

14.6.2.2 Design and Mitigation Considerations

Principal traffic risk mitigation measures include:

- traffic control measures such as speed limits;
- travel management plans;
- spill and emergency response planning; and
- driver training.

14.6.2.3 Evaluation of Probability

The annual probability of traffic accidents involving fuel or chemicals along Highway 914 and in the vicinity of the Wheeler River crossing (i.e., considering a 40 m buffer at each side of the bridge, total of 40 + 40 + 20 = 100 m = 0.1 km), assuming 1,220 trips per year for 330 days per year, was estimated as:

for release to water: $1,220 \times 1.75 \times 0.1 / 1,000,000 = 2.14 \times 10^{-03}$

The above probabilities were calculated using SGI statistics for Highway 914.

According to the probability ratings described in Section 14.5.2, the probability that this accident and malfunction scenario may occur is predicted to be unlikely.

14.6.2.4 Evaluation of Consequence

For the purpose of assessing the potential effects on the aquatic environment from a release of fuels and hazardous chemicals the release of diesel fuel was chosen as a representative scenario, rather than other chemicals, such as acids and bases. The release of organic compounds (such as diesel) would have the potential for downstream transport as a compound in liquid phase distinct from that of the water in the receiving environment with potential contamination occurring over a relatively large spatial extent and timespan. In contrast, the release of acids and bases would dissolve in water relatively quickly and effects on local biota would be expected on a more local basis and over a shorter timeframe.

Amongst the fuels considered for this scenario, the consequences of the release of gasoline and solvents are bounded by the consequences associated with the release of diesel. Both gasoline and solvents are lighter with higher vapour pressure; therefore, they have a shorter half life in the aquatic environment and a lesser tendency for adsorption to sediments and suspended solids in the water column.

Diesel is considered a non-persistent oil as it will lose 40% of its volume due to evaporation within 48 hours of an accidental release, even in cold weather. Small diesel spills (i.e., 2 to 20 m^3) will usually evaporate and disperse within a day or less in the aquatic environment; therefore, there is seldom any oil left on the surface for responders to recover (NOAA 2020). With a specific gravity between 0.82 and 0.88, diesel is much lighter than water, so it is not possible for diesel to sink and accumulate on the seafloor as pooled or free oil unless adsorption occurs with sediment. Diesel dispersed in the water column can adhere to fine-grained suspended sediments that can then settle out and get deposited on the seafloor. This process is more likely to occur near river mouths where fine-grained sediment is carried in by rivers. This process is not likely to result in measurable sediment contamination for small spills (NOAA 2020). The residual diesel is completely degraded within one to two months; therefore, surface water clean up for small-scale diesel spills is not likely feasible.

Nevertheless, the unplanned release of diesel still poses a threat to aquatic organisms, particularly birds if they are exposed. Fish, aquatic invertebrates, and aquatic vegetation that come in direct contact with a diesel spill may be killed. However, small spills in open water are so rapidly diluted that fish kills are unlikely events unless the spill is in confined, shallow water. Diesel spills can affect water-associated birds by direct contact. Mortality is caused by ingestion during preening.

The theoretical maximum size of a 1 µm diesel sheen that can be created by a 30 m^3 spill is $3 \times 10^{+07}$ m^2; however, due to evaporation and dissolution of most of the spilled diesel, the size of the affected area is much smaller, particularly in a slow-moving surface waterbody. The average water flow rate in the Icelander River at station SA-5 is approximately 0.917 m^3/s. When considering the width of the river (i.e., 10 m) and the depth of less than 1 m, the average water velocity is less than 9 cm/s. The spill would quickly reach downstream waterbodies (i.e., an unnamed lake and Whitefish Lake) where the water velocity would dramatically decrease. At this point, a spill would travel less than 1 km a day. Considering the lifetime of diesel, the diesel sheen would not travel beyond 2 km from the bridge on the access road. Thus, the affected area would be limited to areas downstream to Whitefish Lake. McGowan Lake, to the south of Whitefish Lake, would not be affected in the long term (beyond two or three days). The effects under this scenario would be transient, and some adverse effects on aquatic biota and birds may be expected; however, irreversible population level effects are not expected.

Based on this analysis, and in consideration of the consequence scale described in Section 14.5.2, the severity of the consequences of this accident and malfunction scenario are expected to be moderate.

14.6.2.5 Evaluation of Risk

In consideration of both probability and consequence, and based on the risk matrix described in Figure 14.5-2, the overall risk related to Scenario 2 is predicted to be low.

14.6.3 Bounding Scenario 3 – Loss of Freeze Capacity

14.6.3.1 Scenario Description

The freeze wall is expected to be several metres thick as it is developed around the uranium deposit. The freeze wall provides full secondary containment of mining fluids within the mining zone and no fluids will be able to migrate across this barrier to the surrounding groundwater environment. Primary containment of mining fluids is achieved by the control of the mining solutions through an inward hydraulic gradient created by the recovery wells pumps.

If freezing capacity is lost, the freeze wall would eventually thaw and secondary containment would be lost. If this occurs, the mining fluids could migrate into the local groundwater environment and cause contamination. The scale of contamination is difficult to predict as there are large uncertainties associated with the amount of mining fluid that would migrate, the hydraulic conductivity of the thawed freeze wall, the static head, and other geological factors.

The freeze wall will require 14 months to be established. The freeze wall will be in place throughout Operation. After Decommissioning, once the refrigeration is turned off, it will take a minimum of one year for the freeze wall to thaw depending on how long the freeze wall was active and actual ground conditions encountered. This freeze and thaw time frame is very large compared to the time required to repair and establish the freeze capacity. Interruption of the freeze capacity due to mechanical failure of the freeze plant is not perceived to be a major concern, as there is low risk that such an event would result in the migration of mining fluids beyond secondary containment. For reference, intermittent artificial ground freezing has been shown to effectively maintain desired structural stability, and hydraulic sealing while also provide a significant operational energy savings (Alzoubi et al. 2017). Intermittent freezing can be used as an analogue to temporary loss of freezing capacity and provides confirmation that temporary loss of freezing capacity would not likely present a substantial environmental concern.

14.6.3.2 Design and Mitigation Considerations

The freeze wall provides full secondary containment of mining fluids within the mining zone and no fluids will be able to migrate across this barrier to the surrounding groundwater environment. Primary containment of mining fluids is achieved by the control of the mining solutions through inward hydraulic gradient created by the recovery wells pumps.

14.6.3.3 Evaluation of Probability

In Section 14.6.3.1 it was argued that a loss of freeze capacity resulting in freeze wall failure and the subsequent release of mining fluids from the mining theatre into the local/regional groundwater environment was very unlikely. Accordingly, and based on professional judgement, a nominal value of $1x10^{-7}$ was assigned as the annual probability of this scenario.

According to the probability ratings described in Section 14.5.2, the probability that this accident and malfunction scenario may occur is predicted to be highly unlikely.

14.6.3.4 Evaluation of Consequence

In Section 14.6.3.3 it was predicted that the probability of groundwater contamination due to the loss of freeze capacity is highly unlikely. In a very unlikely case of groundwater contamination, establishing an exposure pathway from deep contaminated groundwater to a surface waterbody is associated with large uncertainty. In addition, fate and transport of mine fluids cannot be easily quantified. However, it is recognized that, in a very unlikely case of contamination, remediation at the depth of the mining horizon would be very difficult and the spread of contamination could potentially result in effects that could be characterized as major as per the consequence scale described in Section 14.5.2. Accordingly, Denison has put great effort into making sure the structural stability of the freeze wall is maintained, and that the freeze plant is maintained in good working order.

14.6.3.5 Evaluation of Risk

In consideration of both probability and consequence, and based on the risk matrix described in Figure 14.5-2, the overall risk related to Scenario 3 is predicted to be moderate.

14.6.4 Bounding Scenario 4 – Failure of the Freeze Wall

14.6.4.1 Scenario Description

In this scenario, the structural stability and hydraulic sealing of the freeze wall are compromised in their entirety. It is envisioned that such a scenario could result due to earth movement during major events such as earthquakes. Events such as surficial landslides and/or floods are not expected to cause damage to the freeze wall due to its full depth (approximately 350 m below surface). The subsistence or response of rock mass to loss of volume at the mining area as uranium ore is removed could result in localized effects. The 3D strip numerical model predicted that stresses and displacements did not show instability in the altered sandstone or basement rock at the location where a freeze wall would be placed around the Phoenix Deposit boundary (RESPEC 2021).

In the case of a complete failure of the freeze wall, groundwater and mining fluids within the mining theatre could migrate beyond the compromised section of the freeze wall. This migration process is likely to be very slow. The low temperature of the formation in and around the compromised section of the freeze wall would most likely cause the fluids to freeze and seal or partially seal the opening, further reducing the rate of contamination. The scale of any migration and resulting contamination of the local groundwater environment are difficult to predict as there are large uncertainties associated with the amount of mining fluid that would migrate, the hydraulic conductivity of the thawed freeze wall, the static head, and other hydrogeological/geological factors.

Shallow crevasses can form during earthquake-induced landslides or lateral spreads, or from other types of ground failures. However, faults do not open up during an earthquake and surficial cracks, which are the result of surficial land settlement, are not likely of the depth (USGS 2021) that would pose a risk relative to the mining fluid. Moreover, shallow geological deformities such as crevasses and cracks are typically associated with earthquakes of large magnitudes (6+). Such magnitude earthquakes have not occurred within the past 500 years in the vicinity of the Project site.

14.6.4.2 Design and Mitigation Considerations

The freeze wall provides full secondary containment of mining fluids within the mining zone and no fluids will be able to migrate across this barrier to the surrounding groundwater environment. Primary containment of mining fluids is achieved by the control of the mining solutions through inward hydraulic gradient created by the recovery wells pumps.

14.6.4.3 Evaluation of Probability

In Section 14.6.4.1 it was noted that a large magnitude earthquake could have the potential to damage the freeze wall and result in the release of mining fluids from the mining theatre into the local/regional groundwater environment. A review of seismicity at the Project site (see Section 15 Effects of the Environment on the Project) indicated that the probability of occurrence of a large magnitude earthquake is very unlikely and is less than 10^{-4} per year.

According to the probability ratings described in Section 14.5.2, the probability that this accident and malfunction scenario may occur is predicted to be highly unlikely.

14.6.4.4 Evaluation of Consequence

In Section 14.6.4.1 it was noted that a failure of the freeze wall would only be possible due to a large magnitude (6+) earthquake, which is a very low probability event at the Project site. In addition, it was discussed that a small fracture in the freeze wall may be sealed due to freezing of the intruding groundwater or mining fluid. In this case, only a small amount of contaminated fluid may leave the mining horizon. Similar to the previous scenario, establishing an exposure pathway from deep contaminated groundwater to a surface waterbody is associated with large uncertainty. In addition, the fate and transport of mine fluids cannot be easily quantified. It was also noted that groundwater monitoring and freeze wall thickness monitoring would help detect the loss of freeze capacity. In the very unlikely event of freeze wall failure, mitigation measures, including pumping both within the freeze wall and outside the freeze wall, could be employed. However, it is recognized that, in a very unlikely case of contamination, remediation at the depth of the mining horizon would be very difficult and the spread of contamination could potentially result in effects that could be characterized as major as per the consequence scale described in Section 14.5.2.

14.6.4.5 Evaluation of Risk

In consideration of both probability and consequence, and based on the risk matrix described in Figure 14.5-2, the overall risk related to Scenario 4 is predicted to be moderate.

14.6.5 Bounding Scenario 5 – Process Vessel and Piping System Failure

14.6.5.1 Scenario Description

Large quantities of radon gas can be dissolved in the lixiviant (mining solution) returning from the mining horizon to the surface. The portion of the total dissolved radon in lixiviant, which is above the solution's saturation value, is released when encountering atmospheric pressures and temperatures (Brown 2008). To prevent the release of radon to the working environment, atmospheric tanks and vessels are covered and maintained at negative pressure via ventilation systems. Under normal operating conditions, radon is vented from the processing building to the atmosphere through a stack at an appropriate height to maximize dispersion and minimize potential exposures at the ground surface. If the piping system or vessels fail, such as the thickener tanks, the dissolved radon is released inside the processing plant.

This accident scenario assumes a vessel or pipe leak that releases a portion of the thickener inside the processing building. In 2009, the US Nuclear Regulatory Commission (NRC) issued *Generic Environmental Impact Statement (GEIS) for In-Situ Leach Uranium Milling Facilities* (US NRC 2009). In the GEIS, the potential environmental effects from the postulated accidents involving the operation of in situ recovery facilities located in four geographic regions of the western United States were assessed. One of the scenarios assessed involved the release of radon from failed or leaked thickener. The assessment assumed 20% of the contents of the thickener was released inside the processing building (US NRC 2009). Typical radon concentrations in circulating lixiviant range from 300 to 7,000 Bq/L (Brown 2008). The GEIS used a concentration of approximately 4,000 Bq/L for its assessment.

Denison is planning to include a radon purge tank downstream of the well field where most of the radon in the lixiviant will be released. The activity concentration of radon in the solution downstream of the purge tank before entering the processing building is estimated at 3,700 to 7,400 Bq/L. This concentration range is consistent with the concentrations used by the GEIS.

It should be noted that despite potentially large quantities of radon gas being emitted, it is fresh radon and the progeny equilibrium factors are typically quite low. Most of the radon gas will be released within the first few process areas, wherever first exposed to atmospheric pressure.

The capacity of the thickeners for the Project is 800 m^3. Assuming a release equivalent to 20% of the contents of the thickener and a radon concertation of 4,000 Bq/L, the amount of radon released inside the processing plant would be:

$$800 \text{ m}^3 \times 0.2 \times 4{,}000 \text{ Bq/L} \times 1{,}000 \text{ l/m}^3 = 6.4 \times 10^8 \text{ Bq.}$$

14.6.5.2 Design and Mitigation Considerations

The following principal mitigation measures would be in place to reduce the probability of a release from the process piping and vessels:

- visual inspections;
- regular and preventive inspection, testing, and maintenance programs;
- personnel training and orientation;
- development and implementation of the Occupational Health and Safety Program, including specific plans, procedures and PPE;
- emergency response planning;
- building ventilation;
- full containment of the processing plant; and
- ambient monitoring.

For reference, the engineering design controls identified as mitigating measures above will be included in the detailed design and will be provided for acceptance by the CNSC during Project licensing.

14.6.5.3 Evaluation of Probability

A spill of uranium-bearing solution and subsequent release of radon gas from the released solution could occur as a result of the following events:

- an overflow of the storage or process vessels and thickener;
- a leaks or rupture in thickener;
- a failure of valves or other piping system components;
- a failure of the pumps; and
- a failure of other process components such as screens and filters.

Average probabilities of failures for different components in the solvent extraction unit were based on information provided by the Center for Chemical Process Safety of the American Institute of Chemical Engineers and are shown in Table 14.6-9.

Table 14.6-9: Average Failure Probabilities for Solvent Extraction Process Equipment

Equipment with Potential for a Major Spill or Fire	Failure Rate (all modes; per year)
Vessels (i.e., atmospheric and metallic; assuming two thickeners containing uranium rich solvents)	10^{-3}
Piping (i.e., metal; straight section and connection; (assuming 100 sections)	10^{-4} per item
Pumps (e.g., motor driver and pressure centrifugal; assuming two pumps)	10^{-2}

Source: Center for Chemical Process Safety (AIChE 1989).

If it is assumed that the plant would operate 8,250 hours per year, this would result in an annual failure probability of 3.2×10^{-2} under this scenario, as shown below:

$$10^{-3} \times 2 + 10^{-4} \times 100 + 10^{-2} \times 2 = 3.2 \times 10^{-2}$$

According to the probability ratings described in Section 14.5.2, the probability that this accident and malfunction scenario may occur is predicted to be likely.

14.6.5.4 Evaluation of Consequence

The assessment of an accidental release of uranium-rich solution in a processing plant was completed by US NRC (2009). The analysis considered source terms similar to the source terms calculated in Section 14.6.4. The analysis was conducted for several wind speeds, stability classes, release durations, and receptor distances. For receptor distances of 100 and 500 m, doses for the scenario were calculated to be less than 0.25 and 0.01 mSv, respectively (US NRC 2009). Both doses were less than 25% of the annual dose limit for the public of 1 mSv.

There could be external doses derived from the spill to workers exposed to the released radon, but offsite receptors further than 500 m would be too far away to experience any effects. The assessment also indicated that the dose to an unprotected worker inside the processing plant during a spill could exceed the 50 mSv dose limit specified by CNSC if the worker did not leave the area immediately after the spill. Denison would make sure that the design of the plant includes control measures to reduce exposure to workers and members of the public to levels of radiation that are as low as achievable. The control measures would work to make sure that the processing plant is adequately ventilated, and that spills or leaks are detected by a loss of system pressure, observation, or flow imbalance. Emergency response and spill response plans would include procedures for worker protection, details about personnel protection equipment, and procedures to evaluate exposures during a spill.

Based on this evaluation, and in consideration of the consequence scale described in Section 14.5.2, the severity of the consequences of this accident and malfunction scenario is predicted to be minor.

14.6.5.5 Evaluation of Risk

In consideration of both probability and consequence, and based on the risk matrix described in Figure 14.5-2, the overall risk related to Scenario 5 is predicted to be low.

14.6.6 Bounding Scenario 6 – Facility Fire and/or Explosion

14.6.6.1 Scenario Description

This scenario involves a fire and/or explosion within the processing plant. The most credible event with potential for release of radioactivity is the explosion of the uranium concentrate dryer. A fire or explosion that originates from the dryer could potentially release a large amount of uranium to the atmosphere.

For reference it is acknowledged that this accident scenario could result in significant worker injuries and/or fatalities and therefore, this scenario was rated as “catastrophic” from a consequence perspective in the hazard identification screening evaluation (see Appendix 14-A). The more detailed evaluation of the scenario, as presented herein as Bounding Scenario 6 focuses on the release of uranium to the atmosphere. Protections afforded to workers in the processing plant are assumed to be ALARP and therefore from this perspective there is no further analysis specific to a potential worker fatality that could be considered further within the assessment.

14.6.6.1.1 Release Characterization

The quantification of uranium release from the uranium concentrate dryer followed the widely accepted methodology proposed by the United States Department of Energy (US DOE) to estimate source terms (US DOE 1994).

According to the US DOE, the airborne source term is typically estimated by the following five-component linear equation:

Source term = MAR × DR × ARF × RF × LPF

where:

- **MAR = material at risk**, which is the amount of chemical or radionuclide available to be acted on by a given physical stress. For facilities, processes, and activities, the MAR is a value representing some maximum quantity of chemical present or reasonably anticipated for the process or structure being analyzed.
- **DR = damage ratio**, which is the fraction of the MAR affected by the initiating event(s) (i.e., accident-generated conditions). The DR is estimated based on an engineering analysis of the response of structural materials and materials of construction for containment to the type and level of stress or force generated by the event. These estimates often include a degree of conservatism due to simplification of phenomena to obtain a useable model.
- **ARF = airborne release fraction** (or airborne release rate for continuous release), which is the coefficient used to estimate the amount of a chemical released or suspended in air as an aerosol or gas, and thus available for transport due to physical stresses from a specific accident.
- **RF = respirable fraction** is the fraction of airborne chemical particles that can be transported through air and inhaled into the human respiratory system. The RF is commonly assumed to include particles of 10 µm aerodynamic equivalent diameter or less. Other definitions of ‘respirable particles’ have been presented by various groups at different times, but for the purpose of this assessment, 10 µm and smaller particles were considered respirable. For gaseous chemicals, the RF is 1.
- **LPF = leak path factor**, which is the fraction of the chemical or radionuclide transported through some confinement deposition or filtration mechanism. There can be many LPFs for some accident conditions (e.g., the fraction transported from the package, such as a shipping

container, to the enclosure; the fraction leaked from the enclosure to the operating area around the enclosure or room; or the fraction leaked from the room to the building-atmosphere interface).

Background information on source term parameters for Scenario 6 is summarized in the following bullets.

- The MAR would be the content of the dryer, which was estimated at 2,000 kg of uranium concentrate.
- An explosion within the dryer could potentially affect the entire content of the dryer; therefore, the DR was assumed to be 1.
- The US DOE suggests a value of 7.6×10^{-2} for the ARF for unshielded blast effects from detonations and large volume, confined deflagrations (US DOE 1994).
- The US DOE suggests a value of 0.14 for the RF for unshielded blast effects from detonations and large volume, confined deflagrations (US DOE 1994).
- Since the postulated accident scenario involves an explosion inside the dryer, much of the uranium concentrate would be trapped inside the damaged dryer. It was assumed that 90% of the content of the dryer would be trapped; therefore, the LPF would be 0.1.

Based on these assumptions, the scenario source term was calculated as:

$$2{,}000 \times 1 \times 7.6 \times 10^{-2} \times 0.14 \times 0.1 = 2 \text{ kg of uranium concentrate.}$$

It should be noted that this estimated value is based on several assumptions involving the content of uranium concentrate within the dryer and the LPF for the explosion inside the dryer. In the GEIS (US NRC 2009), the potential environmental effects for a postulated dryer explosion were assessed. This assessment used several conservative assumptions and estimated the source term for a dryer explosion at 1 kg of uranium concentrate.

14.6.6.2 Design and Mitigation Considerations

Denison would make sure that the design of the plant includes control measures to reduce exposure levels to workers and members of the public to levels that are as low as achievable. The control measures would work to make sure that the processing plant is adequately ventilated. Emergency response and spill response plans would include procedures for worker protection, details about personnel protection equipment (particularly respiratory equipment), and procedures to evaluate exposures during a release of uranium powder. In addition, the following is noted with respect to mitigation:

- implementation of regular and preventive inspection, testing, and maintenance programs;
- implementation of personnel training and orientation;

- development and implementation of the Occupational Health and Safety Program, including specific plans, procedures, and PPE;
- implementation of fire safety plan and firefighting systems; and
- ambient monitoring.

For reference, the engineering design controls identified as mitigating measures above will be included in the detailed design and will be provided for acceptance by the CNSC during Project licensing.

14.6.6.3 Evaluation of Probability

The average annual probability of the occurrence of a furnace explosion, which is used as an analogue for Scenario 6, is 4 x 10^{-4}, as provided by the Center for Chemical Process Safety of the American Institute of Chemical Engineers (AIChE 1989).

According to the probability ratings described in Section 14.5.2, the probability that this accident and malfunction scenario may occur is predicted to be highly unlikely.

14.6.6.4 Evaluation of Consequence

The assessment of an accidental release of uranium powder in a processing plant due to a dryer explosion was completed by US NRC (2009). The US NRC analysis considered source terms similar to the source terms calculated in Section 14.6.6.1.1. In the case of the Project and for a release amount of 1 kg inside the processing plant, the dose to offsite receptors at 200 m from the Project site was calculated to be less than the CNSC public dose limit of 1 mSv. The analysis also indicated that the dose to a worker in a full-face-piece powered air-purifying respirator who stays in the area would be 88 mSv, which exceeds the annual worker dose limit of 50 mSv.

Denison would make sure that the design of the plant includes control measures to reduce exposure levels to workers and members of the public to levels that are as low as achievable. The control measures would work to make sure that the processing plant is adequately ventilated. Emergency response and spill response plans would include procedures for worker protection, details about personnel protection equipment (particularly respiratory equipment), and procedures to evaluate exposures during a release of uranium powder.

In the unlikely event of an unmitigated accidental release of uranium due to a dryer explosion, doses to the workers are expected to have a moderate effect, while doses to members of the public are expected to have a minor effect.

Based on this evaluation, and in consideration of the consequence scale described in Section 14.5.2, the severity of the consequences of this accident and malfunction scenario is predicted to be moderate.

14.6.6.5 Evaluation of Risk

In consideration of both probability and consequence, and based on the risk matrix described in Figure 14.5-2, the overall risk related to Scenario 6 is predicted to be low.

14.6.7 Bounding Scenario 7 – Vehicle Accident and Terrestrial Release of Radioactivity and Chemicals

14.6.7.1 Scenario Description

Bounding Scenario 7 is similar to Bounding Scenarios 1 and 2, comprising a release of hazardous materials. However, this release is postulated to occur at an off-site location, with the release occurring to ground, not water.

Based on engagement with Interested Parties, two release locations were used to provide context for this scenario. Generically, the releases at the two locations can be treated in a similar fashion as the probability and consequence are expected to be the same. The first location is at kilometre 160 of Highway 914, which is the location of a cultural camp established by the English River First Nations. The second location is at kilometre 67 of Highway 914, which is a gathering location for the Kineepik Metis Local associated with the Northern Village of Pinehouse. The locations of these camps are shown on Figure 14.6-5.

For reference and as described in Section 14.6.2 for a vehicle accident and subsequent release of hazardous materials, it was conservatively assumed that a volume equivalent to the entire cargo of a shipment would be released during an event. The information related to the fuel and chemicals transported to the Project site is summarized in Table 14.6-8. Based on available Project information, the following are representative plausible hazardous material release events:

- diesel and jet fuel A (30 m^3 or 30,000 L release);
- gasoline (30 m^3 release);
- propane (11,000 gallons or 41.58 m^3 release);
- sulphuric acid (25 m^3 release);
- sodium hydroxide (25 m^3 release); and
- hydrogen peroxide (~18 m^3 release).

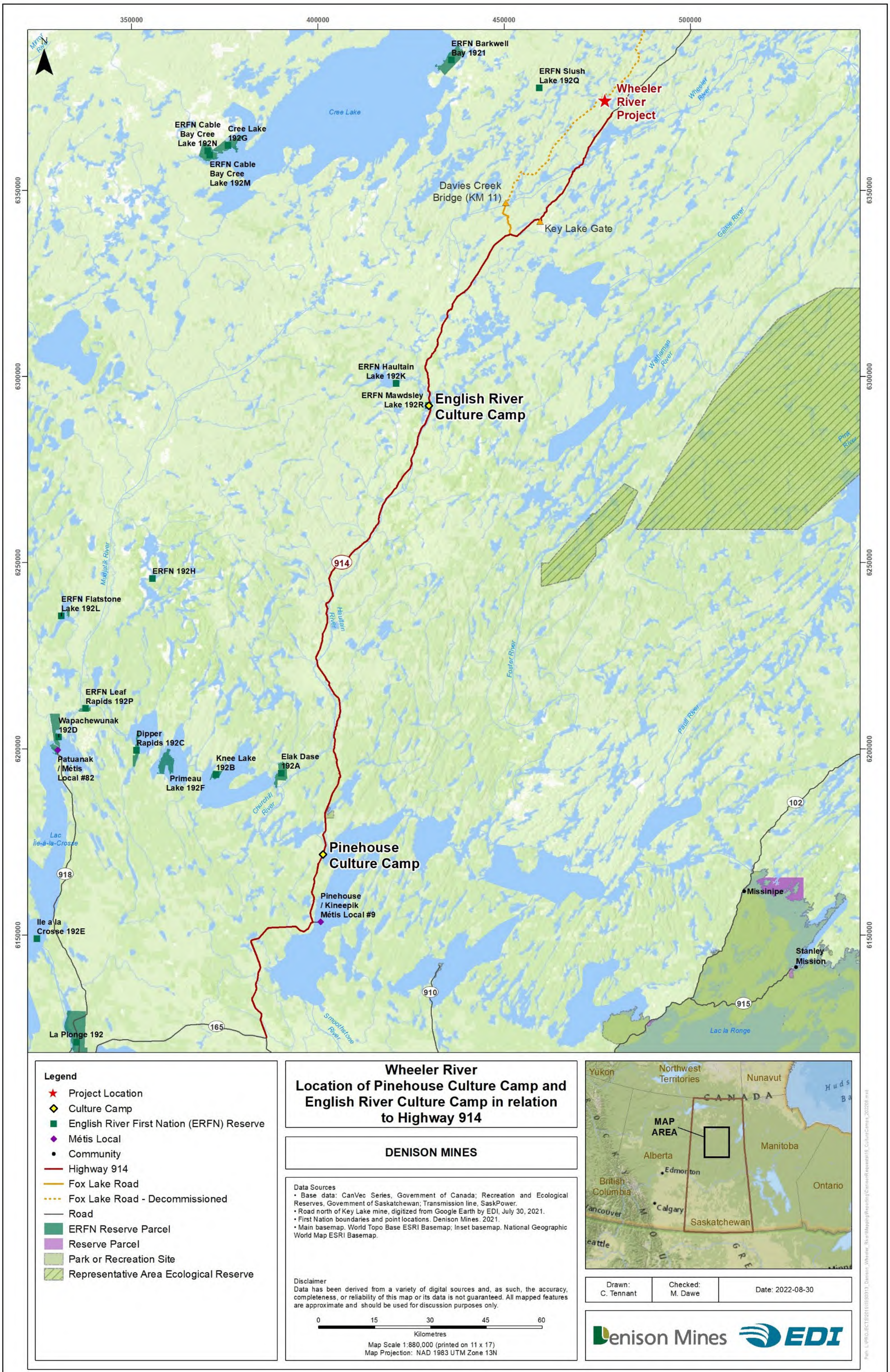


Figure 14.6-5: Location of Terrestrial Release Along Highway 914

14.6.7.2 Design and Mitigation Considerations

Principal traffic risk mitigation measures include:

- traffic control measures such as speed limits;
- travel management plans;
- spill and emergency response planning; and
- driver training.

Additionally, Denison considered several provisions to make sure that the effects of a terrestrial release of hazardous materials are as low as practicable. In addition to transportation mitigations listed for Scenarios 1 and 2, the following provisions were considered.

- The *Transportation of Dangerous Goods Act, 1992* (Government of Canada 2019) outlines the requirements for entities that transport dangerous goods to establish emergency response assistance plans. These plans list specialized personnel and equipment that are required for responding to an incident. It is expected that a contractor responsible for the transportation of uranium concentrate, fuel, and hazardous chemicals would develop these plans. While a contractor could assist Denison with developing emergency response assistance plans, it is Denison's responsibility to apply to Transport Canada for approval of the plans.
- CANUTEC, the Canadian Transport Emergency Centre operated by the Transportation of Dangerous Goods Directorate of Transport Canada, serves as a national advisory service that assists emergency response personnel in handling dangerous goods emergencies on a 24/7 basis.
- Limiting wildlife access to spill locations.
- Cleaning up spills immediately to a pre-determined level.
- Preventing runoff and release to surface water.
- Preventing penetration to groundwater.

It is also noted that Highway 914 (as well as Highway 165, that is also along the Project transport route) is a gravel highway that receives regular year-round maintenance, including grading, dust suppression and snow removal in the winter. Highway 914 also has seasonal posted speed limits and weight restrictions. These factors were also considered within the context of the evaluation of this bounding scenario.

14.6.7.3 Evaluation of Probability

Traffic risk mitigation measures for Scenario 7 are the same as those presented for Scenarios 1 and 2. The annual probability of traffic accidents involving radioactivity, fuels, or chemicals along Highway 914 within 1 km of the designated locations, assuming 1,220 trips per year for fuel and chemicals and 330 days per year for uranium, was estimated as:

$$(1{,}220 + 330) \times 1.75 \times 1 / 1{,}000{,}000 = 2.71 \times 10^{-03}$$

These probabilities were calculated using SGI statistics for Highway 914.

According to the probability ratings described in Section 14.5.2, the probability that this accident and malfunction scenario may occur is predicted to be unlikely.

14.6.7.4 Evaluation of Consequence

Compared to a release to surface water, terrestrial releases of hazardous materials are easier to manage due to lower mobility of released materials in soil (and potentially groundwater). By way of example, a hypothetical diesel fuel release to ground can be used to demonstrate potential consequence of a hazardous material spill.

In a series of experiments during a study contracted by the USDOE, Simmons and Keller (2005) showed that the penetration rate of spilled liquid into soil depends on many factors, including slope, soil permeability, soil wettability, surface roughness, and initial moisture content of soil. In this study, experimental results were fitted into the Green-Ampt model (Simmons and Keller 2005). The results showed that, for most cases, the penetration rates ranged from 0.07 centimetres per second (cm/s) to 0.1 cm/s for silt loam and sandy soils (air porosity of 30% to 45%) with slopes of 2.4% and 4.8%. In most experiments, the final moisture content of 60% was reached after the front head of the spills disappeared. Given that the porosity of the areas around the transportation route are likely to be greater in consideration of regional soil conditions, this penetration rate of 0.1 cm/s is expected to be a conservative value for this assessment. At this penetration rate, a pool of released liquid with a depth of 30 cm would have penetrated the ground surface in 300 s (i.e., 5 minutes).

Assuming that the liquid content of the soil (water + diesel) increases from 20% to 60% for the maximum diesel release of 30 m^3, approximately 75 m^3 of the soil could be contaminated, as calculated below:

- 60% – 20% = 40% of additional liquid; and
- 30 m^3 / 0.4 = 75 m^3 of soil.

If the soil is completely saturated following the spill (from 20% to 100% liquid content), for the maximum diesel release of 30 m3, 37.5 m3 of the soil could be contaminated:

- 100% – 20% = 80% of additional liquid; and
- 30 m^3 / 0.8 = 37.5 m^3 of soil.

Based on the above discussion on water penetration rate, a conservative penetration time of 15 min was made. Based on this assumption, the maximum depth of contamination could be 90 cm (for penetration rate of 0.1 cm/s):

- depth = 900 s × 0.1 cm/s = 90 cm = 0.9 m.

For the penetration rate of 0.07 cm/s over 15 min, the depth of contamination could be 63 cm:

- depth = 900 s × 0.07 cm/s = 63 cm = 0.63 m.

The surface area affected by the spill can be calculated as follows:

- area = 75 m^3 / 0.9 m= 83 m^2, (60% saturation and depth of 0.9 m);
- area = 37.5 m^3 / 0.63 m = 60 m^2, (100% saturation and depth of 0.63 m);
- area = 75 m^3 / 0.63 m = 119 m^2, (60% saturation and depth of 0.63 m); and
- area = 37.5 m^3 / 0.9 m = 42 m^2, (100% saturation and depth of 0.9 m).

From the above calculation, the size of affected area would range from about 42 m^2 to 119 m^2. Shallow groundwater flow is generally affected by local-scale topography, which is represented by level to gently rolling plains around the transportation route. There is a potential for groundwater contamination within the area of soil contamination.

The velocity of groundwater at this location can be calculated as follows:

- V= K × I/n, where V is groundwater velocity, K is horizontal hydraulic conductivity, I is the horizontal hydraulic gradient, and n is the effective porosity.

Assuming that porosity is 0.45, hydraulic conductivity ranges from 7 × 10-5 m/s to 1 × 10-7 m/s, and hydraulic gradient ranges from 0.02 to 0.1, a range of groundwater velocity can be calculated as follows:

- Vmax = 7 × 10-5 m/s × 0.1 / 0.45 = 1.5 × 10-5 m/s; and
- Vmin = 1 × 10-7 m/s × 0.02 / 0.45 = 4.4 × 10-9 m/s.

The wide range of the calculated velocities is a result of variation of soil conditions and the slope of the surface. Studies by Ledezma-Villanueva et al. (2015) and Berry and Burton (1997) show that residual contamination in soil and groundwater is degraded within 75 days. The distance that the groundwater can travel under these extreme (i.e., conservative) conditions ranges from 0.03 m to 100 m:

- Dmin = 1.5 * 10-5 m/s x 75 days x 24 x 3600 = ~100 m
- Dmax = 4.4*10-9 m/s x75 days x 24 x 3600 = ~0.03 m

As highlighted by the calculation, during this time period, no major migration of groundwater is expected. Thus, the contamination of soil and shallow groundwater is expected to be limited to a small area near the release location, given that release site remediation would occur well within the 75 day window.

During the cold season when the soil is frozen, no penetration of spilled material is expected. Therefore, no soil or groundwater contamination is expected. However, due to large spread of the released materials, the remediation is expected to take longer.

Based on the provisions in place and the analysis presented above and in consideration of the consequence scale described in Section 14.5.2, the severity of the consequences of this accident and malfunction scenario is predicted to be minor.

14.6.7.5 Evaluation of Risk

In consideration of both probability and consequence, and based on the risk matrix described in Figure 14.5-2, the overall risk related to Scenario 7 is predicted to be low.

14.7 Summary – Estimation of Overall Risk from Bounding Scenarios

The results of the risk assessment of the bounding accident and malfunction scenarios are summarized in Table 14.7-1. The results of this rigorous assessment predicted that the risk of the selected bounding scenarios is low to moderate. No high-risk scenarios were identified. The results combined the analysis of both the probability and consequence of the effects for each bounding scenario to identify an overall risk rating according to the risk ranking framework presented in Section 14.5.2. The difference between the risk ranking presented in Table 14.7-1 and the original risk screening process (Section 14.5.5) is that the risk ratings in Table 14.7-1 were assigned based on the quantitative assessment of the accident and malfunction scenarios.

The overall risk associated with vehicle accidents resulting in a release of radioactivity (Scenario 1) or hazardous materials (Scenario 2) to surface water, a failure of the process vessel and piping systems (Scenario 5), a facility fire or explosion (Scenario 6), and a vehicle accident resulting in a terrestrial release of radioactivity and chemicals (Scenario 7) was predicted to be low. The overall risk associated with a loss of freeze capacity and failure of the freeze wall (Scenarios 3 and 4) was predicted to be moderate; however, the scenarios were assessed as being highly unlikely from a probability perspective. Overall, low to moderate risk scenarios are deemed to represent a tolerable level of risk in consideration of proposed safeguards and design features that are expected to reduce the risk level to ALARP.

Table 14.7-1: Bounding Scenarios Identified for Further Assessment by the Hazard Identification Process

Potential Accident/ Malfunction	Potential Effect Pathway	Probability	Effect Severity	Overall Risk Rating[1]
Vehicle accident, including rollover, collision, run off road	Aquatic release of radioactivity	Highly unlikely	Moderate	Low
Vehicle accident, including rollover, collision, run off road	Aquatic release of fuel, hazardous chemicals, and reagents	Unlikely	Moderate	Low
Loss of freeze capacity	Loss of freeze wall and secondary underground containment	Highly unlikely	Major	Moderate

Potential Accident/ Malfunction	Potential Effect Pathway	Probability	Effect Severity	Overall Risk Rating[1]
Failure of freeze wall	Loss of secondary underground containment and groundwater contamination	Highly unlikely	Major	Moderate
Process vessel and piping system failure	Release of radon from storage tank	Likely	Minor	Low
Facility fire/ explosion	Release of radioactivity and uranium concentrate powder to atmosphere	Highly unlikely	Moderate	Low
Vehicle accident, including rollover, collision, run off road	Terrestrial release of radioactivity and chemicals	Unlikely	Minor	Low

1 Based on Figure 14.5-2.

14.8 Key Findings and Conclusions

The accidents and malfunctions assessment considered a range of plausible scenarios, outside of day-to-day operations, that could result in effects on human health and/or the biophysical environment. Environmental design features and mitigation measures that would be implemented to reduce such effects were considered.

From 69 potentially hazardous situations identified in an initial hazard identification for accidents and malfunctions, seven scenarios were carried forward for detailed analysis, including risk evaluation. Of these, five scenarios were determined to be low risk overall. The loss of freeze capacity and failure of the freeze wall scenarios were deemed to be of moderate risk; however, given the high unlikeliness of these two scenarios, this level of risk was deemed to be tolerable, and no further mitigation was deemed necessary.

Overall, based on the assessment of accidents and malfunctions presented herein, it is anticipated that potential effects could be addressed through engineering design and compliance with industry best practices that reduce risks associated with the hazard scenarios to ALARP. Based on this assessment, the risks may be characterized as tolerable.

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Appendix 14-A Assessment of Accidents and Malfunctions – Technical Supporting Document to the Wheeler River Project Environmental Impact Statement

See file “S14_App 14-A Accidents and Malfunctions TSD_Wheeler River_Updated_26092023.pdf”

Appendix 14-B Engagement Database Summary – Accidents and Malfunctions

See file “S14_App 14-B Accidents and Malfunctions Engagement_Wheeler River.pdf”

Denison Mines

Wheeler River Project

Final Environmental Impact Statement

November 2024

Powering
PEOPLE, PARTNERSHIPS AND PASSION.

Wheeler River Project

Final Environmental Impact Statement

Section 15 – Effects of the Environment on the Project

November 2024

Denison Mines

Denison Mines Corp.

345 4th Avenue South

Saskatoon, SK, S7K 1N3

Roadmap

This roadmap of the Wheeler River Project Environmental Impact Statement (EIS) has been provided to summarize the main document sections and appendices of the EIS.

Wheeler River Project
Environmental Impact Statement

Executive Summary

Part I: Introduction and Context	Part II: Biophysical Environmental Assessments	Part III: Human Environment Assessments	Part IV: Integrated Topics and Summary
Section 1: Project Introduction and Overview	Section 6: Atmospheric and Acoustic Environment	Section 10: Human Health	Section 14: Accidents and Malfunctions
Section 2: Project Description	Section 7: Geology and Groundwater	Section 11: Land and Resource Use	Section 15: Effects of the Environment on the Project
Section 3: Indigenous and Local Knowledge	Section 8: Aquatic Environment	Section 12: Quality of Life	Section 16: Assessment Summary and Conclusions
Section 4: Engagement	Section 9: Terrestrial Environment	Section 13: Economics	
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Abbreviations, Acronyms and Units

Abbreviation / Acronym	Definition
CNSC	Canadian Nuclear Safety Commission
Denison	Denison Mines Corp.
EA	Environment assessment
ECCC	Environment and Climate Change Canada
EIS	Environmental Impact Statement
GDD	Growing Degree Days
GHG	Greenhouse gas
IK	Indigenous Knowledge
IPCC	Intergovernmental Panel on Climate Change
NASA	National Aeronautics and Space Administration
NRCan	Natural Resources Canada
Project	Wheeler River Project
RCP	Representative concentration pathway
SPSA	Saskatchewan Public Safety Agency

Units	Definition
°C	degrees Celsius
%	percent
cm	centimetre
ha	hectare
km	kilometre
km^2	square kilometre
km/hr	kilometre per hour
mm	millimetre
m	metre
m^3	cubic metre

Glossary

Term	Definition
Climate	The typical, long-term weather pattern of a geographical location or area (usually, 30 years).
Climate Change	Refers to long-term shifts in temperatures and weather patterns and events.
Extreme weather	Short-term weather events that are at the outer limit of or beyond weather that typically occurs. Extreme weather can be associated with too little or too much rain (i.e., drought or floods, respectively), temperatures that are colder or hotter than typical, and/or winds that are stronger than normal.
Greenhouse Gas	A gas in the Earth's atmosphere that absorbs and emits infrared radiation. The most common examples include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).
Growing Degree Days (GDD)	Provide an index of the amount of heat available for the growth and maturation of plants and insects. The GDD represents the annual sum of the number of degrees Celsius that each day's mean temperature is above a specified base temperature (Tbase), such as 5°C.
Natural hazard	Environmental events with the potential to affect the human environment. Examples include floods or drought, forest fires, and seismic events.
Seismic event	An earthquake, or an earth vibration, that may be caused when energy is released in the Earth's crust due to shifting tectonic plates, or due to an explosion, landslide or other earth movement.

15 Effects of the Environment on the Project

Section 19 (1) (h) of the *Canadian Environmental Assessment Act*, *2012* (Government of Canada 2019) requires an environmental assessment (EA) to account for any change to a project that may be caused by the environment. Section 9.4.2 of the *Generic Guidelines for the Preparation of an Environmental Impact Statement – Pursuant to the Canadian Environmental Assessment Act, 2012* (CNSC 2021) also states:

> *"The EIS shall take into account how the environment could adversely affect the project and how this in turn could result in effects on the project….*
>
> *The applicant shall also take into account any potential effects of climate change on the project, including an assessment of whether the project might be sensitive to changes in climate conditions during its lifecycle.*
>
> *The EIS will provide details of planning, design and construction strategies intended to minimize the potential environmental effects of the environment on the project."*

The environmental setting has affected the design of the Wheeler River Project (the Project) and will likely affect its management over the life of the Project. Environmental components that have influenced the Project design (e.g., site selection, layout, and engineering) include the following:

- **Geology and Terrain**
  - The specific location of the Project, including the mine layout and infrastructure, was determined by the location of the ore body. Given this constraint, the goal for facility placement during Project design was to minimize cut and fill where reasonably practical, while maintaining safe, functional operation and traffic flow, and, at the same time, recognizing surface drainage patterns and clearances between facilities (Pozniak 2021). Details on geology and terrain can be found in Section 7 Geology and Groundwater and Section 9.1, respectively, of this Environmental Impact Statement (EIS).
- **Indigenous Knowledge (IK) – Land and Resource Use**
  - Indigenous Knowledge, received from English River First Nation and Pinehouse Kineepik Métis Local 9, has been incorporated into the design of baseline programs and the selection of valued components for this EA.
  - Knowledge from Indigenous community members was integral to informing the Project design and influenced the selection of the access road alignments, mining method, and proposed treated effluent discharge locations (Denison 2020).
  - Details on land and resource use can be found in Section 11 Land and Resource Use of this EIS.

- **Vegetation Communities and Wetlands**
  - The Project Area has been reduced to the extent practicable, keeping human safety in mind, to limit direct disturbance to vegetation communities and wetlands.
  - Much of the proposed Project Area will be developed within previously disturbed areas, including roads currently used for exploration activities, thereby minimizing habitat disturbance.
  - Details on vegetation communities and wetlands can be found in Section 9.2 of this EIS.
- **Fish and Fish Habitat**
  - Denison Mines Corp. (Denison) intends to recycle process water to the greatest extent possible, thereby reducing the demand for a fresh water supply. The proposed recycling process design incorporates a closed-loop system within which only limited make-up water is estimated to be required to supplement in situ recovery mining and on-site processing.
  - The design and installation of any in-water Project components, such as water crossings, a water intake, and a treated effluent discharge pipeline and release point, will incorporate measures to avoid causing harm to fish and fish habitat. Work near the shoreline of fish-bearing waterbodies will be avoided where possible and will follow best management practices, such as erosion and sediment control.
  - As a result of the focus on water recycling, the volume of treated effluent requiring discharge is expected to be low. The quality of effluent will meet regulatory limits designed to protect the aquatic environment.
  - Detailed information on fish and fish habitat can be found in Section 8.3 of this EIS.

Set within this context, the focus of this section of the EIS is the potential effects of natural hazards on the Project (i.e., seismic events, forest fires, extreme weather, and climate change). Reasonable scenarios based upon experience in the Athabasca Basin are considered. The predicted effects on the Project are described, activities sensitive to these potential effects are discussed, and mitigation, contingency plans, and design considerations are presented.

15.1 Approach to Identifying and Evaluating Potential Effects of the Environment on the Project

Several steps were taken to identify and evaluate potential effects of natural hazards on the Project, including:

- identifying and describing the existing environmental conditions related to natural hazards that may affect the Project;
- describing the implications that a natural hazard may have on the performance and environmental consequences of the Project; and

- selecting appropriate mitigation measures to address reasonable risks through the adaptive management process.

A natural hazard is considered to have a potential effect on the Project if it could result in one or more of the following:

- modification to the Project design;
- harm to Project personnel or the public;
- substantial delay in construction (i.e., more than one season);
- interruption in the mining process (i.e., more than one week);
- damage to Project infrastructure;
- threat to public safety; and/or
- damage to infrastructure to the extent that repair is not economically or technically feasible.

Natural hazards that either affected Project design or have the potential to affect Project Construction, Operation, and/or Decommissioning include the following:

- seismic events (e.g., earthquakes);
- forest fires;
- extreme weather (i.e., short-term events such as major precipitation events and drought, atypically high or low temperatures, or atypically high winds); and
- climate change (i.e., long-term changes).

Historical data and published literature were used to characterize the natural hazards that may affect the Project. Predictions were used to characterize potential changes associated with climate change.

Project design features and mitigation measures were described to inform how the potential effects of the environment on the Project would be prevented, minimized, or managed. This approach demonstrates Denison's due diligence in identifying the potential risks from the environment to assist with the planning, design, construction, operation, monitoring, and eventual decommissioning of the Project to reduce overall adverse effects. As part of this process, the existing environmental setting and potential environmental conditions and scenarios that may collectively affect the Project were considered so that suitable and practical mitigation measures could be evaluated and implemented during the various phases of the Project.

15.2 Seismic Events

15.2.1 Existing Environmental Conditions

Seismic activity could damage infrastructure and equipment, injure people, and interrupt Project activities. Community members have enquired about potential earthquakes (22-EN-ERFN-621.5).

According to Natural Resources Canada (NRCan), northern Saskatchewan, where the Project is located, is one of the least earthquake-prone areas in Canada, ranking as a low seismic hazard zone (Figure 15.2-1; NRCan 2021a). No earthquakes of magnitude 3 or over have been recorded in northern Saskatchewan to date (Figure 15.2-2; NRCan 2021b).

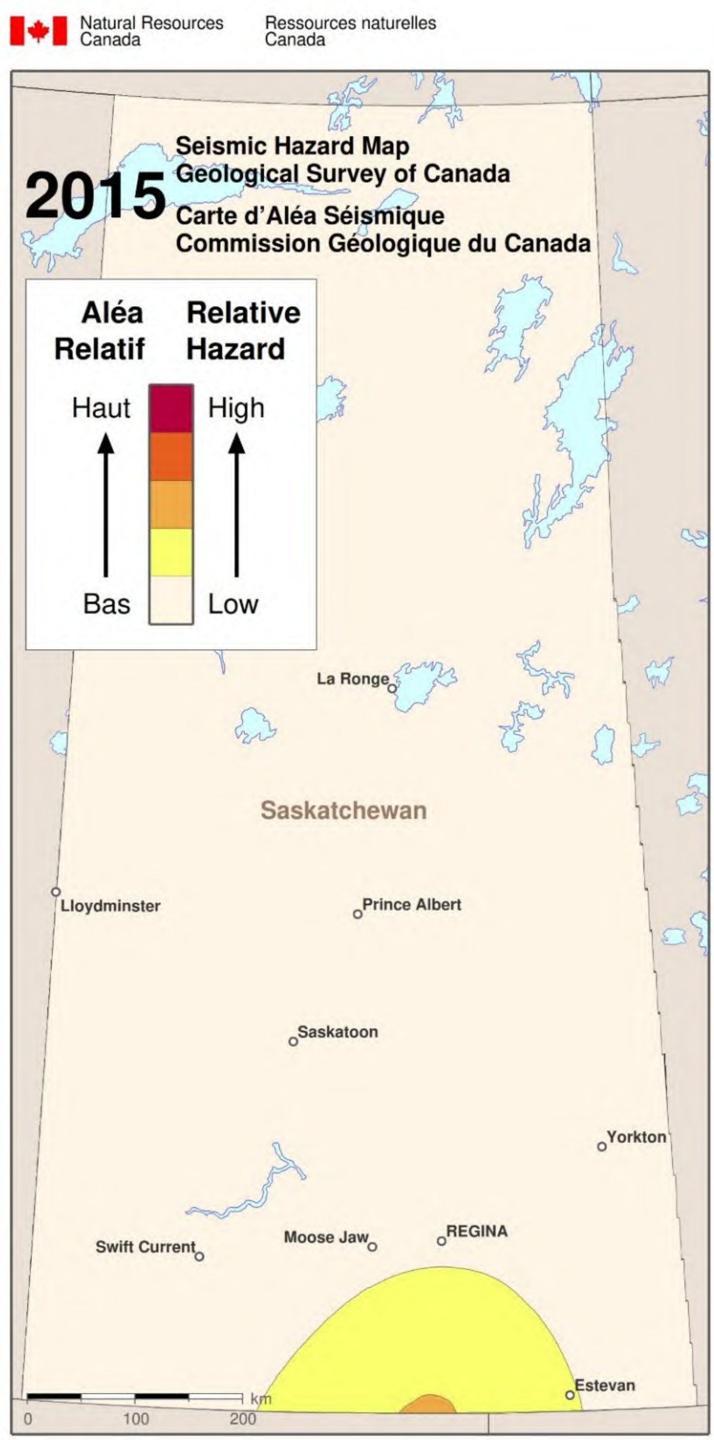


Figure 15.2-1: Seismic Hazard Map for Saskatchewan (NRCan 2021a)

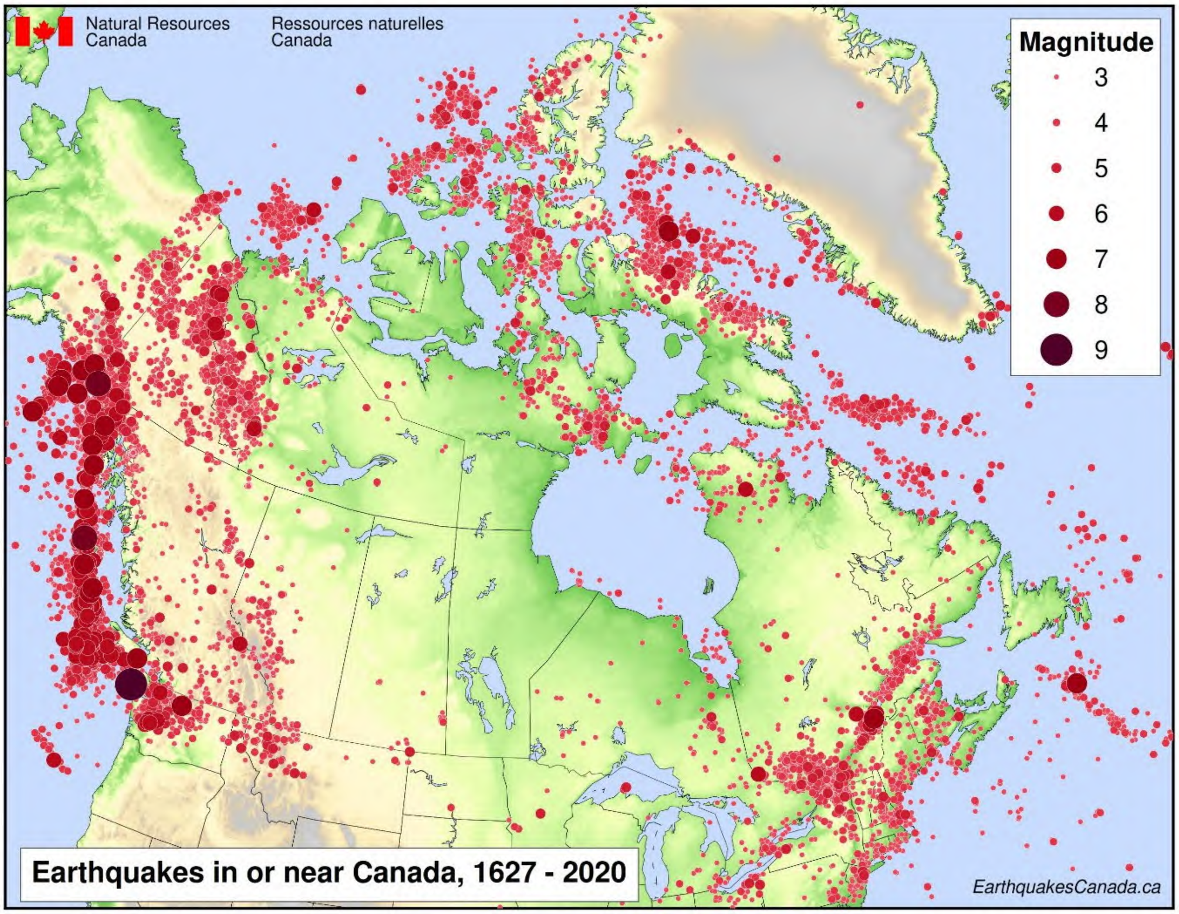


Figure 15.2-2: Earthquakes In or Near Canada, Magnitude 3 and Over, 1627 to 2020 (NRCan 2021b)

15.2.2 Effects on the Project

Because the Project is in a low seismic hazard zone, it is unlikely that a seismic event will occur. Denison will appropriately design buildings to meet the standards of the National Building Code of Canada (National Research Council of Canada 2015). This code uses earthquake probabilities and the nature of the ground motion most likely to occur at a site to determine structural design criteria. These infrastructure design features, combined with the low probability of seismic activity in northern Saskatchewan, are expected to mitigate the potential of any risk from seismic events.

15.3 Forest Fires

15.3.1 Existing Environmental Conditions

Forest fires are common throughout most of northern Saskatchewan and are an important natural disturbance of northern boreal forest ecosystems. Specifically, the Boreal Shield Ecozone of Saskatchewan, where the Project is located, experiences a largely natural fire regime that results in the most area burned per unit area and the highest proportion of very large fires (>50,000 ha) in

Saskatchewan (Parisien et al. 2004). The severity, cause, and extent of forest fires are influenced by local conditions (e.g., the quantity of available fuel or combustible material) and depend on summer weather (e.g., temperature, precipitation, and wind). During the summer, the cause of forest fires is most often lightning strikes; however, in areas used seasonally by people, human-caused forest fires are a common occurrence.

Based on provincial data acquired from the Saskatchewan Ministry of Environment – Wildfire Management Branch (Dallyn 2019), seven fires, covering 257 km^2, have occurred in the Terrestrial Regional Study Area[1] for the Project since 1945 (Table 15.3-1). Of these, three fires covering 22 km^2 occurred within the Wildlife Local Study Area. Lightning caused most of the forest fires in the Terrestrial Regional Study Area, while the remainder were caused by human activity (e.g., recreation, residents, and other incendiary causes), with a small percentage having unknown causes (National Forestry Database 2021).

Table 15.3-1: Overview of Historical Forest Fires from 1945 to 2018 in the Wildlife Local Study Area and Terrestrial Regional Study Area for the Project

Forest Age (Years)	Years When Fire Occurred	Extent of Local Study Area (km^2) Affected by Fire	Percent of Local Study Area (%) Affected by Fire	Extent of Regional Study Area (km^2) Affected by Fire	Percent of Regional Study Area (%) Affected by Fire
0–10	None	0	0	0	0
11–20	2004, 2007, 2008	3.47	7.3	59.28	14.8
21–30	1990, 1998	0	0	0.54	0.1
31–40	1981	15.96	33.6	163.56	40.9
41–70	1973	2.53	5.3	33.8	8.5
70+	None	0	0	0	0
Total		**21.96**	-	**257.18**	-

Source: Dallyn 2019.

15.3.2 Effects on the Project

Forest fires can damage infrastructure and equipment, interrupt Project activities, create unsafe working conditions, and/or result in injuries. While forest fire management is the responsibility of the provincial government, Denison will have fire suppression obligations as an industrial and commercial operator. It is expected that Denison will enter into a fire control agreement with the province (as other northern uranium mine and mill facilities have done) as per *The Wildfire Act* (Government of Saskatchewan 2014). This will allow for fire fighting support from the province should a fire develop near the Project. Pursuant to section 19(3) of *The Wildfire Act*, Denison would

[1] The Terrestrial RSA was used to summarize the frequency of forest fires because it is the largest spatial boundary used to describe terrestrial environmental conditions associated with the Project.

be responsible for initially controlling and extinguishing a wildfire burning within a part of designated lands on which the Project is actively being conducted or is located.

Denison's Emergency Response Plan will include information on how to prevent and suppress forest fires near the Project. Fire guards (i.e., buffer zones of 30 m) will be established and maintained between specific Project facilities (e.g., main camp) and forested areas to minimize potential risks from forest fires. On-site emergency response equipment will be available for fire suppression and fire fighting. The fire water system for the Project will include a freshwater tank, two electric fire water pumps, and a back-up diesel fire water pump for on-site fire suppression needs. Denison's Emergency Preparedness and Response Program for the Project will address appropriate responses for forest fire events that occur.

Although the potential exists for forest fires to occur during the life of the Project, fire is not expected to have a detrimental effect on the Project given the design features and mitigation measures that Denison will have in place for the Project. Denison will appropriately design facilities and operate the site in accordance with the Fire Protection Program, which will be developed specifically for the Project and based on proven programs at existing northern sites. Consideration for the projected increase of forest fire frequency and severity due to climate change in the coming decades (see Section 15.3.2) will be made.

15.4 Extreme Weather (Short-term Events)

15.4.1 Existing Environmental Conditions

Saskatchewan has a continental climate, experiencing extremes in temperatures and weather events. Air temperatures from 1981 to 2020 at Key Lake ranged from an extreme maximum of +36°C in summer to an extreme minimum of −53°C in winter (ECCC 2021; Appendix 6-C in Section 6). The extreme daily precipitation at Key Lake during the same time period was 72 mm of rainfall in July 1998 and 27 cm of snowfall in September 1997 (ECCC 2021). The prevailing wind direction is from the west (Appendix 6-C), with an extreme hourly speed of 60 km/hr from the northeast measured in April 1985 (ECCC 2021). Community members have noted changes to local waterbodies due to both flood and drought conditions (18-EN-VB-4.39).

Detailed information on the existing climate for the Project Area can be found in Appendix 6-C.

15.4.2 Effects on the Project

Table 15.4-1 provides a summary of short-term extreme weather events, the potential effects on the Project, and mitigation and management plans associated with each event. In this context, short-term refers to events that take place over several hours, days, or weeks, and contrasts with long-term events, such as climate change.

Research suggests increased warming over the coming decades due to climate change is likely to cause changes in the frequency, severity, and/or nature of weather extremes in the northern portions of North America (Seneviratne et al. 2021), which may affect the Project. See Section 15.5 for details on projected climate conditions and effects on the Project.

Table 15.4-1: Summary of Potential Effects of Short-term Extreme Weather Events on the Project and Associated Mitigation

Extreme Weather Event	Potential Effects on the Project	Mitigation
Major precipitation events (e.g., heavy, prolonged periods of precipitation lasting days to weeks) or a rapid spring melt in the region surrounding the Project Area.	• Damage to Project infrastructure from flooding. • Contaminated water storage and processing facilities could be compromised (i.e., increased runoff could drain into the various ponds constructed on site and increase the levels in these ponds over freeboard capacity).	• Suitable equipment and design systems will be selected for the Project to enable operation under heavy precipitation events. • Denison's Emergency Preparedness and Response Program for the Project will include information on planning for and responding to severe weather events. • Weather forecasts will be monitored, which will provide advanced warning and time to prepare for extremes in precipitation. • Health and safety policies will be implemented, and risk assessments will be undertaken, before working in adverse weather conditions. • Staff will be educated through formal training programs to make sure they understand the risks of and procedures for working in extreme weather event conditions. • Employees will be required to wear appropriate personal protective equipment (e.g., rain gear) while working outside in extreme weather. Radio communication will be maintained with anyone working away from the mine site under these conditions. • Diesel generators will be available on site at strategic locations to provide back-up power in the case of a power outage. Generators will be used to maintain power to the processing plant and the accommodations facility, as well as to maintain other essential services, as required. • Water management infrastructure will be designed to meet the requirements of the Environmental Code of Practice for Metal Mines (e.g., "Surface drainage facilities should be designed to handle peak conditions at least equivalent to a once in 100-year flood event"; ECCC 2009). • The site surface drainage network for the Project will either collect or divert water. Where practical, reasonable efforts will be made to divert non-contact surface runoff away from any developed features in the Project Area. Precipitation and snowmelt runoff that contact potentially contaminated surfaces will be captured, collected, and diverted to impound areas identified as site runoff ponds or collection areas. • The wellfield runoff pond has been sized to accommodate the Probable Maximum Precipitation reporting to the pond and sized to 38,200 m^3.

Extreme Weather Event	Potential Effects on the Project	Mitigation
		• The ponds and pads in the Project Area have been designed to accommodate the Probable Maximum Precipitation, and the water management infrastructure will allow for transferring water from pond to pond as required. • Snow will be cleared from roadways and moved away from building air supply and exhaust locations. Roadways will be repaired and maintenance will be issued as required. • Ditches and culverts will be monitored and cleared of any debris within the channel when safe to do so.
Drought	• Could lead to an eventual reduction in or loss of natural runoff in the Wheeler River watershed and Icelander River drainage area, which may affect access to make-up water required for use by the Project.	• Suitable equipment and design systems will be selected for the Project to enable operation during drought. • Denison intends to recycle process water to the greatest extent possible, thereby reducing the demand for a fresh water supply, which will be advantageous during drought conditions. Fresh water will be sourced from either a shallow groundwater well or an intake from Whitefish Lake.

Extreme Weather Event	Potential Effects on the Project	Mitigation
Extremely high air temperatures	• Adverse effects on the health of workers due to heat exhaustion, dehydration, and heat stroke. • Workers becoming more distracted and more prone to error. • Equipment not running as smoothly and being more prone to malfunctions, which can increase the risk of exposure and accidents. • Greater energy needs on site to keep air conditioning systems running. • An increased likelihood of forest fires in the Project Area during dry years.	• Suitable equipment and design systems will be selected for the Project to enable operation under extreme high temperatures. • Denison's Emergency Preparedness and Response Program for the Project will include information on planning for and responding to severe weather events. • Health and safety policies will be implemented, and risk assessments will be undertaken before working in adverse weather conditions. • Staff will be educated through formal training programs to make sure they understand the risks of and procedures for working in extreme weather event conditions. • Employees will be required to wear appropriate personal protective equipment while working outside in extreme weather. Radio communication will be maintained with anyone working away from the mine site under these conditions. • Weather forecasts will be monitored, which will provide advanced warning and time to prepare for extremes in air temperature, precipitation, and wind. • Diesel generators will be available on site at strategic locations to provide back-up power in the case of a power outage. Generators will be used to maintain power to the processing plant and the accommodations facility, as well as to maintain other essential services, as required.
Extremely low air temperatures	• Adverse effects on the health of workers due to frostbite and hypothermia. • Workers becoming more distracted and more prone to accidents. • Equipment and machinery not functioning optimally, which can increase the exposure of workers to cold conditions and increase accidents. • If extremely low temperatures occur in tandem with snowfall, conditions such as blowing snow can slow mine operations by decreasing visibility and slowing transport. • Greater energy needs on site to keep heating systems running more than usual.	• Suitable equipment and design systems will be selected for the Project to enable operation under extreme low temperatures. • Denison's Emergency Preparedness and Response Program for the Project will include information on planning for and responding to severe weather events. • Health and safety policies will be implemented, and risk assessments will be undertaken before working in adverse weather conditions. • Staff will be educated through formal training programs to make sure they understand the risks of and procedures for working in extreme weather event conditions. • Employees will be required to wear appropriate personal protective equipment (e.g., cold weather gear) while working outside in extreme weather. Radio communication will be maintained with anyone working away from the mine site under these conditions.

Extreme Weather Event	Potential Effects on the Project	Mitigation
	• Extended winter conditions resulting in more precipitation falling as snow rather than rain. If snow accumulation increases substantially, roadways and the runway would require additional clearing.	• Weather forecasts will be monitored, which will provide advanced warning and time to prepare for extremes in air temperature, precipitation, and wind. • Diesel generators will be available on site at strategic locations to provide back-up power in the case of a power outage. Generators will be used to maintain power to the processing plant and the accommodations facility, as well as to maintain other essential services, as required.
Extremely high winds	• Roofing could be dislodged. • Equipment shrouds and covers could be damaged or removed, which could then present a safety hazard. • Trees could blow over, which could temporarily block roads. • Power lines and building services could be damaged if improperly designed or installed. • Electrical blackouts could occur. • High winds during below-freezing air temperatures would contribute to wind chill and blowing snow. Blowing snow would reduce visibility, limiting access to and from the Project.	• Suitable equipment and design systems will be selected for the Project to enable operation under high wind events. • Staff will be educated through formal training programs to make sure they understand the risks of and procedures for working in extreme weather event conditions. • Denison's Emergency Preparedness and Response Program for the Project will include information on planning for and responding to severe weather events. • Employees will be required to wear appropriate personal protective equipment (e.g., cold weather gear, rain gear) while working outside in extreme weather. Radio communication will be maintained with anyone working away from the mine site under these conditions. • Weather forecasts will be monitored, which will provide advanced warning and time to prepare for extremes in air temperature, precipitation, and wind. • Diesel generators will be available on site at strategic locations to provide back-up power in the case of a power outage. Generators will be used to maintain power to the processing plant and the accommodations facility, as well as to maintain other essential services, as required.

15.5 Climate Change

Climate change can be defined as a long-term change in average weather patterns, particularly since the early 20th century, that are largely attributed to increased levels of atmospheric greenhouse gases (GHGs) produced by human activities, such as the burning of fossil fuels (NASA 2021). Globally, mean surface air temperature has increased progressively over the last 120 years. Between 2001 and 2020, the global temperature was nearly 1°C higher than recorded between 1850 and 1900 (IPCC 2021). As a result, the world has experienced greater climate variability by way of changes in the frequency and magnitude of extreme climatic events, and regional differences in weather patterns. For example, historical records show increased precipitation events in higher latitudes and decreased events near the equator (Warren and Lemmen 2014).

Concerns related to climate change were raised during engagement and consultation activities completed by Denison (e.g., 22-EN-ERFN-621.15, 22-EN-SUR-652.57). It should be noted that these concerns pertain to climate change rather than GHG emissions specifically. The concerns included observations of climate-related changes that have been noticed by the English River First Nation (e.g., depth of permafrost; 16-EN-ERFN-100.17) and observations by the English River First Nation Trapper who provided local knowledge in support of the EIS (19-LK-ERFNTrap-134.232). In addition, the Village of Pinehouse Lake posed questions regarding the potential effects of the Project on climate change (21-EN-VPL-444.4 and 21-EN-VPL-444.18).

In Canada, the annual mean surface air temperature increased by 1.5°C between 1950 and 2010, with stronger warming trends seen in the northern and western portions of the country (Warren and Lemmen 2014). According to the 2021 Intergovernmental Panel on Climate Change Sixth Assessment Report (IPCC 2021), temperature increases in Canada are projected to be very large compared to the global average, particularly in the winter. Moreover, annual precipitation (i.e., snow) is expected to increase between December and February in the northern portion of Canada.

15.5.1 Global Climate Models

Climate models are used to depict how the climate is likely to change in the future. Climatic projections for the Project were derived from an interactive, online climate modelling tool (i.e., Climate Atlas; PCC 2019). This tool is based on an ensemble of 24 different Global Climate Models developed by international research groups following a rigorous statistical process accepted by the Intergovernmental Panel on Climate Change (Collins et al. 2013). The multi-Global Climate Model ensemble outputs are based on plausible representative concentration pathways (RCPs) that describe predicted trajectories of atmospheric concentrations over time (for GHGs, aerosols, and other air pollutants) and the resulting trajectories of key climate indicators (Warren and Lemmen 2014). The climate model outputs have been statistically downscaled into high-resolution (10 km x 10 km regional grid) predicted temperature and precipitation data for all of Canada. The Project

Area falls within the Tomblin Lake regional grid unit (PCC 2019). The ensemble output data for this region are expected to help guide adaptive management of the Project throughout the life of the mine.

15.5.1.1 Uncertainties and Assumptions

Although it is widely accepted that Canada's climate is changing, predicting the exact changes or effects of those changes at any given location or time is not possible because of inherent natural climate variability, climate model uncertainty, and emission scenario uncertainty. The relative importance of the three sources of uncertainty depends on the geographic scale of the model output (i.e., global projections are more robust than continental projections); the specific climate variable considered (e.g., temperature projections are more reliable than precipitation projections); and the temporal scale of the variable in question (i.e., annual estimates are more reliable than seasonal or monthly estimates) (Climate Data Canada 2021). Overall uncertainty is mitigated by implementing a multi-model ensemble approach that presents a range of possible climate conditions, considering more than one emissions scenario to forecast a range of potential futures, and presenting results over a long-term horizon.

In Section 15.5.2, the ensemble outcomes for the Tomblin Lake regional grid unit, following two RCP scenarios (i.e., RCP4.5 and RCP8.5), are presented. The RCPs are based on a set of assumptions about driving forces, such as technological change, demographic and socioeconomic development, and land use, and the key interactions between these driving forces (Climate Data Canada 2021). The High Carbon scenario (i.e., RCP8.5) assumes continued high GHG emissions until the end of the century, while the Moderate Carbon scenario (i.e., RCP4.5) assumes that drastic reductions of emissions in the coming decades will stabilize the concentration of GHGs in the atmosphere by the end of this century (PCC 2019). It is assumed that the lowest emission scenario (i.e., RCP2.6), where future GHG emissions are strongly declining, is unattainable (PCC 2019).

15.5.1.2 Climate Change Parameters

The climate variables in the Climate Atlas (PCC 2019) selected to inform the EIS include the following:

- total precipitation (annual, spring, summer, fall, winter);
- mean temperature (annual, spring, summer, fall, winter);
- maximum temperature (annual, spring, summer, fall, winter);
- minimum temperature (annual, spring, summer, fall, winter);
- maximum 1-day precipitation (annual);
- heavy precipitation (annual);
- very hot days (>30°C);
- very cold days (<30°C); and

- growing degree days (5°C).

The projected trends that these climate variables may represent include potential changes to extreme weather events, such as storms (rain or snow), heat waves, extreme cold periods, and forest fire activity that could affect Project infrastructure, the local environment, and communities in the coming decades. The mean values of each climate indictor are the average values of the model ensemble over three time periods: 1) 1976 to 2005 (simulated historical values); 2) 2021 to 2050 (near-term values); and 3) 2051 to 2080 (far-term values). These time periods align with the Project's expected 38-year life of mine (including Post-Decommissioning monitoring). See Section 5.3.4 for the temporal boundaries of the Project.

15.5.2 Expected Environmental Conditions

Please refer to Appendix D in Appendix 6-C of Section 6 for a summary of precipitation values presented in the EIS. Table 15.5-1 and Table 15.5-2 summarize the predicted mean values of the climate variables for the Tomblin Lake regional grid unit, following the RPC4.5 and RCP8.5 scenarios, respectively, as indicated by the Climate Atlas (PCC 2019). In both emission scenarios, mean and maximum annual temperatures are predicted to increase approximately 2°C by mid century, and 3°C to 5°C by 2080, with the greatest increases in warming expected in the fall and winter months. In addition, the number of very hot days (>30°C) is expected to increase from one day per year (historical mean) to one to two weeks per year by 2080, depending on the emission trajectory. Minimum temperatures in the Tomblin Lake regional grid unit are predicted to increase, and the number of very cold days is expected to decrease in the coming decades. However, total precipitation is not expected to change substantially over time, although the greatest increases are expected in the spring and fall, and extreme rain events (1-day maximum rain events) are expected to increase minimally (<5 mm) in both predicted emission scenarios. Although the temperature increases are expected to result in more growing days for forage and crops, increased evaporation could cause water stress and potentially decrease productivity (Warren and Lemmen 2014). Overall, the ensemble model projections at this location, regardless of emission scenario, indicate future climate conditions over the life of the Project will likely include warmer, snowier winters and longer, hotter summers (Figure 15.5-1 and Figure 15.5-2). Given the uncertainty around projected precipitation, it is not clear if the increased trend in total and extreme precipitation events will produce local climatic conditions that will affect the Project.

For the purposes of demonstrating the uncertainties of climate model predicted values versus observed data, the Max 1-day precipitation annual average historical data for Tomblin Lake, high carbon (RCP8.5) was compared to the predictive model results from the period of 1950 to 2013 (i.e., ensemble high carbon dataset). The predicted model data was hindcast for periods prior to 2006 and these values are then based on the historical data set with the ensemble values derived from 24 CMIP5 global climate models (the complete list of models can be found at https://climateatlas.ca/data-sources-and-methods) (Climate Atlas of Canada, 2023). A correlation coefficient (R2) value was calculated for these two datasets and the result was a coefficient of 0.36 which indicates the level of uncertainty that can be expected in the forward casting of precipitation data into the future.

The simulated future climate conditions at the Project (PCC 2019) support findings from other research on the potential effects of climate change on Canada's boreal forest, within which the Project is located (Warren and Lemmen 2014, Wotton et al. 2017). Specifically, climate change is expected to result in more frequent forest fires in boreal forests due to the influence of factors affecting fire occurrence, such as lightning, fuel moisture, temperature, precipitation, and vegetation (Government of Canada 2020). The warming temperatures could add damaged or dead wood to the forest fuel load (e.g., from insect outbreaks, ice storms, or high winds) and may increase the risk of fire activity. While climate change is expected to vary regionally across the extent of Canada's boreal forest, in general, forest fire frequency, severity, and extent are expected to increase in all areas of the Canadian boreal forest (including the Project Area) over the remaining century (Wotton et al. 2017).

***Table 15.5-1:* Predicted Climate Conditions of a RCP4.5 Moderate Carbon Future[1]**

Climate Variable	Time Period	Historical Mean[3]	Near Term (2021–2050)			Far Term (2051–2080)		
			Mean	Change	% Change	Mean	Change	% Change
Total Precipitation (mm)[2]	annual	495.7	484	28.0	6	500	44.0	10
	spring	72	78	6.0	8	83	11.0	15
	summer	196	206	10.0	5	208	12.0	6
	fall	120	126	6.0	5	131	11.0	9
	winter	68	74	6.0	9	77	9.0	13
Mean Temperature (°C)	annual	-2.8	-0.9	1.9	68	0.3	3.1	111
	spring	-3.2	-1.5	1.7	53	-0.5	2.7	-84
	summer	14.2	15.9	1.7	12	16.8	2.6	18
	fall	-1.2	0.9	2.1	175	1.9	3.1	258
	winter	-21.6	-19.2	2.4	11	-17.4	4.2	19
Maximum Temperature (°C)	annual	2.5	4.4	1.9	74	5.5	3.0	117
	spring	3.3	4.9	1.6	49	5.9	2.6	79
	summer	19.9	21.6	1.7	8	22.6	2.6	13
	fall	2.8	4.7	2.0	70	5.7	2.9	103
	winter	-16.2	-14.0	2.2	13	-12.5	3.7	23
Minimum Temperature (°C)	annual	-8.2	-6.1	2.1	25	-4.9	3.4	41
	spring	-9.8	-7.9	1.9	19	-7	3.0	30
	summer	8.5	10.2	1.7	20	11	2.6	31
	fall	-5.1	-2.9	2.2	43	-2	3.2	63
	winter	-26.8	-24.1	2.6	10	-22	4.6	17
Max 1-Day Precipitation (mm)	annual	27.9	25.9	1.8	8	26.7	2.7	11
Heavy Precipitation Days[4]	annual	1	1	0	0	1	0	0
Very Hot Days (+30°C)	annual	1	4	3.0	300	7	6.0	600

Climate Variable	Time Period	Historical Mean[3]	Near Term (2021–2050)			Far Term (2051–2080)		
			Mean	Change	% Change	Mean	Change	% Change
Very Cold Days (-30°C)	annual	44	33	-11.0	-25	24	-20.0	-45
Growing Degree Days (Base 5°C)[5]	annual	1,056	1,299	243.0	23	1,447	390.6	37

Notes:

1 Predicted values are for the Tomblin Lake regional grid unit (Climate Atlas 2019; PCC 2019).

2 Precipitation includes both rain and snow.

3 Historical mean (1976 to 2005) derived from the ensemble statistical models.

4 A Heavy Precipitation Day is a day on which at least a total of 20 mm of rain or frozen precipitation falls.

5 Growing Degree Days (GDD) provide an index of the amount of heat available for the growth and maturation of plants and insects. The GDD represents the annual sum of the number of degrees Celsius that each day's mean temperature is above a specified base temperature (Tbase). Generally, 5 °C GDD are used for assessing the growth of canola and forage crops.

Table 15.5-2: Predicted Climate Conditions of a RCP8.5 High Carbon Future[1]

Climate Variable	Time Period	Historical Mean[3]	Near Term (2021–2050)			Far Term (2051–2080)		
			Mean	Change	% Change	Mean	Change	% Change
Total Precipitation (mm)[2]	annual	495.7	487	31.0	7	509	53.0	12
	spring	72	79	7.0	10	86	14.0	19
	summer	196	205	9.0	5	204	8.0	4
	fall	120	129	9.0	8	138	18.0	15
	winter	68	74	6.0	9	82	14.0	21
Mean Temperature (°C)	annual	-2.9	-0.5	2.4	83	1.9	4.8	166
	spring	-3.3	-1.2	2.1	64	0.7	4.0	121
	summer	14.2	16.2	2.0	14	18.4	4.2	30
	fall	-1.2	1.2	2.4	200	3.5	4.7	392
	winter	-21.6	-18.7	2.9	13	-15.4	6.2	29
Maximum Temperature (°C)	annual	2.5	4.7	2.2	86	7.0	4.5	177
	spring	3.3	5.1	1.9	57	6.9	3.6	111
	summer	19.9	22.0	2.0	10	24.2	4.3	22
	fall	2.8	5.0	2.2	78	7.2	4.4	159
	winter	-16.2	-13.6	2.6	16	-10.7	5.5	34
Minimum Temperature (°C)	annual	-8.2	-5.7	2.5	30	-3.2	5.0	61
	spring	-9.8	-7.6	2.2	23	-5.5	4.3	44
	summer	8.5	10.5	2.0	24	12.6	4.1	49
	fall	-5.1	-2.6	2.5	49	-0.2	4.9	96
	winter	-26.8	-23.6	3.2	12	-19.9	6.9	26
Max 1-Day Precipitation (mm)	annual	27.9	25.9	1.8	7	27.5	3.4	14

Climate Variable	Time Period	Historical Mean[3]	Near Term (2021–2050)			Far Term (2051–2080)		
			Mean	Change	% Change	Mean	Change	% Change
Heavy Precipitation Days[4]	annual	1.1	1.3	0.2	0	1.6	0.5	46
Very Hot Days (+30°C)	annual	1	5	4	400	14	13	1,300
Very Cold Days (-30°C)	annual	45	30	-15	-33	15	-30	-67
Growing Degree Days (Base 5°C)[5]	annual	1,056	1,349	293	28	1,690	634	60

Notes:

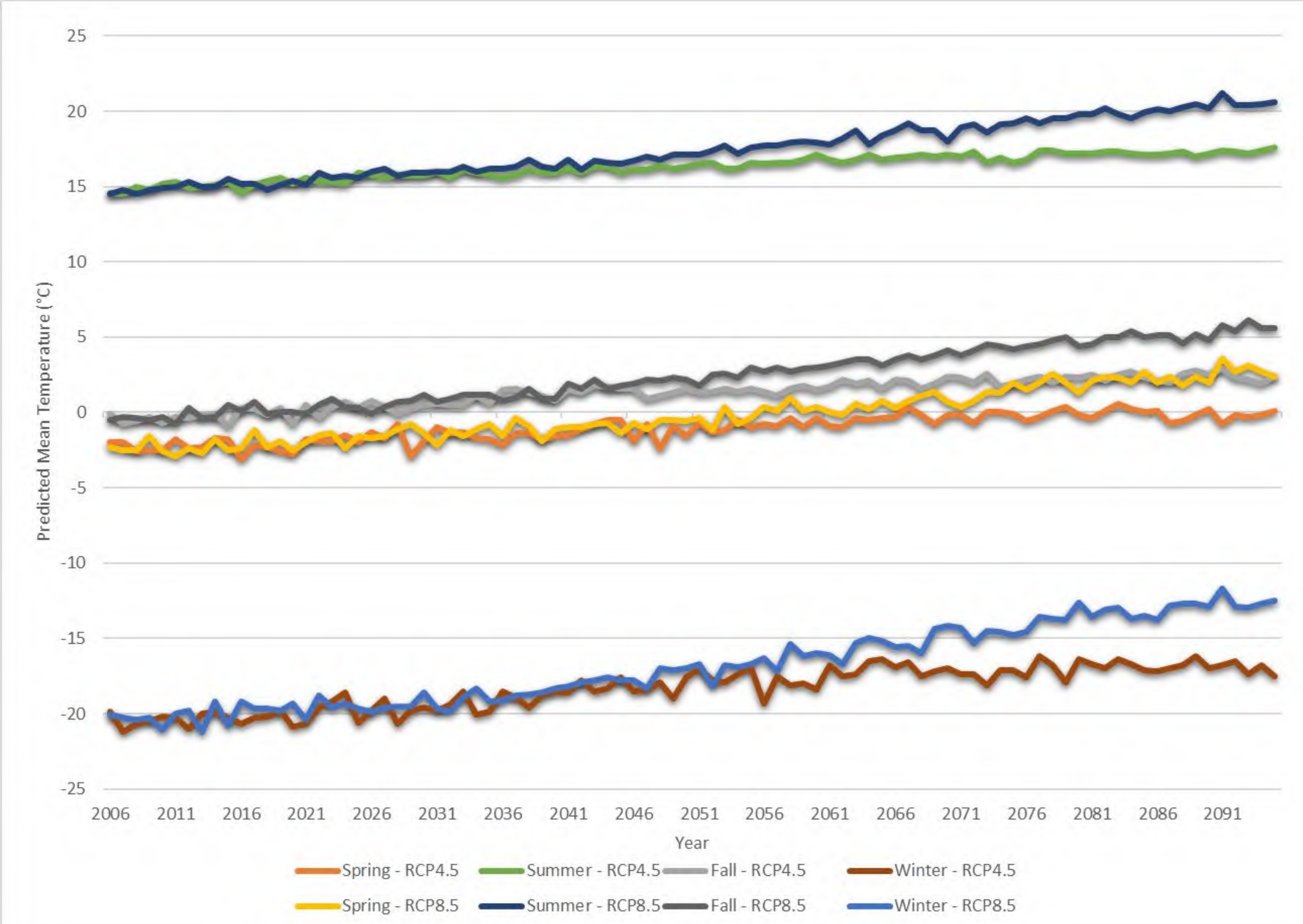
1 Predicted values are for the Tomblin Lake regional grid unit (Climate Atlas 2019).

2 Precipitation includes both rain and snow.

3 Historical mean (1976 to 2005) derived from the ensemble statistical models.

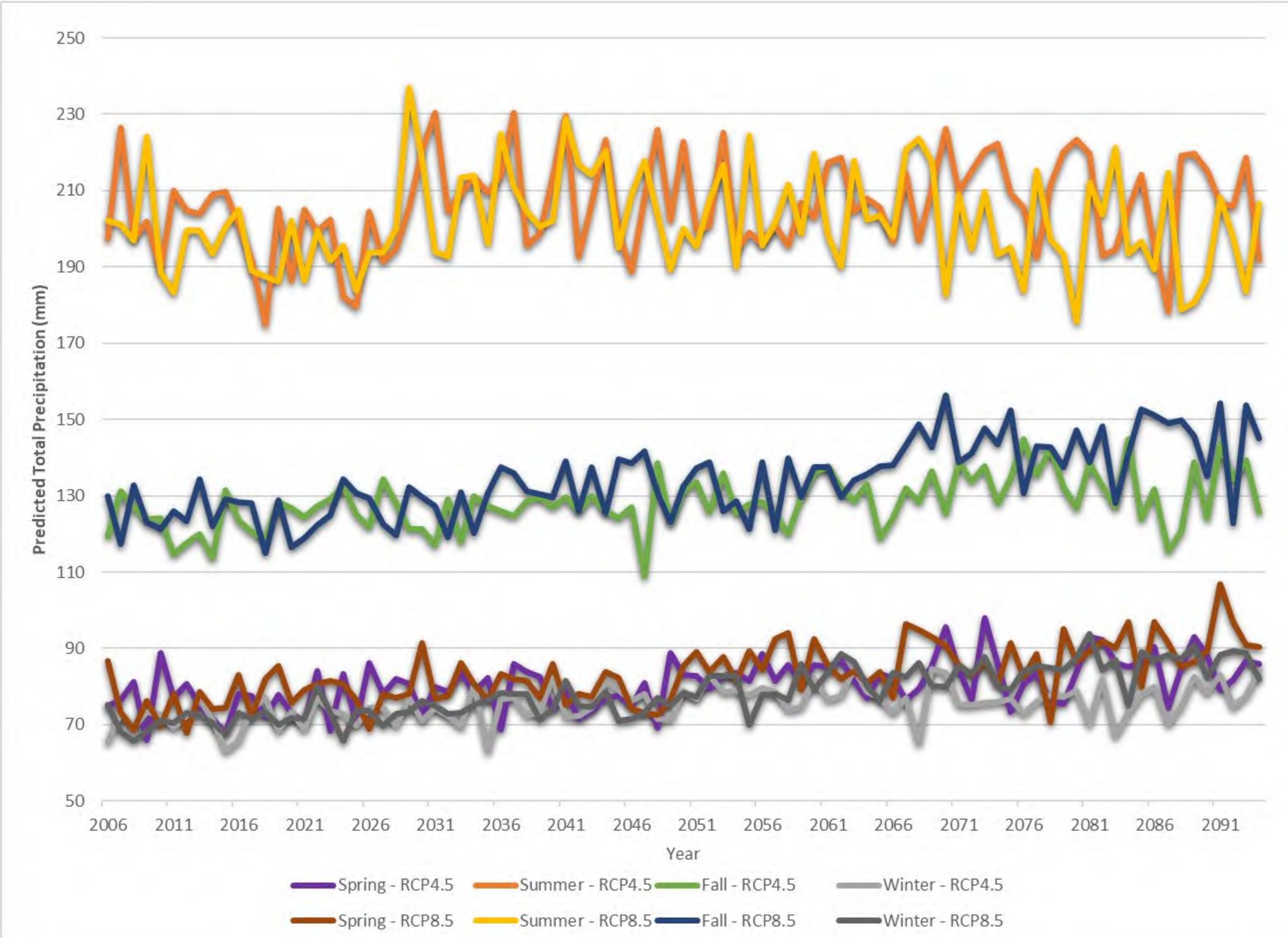
4 A Heavy Precipitation Day is a day on which at least a total of 20 mm of rain or frozen precipitation falls.

5 Growing Degree Days (GDD) provide an index of the amount of heat available for the growth and maturation of plants and insects. The GDD represents the annual sum of the number of degrees Celsius that each day's mean temperature is above a specified base temperature (Tbase). Generally, 5 °C GDD are used for assessing the growth of canola and forage crops.



Note: the Project's expected 38-year life of mine is approximately 2024 to 2054

Figure 15.5-1: Predicted Mean Temperature for the Tomblin Lake Regional Grid Unit Following the RPC4.5 and RCP8.5 Scenarios



Note: the Project's expected 38-year life of mine is approximately 2024 to 2054

Figure 15.5-2: Predicted Total Precipitation for the Tomblin Lake Regional Grid Unit Following the RPC4.5 and RCP8.5 Scenarios

15.5.3 Effects on the Project

According to Section 5.1.5 of the *Strategic Assessment of Climate Change* (Government of Canada 2021), "*All proponents will be required… to provide information in the Impact Statement on how the project is resilient to and at risk from both the current and future impacts of a changing climate.*" The Project will be developed with consideration of the predicted changes in climate conditions that could occur during its lifecycle from pre-construction design through to Post-Decommissioning monitoring. Denison has incorporated design features and mitigation measures related to forest fires (see Section 15.3.2) and extreme weather (see Section 15.4.2) into the Project. The Project has also been designed using engineering best practices and will meet current regulations and building codes. Additional growing days due to increased temperatures may be beneficial to the Project during Decommissioning, allowing for accelerated revegetation and reclamation of natural vegetation communities.

Denison will develop an Emergency Preparedness and Response Program for the Project to address forest fires and extreme weather that may occur. If unforeseen effects on the Project occur from longer and more severe forest fire seasons associated with climate change, or increased frequency or severity of extreme weather (e.g., ice storms, snowstorms, flooding), Denison will apply adaptive management that includes monitoring climate factors so that they can proactively mitigate or prevent adverse climate effects on the Project.

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Appendix 15-A Engagement Database Summary – Effects of the Environment on the Project

See file “S15_App 15-A Effects of the Environment on the Project Engagement_Wheeler River.pdf”

Denison Mines

Wheeler River Project

Final Environmental Impact Statement

November 2024

Powering **PEOPLE, PARTNERSHIPS AND PASSION.**

Wheeler River Project

Final Environmental Impact Statement

Section 16 – Assessment Summary and Conclusions

November 2024

Denison Mines

Denison Mines Corp.

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Roadmap

This roadmap of the Wheeler River Project Environmental Impact Statement (EIS) has been provided to summarize the main document sections and appendices of the EIS.

Wheeler River Project
Environmental Impact Statement

Executive Summary

PART I: INTRODUCTION AND CONTEXT

- Section 1: Project Introduction and Overview
- Section 2: Project Description
- Section 3: Indigenous and Local Knowledge
- Section 4: Engagement
- Section 5: Approach and Methodology of the Assessment

PART II: BIOPHYSICAL ENVIRONMENTAL ASSESSMENTS

- Section 6: Atmospheric and Acoustic Environment
- Section 7: Geology and Groundwater
- Section 8: Aquatic Environment
- Section 9: Terrestrial Environment

PART III: HUMAN ENVIRONMENT ASSESSMENTS

- Section 10: Human Health
- Section 11: Land and Resource Use
- Section 12: Quality of Life
- Section 13: Economics

PART IV: INTEGRATED TOPICS AND SUMMARY

- Section 14: Accidents and Malfunctions
- Section 15: Effects of the Environment on the Project
- Section 16: Assessment Summary and Conclusions

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Abbreviations, Acronyms, and Units

Acronym / Abbreviation	Definition
AADT	Average annual daily traffic
COI	Communities of Interest
COPC	Constituent of potential concern
Denison	Denison Mines Corp.
EA	Environmental assessment
EIS	Environmental Impact Statement
ERFN	English River First Nation
HRMP	Heritage Resources Management Plan
ILRU	Indigenous Land and Resource Use
IK	Indigenous Knowledge
ISR	In situ recovery
KI	Key indicator
LK	Local Knowledge
LSA	Local Study Area
OLRU	Other Land and Resource Use
Project	Wheeler River Project
RSA	Regional Study Area
TAADT	truck average annual daily traffic
TSP	total suspended particulate
VC	Valued Component

Units	Definition
cm	centimetre
ha	hectares
km	kilometre
m	metre
mSv/yr	millisieverts per year

Glossary

Term	Definition
Cumulative Effect	A cumulative effect occurs when a residual adverse effects of the Project on a given valued component overlaps spatially and/or temporally with the same residual adverse effects on the valued component from other past, present, and reasonably foreseeable projects or activities.
Environmental Assessment	An assessment of potential environmental consequences of a project. The environmental assessment considers the existing environment where the Project is to be located (including, but not limited to, Indigenous and Local Knowledge), predicts potential effects to valued components of the environment, identifies mitigation measures used to limit the effects of the project on the local environment, classifies potential effects remaining after mitigation, and describes monitoring and follow-up programs.
Environmental Impact Statement	A document that contains the environmental assessment for a project, and can also include details on the project description, engagement, mitigation measures, residual and cumulative effects, accidents and malfunctions, and effects of the environment on the project.
Follow-up Program	A follow-up programs addresses uncertainties identified during the environmental assessment process (e.g., to verify predictions made during the environmental assessment; determine the effectiveness of proposed and implemented mitigation measures) and to determine if and when to implement adaptive management measures.
Key Indicator	An important component or aspect of a valued component that is expected to be affected (changed) as a result of the Project.
Local Study Area	The area that surrounds the Project Area where both direct and indirect effects resulting from Project activities can be reasonably measured.
Measurable Parameter	A parameter or metric associated with a key indicator that can be used to detect and measure Project-related changes.
Mitigation/Mitigation Measure	Mitigation is the elimination, reduction, or control of the adverse effects of the Project and includes restitution for any damage to a valued component caused by such effects through replacement, reclamation, compensation, or any other means. Mitigation measures refer to Project-specific mitigation and can include, but are not limited to, engineering design features and responses, best management practices, management plans, emergency response programs, and training.
Monitoring Program	A monitoring program is designed to meet regulatory requirements (e.g., permit or license conditions), and/or to demonstrate compliance with environmental commitments made in the Environmental Impact Statement.
Project Area	The area within which the Project and all components/activities are located (i.e., the Project footprint; the area of maximum physical disturbance).
Regional Study Area	The area that surrounds and includes the LSA, established to assess the potential, largely indirect effects of the Project in a regional context.
Residual Effect	The potential adverse effect of the Project on a valued component after mitigation measures have been considered.
Valued Component	Aspects of the biophysical and human environments that will likely be affected (adversely or positively) by the Project. The valued components reflect identified scientific, Local Knowledge, Indigenous Knowledge, and community interests.

16 Assessment Summary and Conclusions

This section provides a plain language summary of the assessment conducted for each Valued Component (VC) identified and evaluated in the Wheeler River Project (the Project) Environmental Impact Statement (EIS). Additional supporting information has been included in the following appendices:

- Appendix 16-A Summary of Residual Effects;
- Appendix 16-B Summary of Cumulative Effects; and
- Appendix 16-C Summary of Monitoring and Follow-up Programs.

The approach and methodology for the EIS is described in detail in Section 5. Figure 16.1-1 provides a graphic representation of the environmental assessment (EA) process used in this EIS. In general, the EA involved the following steps:

- scope of the assessment;
- integration of the influence of Indigenous Knowledge, Local Knowledge and engagement on the assessment;
- summary of existing conditions relevant to VCs;
- identification and description of potential interactions between the Project and VCs;
- identification and description of mitigation measures applicable to VCs to eliminate, reduce, or control the potential adverse Project-related effects;
- identification and characterization of predicted Project residual effects for VCs after mitigation;
- characterization of significance and assignment of the level of confidence in the predictions;
- identification and characterization of potential cumulative effects; and
- identification of required monitoring and follow-up.

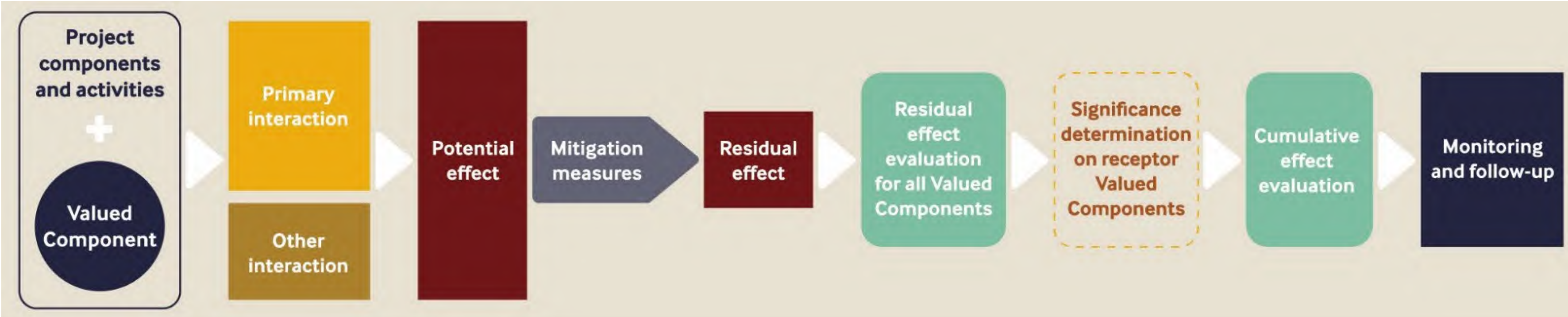

Figure 16.1-1: Environmental Assessment Process for the Wheeler River Project

16.1 Atmospheric and Acoustic Environment

16.1.1 Air Quality

The existing air quality environment in the Project Area is typical of a remote northern setting. The baseline monitoring program for the Project indicated low existing levels of dust, nitrogen dioxide (NO_2), sulphur dioxide, and radon. The Project is expected to introduce new emission sources to the area, which in turn are expected to change the ambient air environment. Predictions of air quality concentrations were completed as part of the assessment using dispersion modelling to evaluate how the anticipated Project activities may change the existing air quality environment, and what the potential effects of those changes may be.

Air emission sources associated with the Project include site clearing and construction activities, dust from use of unpaved road surfaces, fuel combustion (e.g., power generators, diesel-powered mobile equipment), drilling in the wellfield, and process operations at the ISR plant. Potential effects related to Air Quality were identified pertaining to the predicted concentrations in air of various air quality indicators, including particulate matter, combustion products, and radon.

Several mitigation measures were identified to minimize the residual effects of the Project on Air Quality. These include regular watering of unpaved roads and surfaces to supress dust emissions, limiting vehicle speeds, equipping the process exhausts with scrubbers, and making sure stack heights are sufficiently high to prevent building downwash effects.

Results of the air quality modelling were compared to thresholds set by federal and provincial authorities pertaining to the predicted concentrations in air of various air quality indicators. Residual effects were predicted at receptors located beyond the Property Boundary for 24-hour concentrations of total suspended particulate (TSP), particulate matter (PM_{10}), and uranium, and 1-hour concentrations of NO_2 during at least one Project phase. Overall, residual effects were predicted to be limited in geographic extent and mostly infrequent. The 24-hour TSP and PM_{10} exceedances for Construction and Operation were predicted to be sporadic. Residual effects were predicted to be short-term for Construction and unlikely for Operation. For Decommissioning, 24-hour TSP exceedances were predicted to be infrequent. Exceedances of the 24-hour uranium criterion for Operation and the 1-hour NO_2 criterion in all three Project phases were predicted to be infrequent. There is no significance determination for the Air Quality VC, as the results for Air Quality are carried through to Aquatic, Terrestrial and Human Health assessments, where effect significance has been evaluated.

Air emissions from other reasonably foreseeable projects in the area are not expected to combine with those from the Project and increase ambient air concentrations. However, there is potential for a cumulative effect at sensitive locations near Highway 914 due to Project-related traffic and traffic from Cameco's McArthur River and Key Lake operations. A 5-km portion of Highway 914 from the Project access road and south towards Key Lake was included in the air model and emissions from Project traffic were assessed. While traffic associated with Cameco's operations was not modelled, conservative regional background concentrations were added to the air model predictions. Air emissions from Cameco-related traffic are adequately captured by the conservative background concentrations and thus considered in the assessment of Project-related effects.

To confirm the residual effects of the Project on Air Quality, and to demonstrate compliance with provincial ambient air quality standards, an adaptive air emissions monitoring plan will be implemented at the permitting and licensing stage. The air emissions monitoring plan will evaluate the effectiveness of the dust management plan.

16.1.2 Noise

The Project Area is currently characterized by low ambient sound levels that are primarily attributable to sounds of nature, as would be expected for a remote location. The Project is expected to introduce new sound sources of an industrial nature into this environment, which is expected to change the nature of the existing environment and result in localized increases in sound levels. Any change to the existing sound environment in the vicinity of the Project has the potential to affect Indigenous groups and the public in terms of creating nuisance noise that may affect human health and change animal behaviours as related to hunting activity.

Noise sources associated with the Project include site clearing activities, construction of facilities, power generators, diesel-powered mobile equipment, drilling in the wellfield, on-site traffic and air traffic, chilling equipment associated with the freeze plant, and various equipment associated with the ISR process (e.g., pumps).

The assessment of Noise included a baseline monitoring program to characterize existing sound levels, and the use of predictive models to assess how the Project may affect the existing sound environment. The predicted changes to the sound environment were assessed against federal and provincial guidelines to evaluate the resulting change.

Mitigation measures included limiting the use of equipment during night-time hours where possible, planning the site layout such that significant noise sources are as far as possible from sensitive locations, and making sure generator air discharges are directed away from sensitive locations. A noise monitoring program has been recommended to evaluate the effectiveness of mitigation measures and predictions made in the assessment.

The predicted sound levels were below the threshold values from the federal and provincial guidelines at all receptor locations; however, the increase in noise from baseline conditions was predicted to be noticeable at the nearest cabin. As a conservative approach, this was carried forward as a residual effect and follow-up monitoring will be conducted. As with the Air Quality VC, the Noise VC has not been evaluated for significance. The Noise VC was carried through the Terrestrial and Land and Resource Use assessments, where a significance determination has been completed.

Noise emissions from other reasonably foreseeable projects in the area are not expected to combine with those from the Project and increase ambient noise levels. However, there is potential for a cumulative effect at sensitive locations near Highway 914 resulting from Project-related traffic and Cameco's McArthur River and Key Lake operations. A model was prepared that estimated the contributing sound levels of this amount of traffic on Highway 914 at each of the sensitive receptors. The predicted sound levels due to combined truck traffic along Highway 914 did not change the acoustic assessment results based on the federal or provincial guidelines.

16.2 Geology and Groundwater

16.2.1 Geology

Geology includes bedrock, soils, and geomorphology (i.e., the study of physical features on the earth and their relationship to underlying geological structures). Geology was recognized as an important component of the environment that may be affected by the Project, and changes to Geology could in turn lead to effects on other VCs selected for assessment. For example, terrain morphology dictates landscape function, such as surface drainage patterns, and reflects the underlying surficial (geological) materials.

Geology was considered to be an intermediate VC (i.e., does not have an assessment endpoint). Changes to this intermediate VC were evaluated to facilitate the assessment of Project interactions, with links to other disciplines for inclusion in their assessments, including Terrestrial Environment, and Land and Resource Use.

The geological conditions are well understood based on Project-specific and regional information. The Project Area and operations have been designed to limit disturbance to the natural geological environment. One component of the geologic assessment focused on subsidence at ground surface associated with extraction of rock mass (ore) at significant depth (approximately 400 m) below ground, from within the mining area. The assessment predicted a very minor change in ground elevation in the range of 2.4 to 2.8 mm within a discrete and localized area of the Project Area. This minor change may not be measurable and is likely within the bounds of other routine operational surface disturbances. Subsidence, should it occur, will be limited in terms of vertical displacement, and localized to a small portion of the Project Area.

As assessment was completed to understand the potential cumulative effects of the Project with existing and future developments on the physical aspects of the Geology VC. No cumulative effects on the Geology VC are expected. Subsidence is expected to be limited in terms of vertical displacement, if detectable, and localized to a small portion of the Project Area that does not spatially overlap with other project footprints and their potential effects on geology.

As part of the mining operations, detailed monitoring activities will be completed to assess the performance of various components of the Project associated with engineering mining designs, subsidence, performance, and infrastructure designs to protect the Geology VC. Subsidence at ground surface within the wellfield will be evaluated from Construction through to Decommissioning, by monitoring the elevation of collars (top of pipe) for wells within the wellfield. The monitoring program developed will include a contingency plan should conditions with respect to subsidence not meet expectations (e.g., levels of subsidence are outside the range of expectations).

16.2.2 Groundwater

Groundwater is an integral component of the hydrologic cycle and is considered an important component and pathway (intermediate VC) to the Surface Water VC. Groundwater was selected as a VC for assessment because it is important in maintaining ecological habitats through its influence on the hydrology and water quality of surface water bodies, including wetlands. Indigenous Knowledge and engagement activities clearly identified the importance Interested Parties place on groundwater as a pathway to surface water, and the associated potential for changes in groundwater inputs to surface water to influence Fish and Fish Habitat, Sediment Quality, Vegetation, Wildlife, Human Health, and Indigenous Land and Resource Use.

The groundwater assessment focused on predicting changes in groundwater flow patterns and groundwater table elevations (Groundwater Quantity), and concentrations of chemical constituents in groundwater that may affect local surface water environments (Groundwater Quality).

The primary potential effects from the Project on groundwater included changes to Groundwater Quantity and Groundwater Quality during Operation as a result of surface facilities (ponds, landfills, laydown and wash areas) and mining, as well as the migration of chemical constituents in groundwater from the remediated mining area as natural groundwater flow conditions are re-established in Post-Decommissioning.

The overall Project Area and Operation have been designed to limit disturbance to the natural groundwater environment outside of the immediate mining area. To minimize residual effects of the Project on Groundwater Quantity and Quality, and protect discharges to local surface water bodies, specific and established engineering design features and mitigation measures will be employed, such as liners, leak detection systems, leachate collection systems at landfills, pads, and ponds, as well as impermeable cover designs during decommissioning. The freeze wall will be established as tertiary containment before mining operations commence to create hydraulically isolated mining area. Groundwater will be remediated during Decommissioning to acceptable standards, which are referred to as mining area decommissioning objectives. These objectives reflect concentrations of mining-associated groundwater constituents that are protective of the surface water environment after giving consideration to the removal of the hydraulic isolation of the freeze wall following the decommissioning stage.

To carefully evaluate how constituents dissolved in the remediated groundwater within the mining area may migrate away from and interact with the environment, a rigorous numerical model of groundwater flow and chemical constituent behaviour along the groundwater flow path was used as a predictive tool. The model was founded on proven scientific principles and processes (e.g., groundwater flow, contaminant transport, and geochemical reaction processes) and allowed future conditions to be evaluated. A determination of significance is not defined for the Groundwater VC; however, the results of the numerical model support the conclusion that, with the implementation of appropriate mitigation, the residual effects of the Project on the Groundwater VC will not result in a significant adverse effect to surface water. Migration of dissolved constituent concentrations along the groundwater flow path from the mining area to Whitefish Lake (the local surface water receptor) is predicted to take hundreds to thousands of years, with concentrations in groundwater reaching Whitefish Lake remaining below values that would result in an environmental risk.

As assessment was completed to understand the potential cumulative effects of the Project with existing and future developments on the Groundwater Quantity and Quality. No cumulative effects are expected since changes in Groundwater Quantity and Quality are localized and not anticipated to overall spatially or temporally with changes in groundwater associated with existing or reasonably foreseeable developments. Results of cumulative effects assessments for VCs in the aquatic environment are discussed in the next section.

Groundwater Quantity and Quality will be monitored from pre-Construction through Operation to assess the performance of the engineering mining designs and performance and infrastructure designs put in place to protect the Groundwater VC. During Decommissioning, monitoring will focus on demonstrating that groundwater remediation within the ISR mining zone meets decommissioning objectives. In Post-Decommissioning, the primary objectives of monitoring will be to demonstrate that natural flow conditions are re-established, and that chemical stability has been achieved with respect to groundwater quality. Chemical stability will be demonstrated by verifying groundwater reactive transport of constituents of potential concern in remediated groundwater aligns with the predictive model. A groundwater monitoring plan including an excursion contingency plan and measures for adaptive management will be implemented for the Project.

16.3 Aquatic Environment

16.3.1 Surface Water Quantity

The Surface Water Quantity VC considers hydrological parameters of interest, including flow regimes and water levels in watercourses and waterbodies within defined study areas. Key considerations of the assessment are associated with how Project activities, including but not limited to water-taking activities, treated water release, and changes to drainage patterns, may change hydrological conditions.

Denison initiated baseline hydrological monitoring for the Project in 2011, which has continued to the present. The extensive hydrological records for the area were utilized to establish a site specific hydrological flow model to support the effects assessment for the Project.

Project interactions with the Surface Water Quantity VC are generally associated with changes in watershed areas as a result of mine construction and implementation of the water management plan, water-taking activities, and treated effluent discharge. The full measure of change in watershed areas will be realized during Construction, whereas water-taking activities and treated effluent discharge will occur through Operation and Decommissioning.

To mitigate the residual effects of the Project on Surface Water Quantity, Denison will minimize water taking activities by maximizing recycling of contact and process water for re-use. Denison will also limit and stage construction of the Project Area, maintain existing drainage patterns with the use of culverts, where applicable, and maintain access roads by periodically regrading and/or ditching to improve water flow, reduce erosion, and manage vegetation growth.

Flows and water levels in lakes and rivers within the LSA for the Surface Water Quantity VC are expected to experience some adverse change (i.e., reduction) as a result of altering the drainage areas reporting specifically to Whitefish Lake and water taking from this same waterbody. However, under all scenarios, including under low flow (5^{th} percentile), the reduction in flow is expected to be less than 3% and, therefore, below the criterion for magnitude of 5% - which is the level that would be considered a low effect to existing environmental flows. Effects to surface water flows and levels are also predicted to be localized to the sub-watersheds within proximity to the Project and specifically Whitefish Lake. The effects are predicted to be fully reversible following Decommissioning as natural drainage patterns will be restored. Following mitigation through design and water management, the residual effects on Surface Water Quantity from the Project are predicted to be not significant.

As the interactions of the Project with the Surface Water Quantity VC is of small magnitude, highly localized to Whitefish Lake and not further propagated downstream of this immediate area, interaction with other existing or reasonably foreseeable activities are not expected to occur over the Project timeline. Therefore, no cumulative effects are expected for the Surface Water Quality VC.

Monitoring programs will be established for confirming the predictions made in the assessment. The programs should remain consistent with the historical long-term monitoring study to facilitate continued establishment of long-term streamflow trends at the site through relationships to long-term, government-operated hydrometric gauging stations in the same watersheds.

16.3.2 Surface Water Quality

The Project is located in a primarily undisturbed area of the boreal forest and the existing water quality in the lakes and rivers is indicative of a low level of disturbance. Water quality parameters during baseline were generally below guidelines for the protection of aquatic life; however, several constituents had concentrations above the guidelines, including aluminum, lead, iron, and cadmium. In these cases, the maximum concentration was only marginally above the guideline value. The waters within the LSA and RSA sustain aquatic life and support activities that are important to local users and Indigenous peoples. Changes to Surface Water Quality have the potential to influence (i) biodiversity and biological function through direct exposure and indirect food chain influence (i.e., aquatic sediments, fish and fish habitat, and benthic invertebrates), and (ii) the cultural values of Indigenous peoples and communities, the general public, and other Interested Parties.

Project activities may interact with Surface Water Quality during all Project phases. In general, the interactions were characterized as being primarily associated with routine controlled discharges from the site. During site preparation and construction, the primary effect pathway related to the mobilization of suspended material into natural surface water features is as a result of land disturbance and clearing. During Operation and Decommissioning, water from the treated effluent monitoring ponds will be released to the environment and directed to Whitefish Lake only. Direct discharge of treated effluent to the natural environment has the potential to change surface water constituent concentrations and temperature. Potential effects to Surface Water Quality as a result of Project discharges (surface drainage and effluent release) to local receiving environments were assessed by way of conservative numerical modeling.

To mitigate effects of the Project on Surface Water Quality, Denison will develop and implement a site-wide water management plan that includes an integrated framework to manage water quality and establish water management practices for each of the primary site aspects and areas of the site where contact water is expected. Water management will include maximizing the recycle and reuse of contact and process water to reduce freshwater intake and release of treated effluent to Whitefish Lake. Denison will design the treated effluent discharge diffuser/outfall to provide effective mixing and dilution such that discharge flows do not detrimentally affect water quality in a localized area of Whitefish Lake. Denison will also develop site-specific effluent treatment protocols to meet release limits in accordance with provincial standards and licence/permit conditions.

Residual adverse effects are expected on Surface Water Quality due to the mobilization of solids and treated effluent discharge to Whitefish Lake;; however, with the implementation of appropriate design criteria for site water management and the effluent discharge pipeline and diffuser, in addition to meeting provincial and federal criteria for discharge criteria and mine water treatment (as needed), the residual effects of the Project on Surface Water Quality are anticipated to be not significant.

The residual effects of the Project are expected to temporally interact with the residual effects of other projects and activities in the surface water quality RSA. The primary Project activity potentially contributing to cumulative effects on surface water quality is the discharge of treated effluent to the aquatic environment during Operation and Decommissioning which may interact with other projects' releases to drainages which ultimately report to Russell Lake. Temporal overlap of foreseeable projects and the Project will also occur during "future centuries" as there is potential for increased contaminant transport via groundwater to surface water during this period. During all phases ("Future Centuries" included) the changes in surface water quality due to effluent discharge or groundwater interaction from foreseeable projects and activities are not anticipated to spatially overlap with those from the Project and therefore a cumulative effect is not expected.

Monitoring programs will confirm the effectiveness of mitigation measures and predictions made in the assessment and will include measurement of radiological and non-radiological water quality parameters to meet regulatory criteria. Monitoring will occur within the collection ponds and the receiving water (i.e., Whitefish Lake). In consultation with Indigenous communities, relevant federal and provincial agencies, and other Interested Parties, in the development and implementation of this VC-specific program, specific monitoring and follow-up plans will be prepared to refine and finalize the monitoring approach.

16.3.3 Sediment Quality and Benthic Invertebrates

The Sediment Quality and Benthic Invertebrate VCs were selected for inclusion because Project activities have the potential to affect them via erosion-driven mobilization of suspended sediment, groundwater interactions with surface water features, and treated effluent discharge to the natural environment throughout all phases of development.

Baseline sediment quality surveys confirmed that the waterbodies in the LSA (i.e., McGowan Lake, Whitefish Lake North, and Whitefish Lake South) were dominated by clay substrates, with silt and sand being present in lesser proportions. For parameters where sediment quality guidelines are available, sediment metal concentrations in these waterbodies were at or below their respective reference criteria or guidelines for the protection of aquatic life.

Benthic invertebrate communities were characteristic of depositional lake habitats (i.e., chironomids, midges, water fleas, and worms) in McGowan Lake and Whitefish Lake. Overall, the diversity of benthic invertebrate communities was highest in McGowan Lake followed by Whitefish Lake South and then Whitefish Lake North.

The physical and chemical attributes of aquatic sediments directly influence benthic invertebrate community distribution, diversity, abundance, and health. Potential changes to water quantity and quality are key considerations in the assessment process and draw a high level of concern from interested parties. Changes to Surface Water Quality have the potential to influence sediment particle size, chemistry, and distribution within the aquatic environment, and in turn influence biodiversity and biological function. Such effects are of interest with respect to the cultural values of Indigenous communities.

Project activities may interact with Sediment Quality and Benthic Invertebrates during all Project phases. In general, the interactions were characterized as being primarily associated with (i) routine controlled discharges from the site and (ii) mobilization of suspended material into natural surface water features as a result of land disturbance and clearing. During Operation and Decommissioning, water from the effluent monitoring ponds will be tested prior to release to the environment. Routine discharge of this sort will be directed to Whitefish Lake only. Additionally, a reduction in surface drainage reporting to Whitefish Lake, due to Project development activities, may change water levels and flows in the receiving water, thereby influencing the depositional properties of the lake and the benthic invertebrate community. The installation of the pipeline and diffuser structure will result in the overprinting of a small proportion of the Whitefish Lake (LA-5) benthic substrate (less than 0.05% of LA-5).

To mitigate effects of the Project on Sediment Quality and Benthic Invertebrates, Denison will develop and implement a site-wide water management plan that includes an integrated framework to manage water quality and establish water management practices for each of the primary site aspects and areas of the site where contact water is expected. This plan will include the collection and monitoring of contact water to determine whether treatment is required prior to release to the environment, which will inform optimal levels of treatment. This plan will also include the monitoring and management of effluent, including contingency for effluent treatment as may be required so that water discharge objectives are achieved as defined by applicable provincial and federal regulatory instruments. These measures are expected to mitigate effects associated with mobilization of solids and changes to Sediment Quality that may affect Benthic Invertebrates. Denison will design the discharge diffuser/outfall to have the smallest footprint possible while still providing effective mixing and dilution such that discharge flows do not detrimentally affect sediments.

The assessment predicted residual effects to Sediment Quality and Benthic Invertebrates due to change in sediment quantity and physical quality (particle size), change in sediment quality (chemical composition), change in aquatic habitat (area), and change in water level or flow; however, with the implementation of appropriate mitigation measures and the predicted effects being assessed as low magnitude, localized, and fully reversible, the residual effects on Sediment Quality and Benthic Invertebrates are anticipated to be not significant.

The residual effects of the Project are expected to temporally interact with the residual effects of other projects and activities in the Sediment Quality and Benthic Invertebrate VCs RSA. The primary Project activity potentially contributing to cumulative effects on sediment quality and benthic invertebrates is via the surface water quality pathway and specifically through the discharge of treated effluent to the aquatic environment during Operation and Decommissioning which may interact with other projects' releases to drainages which ultimately report to Russell Lake. Temporal overlap of foreseeable projects and the Project will also occur during "future centuries" as there is potential for increased contaminant transport via groundwater to surface water during this period. During all phases ("Future Centuries" included) the changes in surface water quality due to effluent discharge or groundwater interaction from foreseeable projects and activities are not anticipated to spatially overlap with those from the Project and therefore a cumulative effect on Sediment Quality and Benthic Invertebrates is not expected.

Monitoring and follow-up are recommended for the Sediment Quality and Benthic Invertebrate VCs to verify the accuracy of the predicted effects and effectiveness of proposed mitigation measures. The sediment quality and benthic invertebrate monitoring program will be considered in conjunction with the surface water quantity (hydrology) and surface water quality monitoring programs as they are specifically tied to these programs from the perspective of pathways of effects. Monitoring of total suspended solids in the effluent monitoring ponds and other catchment ponds, prior to discharge to the environment, will be important in providing context to further evaluate Project-related effects to Sediment Quality and Benthic Invertebrates in the receiving water environment (Whitefish Lake or LA-5).

16.3.4 Fish and Fish Habitat

The Fish and Fish Habitat VC was selected for inclusion in the assessment as Project activities have the potential to cause erosion-driven mobilization of suspended sediment. Project activities are also expected to discharge treated effluent to the natural environment, overprint fish habitat, and locally increase access to fisheries resources with the addition of a new access road and temporary increase of employees to the site. Furthermore, inclusion of the Fish and Fish Habitat VC is vital due to its importance to Indigenous peoples from a cultural and subsistence perspective.

Fish and fish habitat surveys in the LSA and RSA identified river, stream, and lake features that support a variety of fish species, including Lake Trout, Lake Whitefish, Northern Pike, Walleye, Yellow Perch, Arctic Grayling, and several other sucker and forage fish species. With the help of Indigenous Knowledge, Local Knowledge, and in-field surveys, critical spawning and nursery habitats for keystone species were identified and summarized for the LSA, specifically for Whitefish Lake and Russell Lake. Baseline conditions for the Fish and Fish Habitat VC were assessed in conjunction with baseline information specific to the Surface Water Quantity and Surface Water Quality VCs due to the interconnected nature of these VCs.

Project activities may interact with Fish and Fish Habitat during all Project phases. In general, the interactions were characterized as being primarily associated with routine controlled discharges from the site and mobilization of suspended material into natural surface water features as a result of land disturbance and clearing. During Operation and Decommissioning, excess treated water from the effluent monitoring ponds will be released to the environment. Routine discharge of this sort will be directed to Whitefish Lake only. Changes in Surface Water Quality due to treated effluent discharge may affect the water chemistry and water temperatures of Whitefish Lake. The installation of the pipeline and diffuser structure (discussed above) will result in the overprinting of a small proportion of the Whitefish Lake (LA-5) substrate (less than 0.05% of LA-5). No other alteration, disruption, or destruction of aquatic habitat in the LSA is expected. Changes in fish populations resulting from increased fishing activity, which may occur following improved accessibility due to the development of access roads, are also possible.

To mitigate effects of the Project on Fish and Fish Habitat, Denison will develop and implement a site-wide water management plan that includes an integrated framework to manage water quality and establish water management practices (i.e., runoff control and silt fencing) for each of the primary site aspects and areas of the site where contact water is expected. This plan will include the collection and monitoring of contact water to determine whether treatment is required prior to release to the environment, which will inform optimal levels of treatment. This plan will also include the monitoring and management of treated effluent, including contingency for effluent treatment as may be required so that water discharge objectives are achieved as defined by applicable provincial and federal regulatory instruments. These measures are expected to mitigate effects associated with mobilization of solids and changes to water and sediment quality that may affect Fish and Fish Habitat. Denison will design the discharge diffuser/outfall to have the smallest footprint possible while still providing effective mixing and dilution such that discharge flows do not detrimentally affect fish lifecycle processes.

Construction of the access road will involve the installation of two stream crossings. These stream crossings are located at the historical watercourse crossings along the proposed airstrip access road. These crossings will be constructed as clear-span bridges, and their mitigative design will provide for protection of Fish and Fish Habitat.

A lack of transportation to fishing areas will minimize the geographic extent of any workforce fishing, and a lack of facilities to store or cook fish will limit the quantity of harvest.

The assessment predicted residual effects on Fish and Fish Habitat due to change in water quality (including temperature), change in sediment quality, change in aquatic habitat (aerial extent), and change in fish harvest from increased site access. However, with the implementation of appropriate mitigation measures, the predicted residual effects were characterized as low magnitude, localized, and fully reversible, and are, therefore, anticipated to be not significant.

The residual effects of the Project are expected to temporally interact with the residual effects of other projects and activities in the Fish and Fish Habitat RSA. The primary Project activity potentially contributing to cumulative effects on Fish and Fish Habitat is via the surface water quality pathway and specifically through the discharge of treated effluent to the aquatic environment during Operation and Decommissioning which may interact with other projects' releases to drainages which ultimately report to Russell Lake. Temporal overlap of foreseeable projects and the Project will also occur during “future centuries” as there is potential for increased contaminant transport via groundwater to surface water during this period. During all phases (“Future Centuries” included) the changes in surface water quality due to effluent discharge or groundwater interaction from foreseeable projects and activities are not anticipated to spatially overlap with those from the Project and therefore a cumulative effect on Fish and Fish Habitat is not expected. Physical alteration or loss of fish habitat is expected to be localized and of small spatial extent. No interactions with existing and reasonably foreseeable activities are envisioned over the Project timeline in this regard; therefore, no cumulative effects are expected to Fish and Fish Habitat.

Monitoring for the Fish and Fish Habitat VC will occur to verify the accuracy of the predicted effects and the effectiveness of the proposed mitigation measures. Effluent and receiving water quality monitoring will be conducted as per federal and provincial regulations and will include radiological and non-radiological parameters. Monitoring of the biological environment will be undertaken to meet federal and provincial regulations (e.g., Metal and Diamond Mining Effluent Regulations Environmental Effects Monitoring program) and will occur in consultation with Indigenous groups. Monitoring of worker habits in relation to fisheries resources may be applicable to allow for adaptive management of the Fish and Fish Habitat VC.

16.3.5 Fish Health

The Fish Health VC was selected for inclusion as treated effluent discharge to the natural environment has the potential to change chemical and radiological exposure. Furthermore, inclusion of the Fish Health VC is vital due to its importance to Indigenous peoples from a cultural and subsistence perspective. Generally, constituents of potential concern in fish may include heavy metals, including mercury. Concentrations of mercury and selenium in fish tissues collected during baseline studies were below guidelines that are protective of human health and freshwater aquatic life.

The main Project activity that may affect Fish Health is the release of treated effluent to Whitefish Lake. Changes in surface water quality and sediment quality have the potential to affect Fish Health in the receiving environment.

To mitigate effects of the Project on Fish Health, Denison will develop and implement a site-wide water management plan that includes an integrated framework to manage surface water quality and establish water management practices for each of the primary site aspects and areas of the site where contact water is expected. This plan will include the collection and monitoring of contact water to determine whether treatment is required prior to release to the environment, which will inform optimal levels of treatment. This plan will also include the monitoring and management of treated effluent, including contingency for effluent treatment as may be required so that water discharge objectives are achieved as defined by applicable provincial and federal regulatory instruments. These measures are expected to mitigate effects associated with changes in Surface Water Quality and Sediment Quality that may affect Fish Health.

The assessment predicted residual effects on Fish Health due to treated effluent discharge. Identified residual effects are expected to be associated with changes in Surface Water Quality and Sediment Quality; however, the changes are expected to remain well below levels that may affect Fish Health. Considering this, and with the implementation of appropriate mitigation measures, the predicted residual effects of the Project on Fish Health are expected to be not significant.

The residual effects of the Project are expected to temporally interact with the residual effects of other projects and activities in the Fish Health RSA. The primary Project activity potentially contributing to cumulative effects on fish health is via the surface water quality pathway and specifically through the discharge of treated effluent to the aquatic environment during Operation and Decommissioning which may interact with other projects' releases to drainages which ultimately report to Russell Lake. Temporal overlap of foreseeable projects and the Project will also occur during "future centuries" as there is potential for increased contaminant transport via groundwater to surface water during this period. Changes to fish tissue concentrations in the LSA are also predicted to remain within or near existing levels and are not predicted to be associated with effects on Fish Health, nor propagated further downstream (i.e., to Russell Lake). During all phases ("Future Centuries" included) the changes in surface water quality due to effluent discharge or groundwater interaction from foreseeable projects and activities are not anticipated to spatially overlap with those from the Project and therefore a cumulative effect on Fish Health is not expected.

A monitoring program for Fish Health is recommended to confirm the effectiveness of mitigation measures and predications made in the assessment. The program will involve the collection of multiple fish species to assess changes in fish tissue concentration of constituents of interest.

16.4 Terrestrial Environment

16.4.1 Terrain, Soil, and Organic Matter/Peat

The Project Area is primarily located on undeveloped forested land (with some discrete anthropogenic disturbance) within gently rolling terrain characterized by eskers and drumlins. The Project has mostly been sited on stable terrain designated as upland and/or anthropogenically disturbed land (>99% of the Project Area), and (to the extent possible) avoids lowland, lakes, and waterbodies. The soil erosion potential and susceptibility to compaction will likely vary depending on slope class and slope position and other site-specific characteristics (e.g., cover vegetation and exposure).

Primary Project activities with the potential to cause adverse effects on Terrain, Soil, and Organic Matter/Peat including surface land clearing, major earthworks, surface/grading preparations, and/or associated mobilization of equipment, assets, and personnel that will occur during Construction, Operation, and Decommissioning. Denison will rely on a variety of mitigation measures to minimize potential effects on Terrain, Soil, and Organic Matter/Peat, including Project design measures to optimize the Project Area, development of an erosion and sediment control plan, and a commitment to progressive and final reclamation to achieve a safe, stable, and self-sustaining landscape.

Following implementation of these Project-specific mitigations, the assessment predicted residual effects on Terrain (morphology and stability), Soil (quantity and quality), and Organic Matter/Peat (quantity). Changes in Terrain, Soil, and Organic Matter/Peat are anticipated to be within the range of natural variation; therefore, the residual effects are predicted to be not significant. The residual effects of the Project are expected to interact with the residual effects of other projects and activities in the Terrestrial RSA resulting in potential cumulative effects on Terrain, Soil and Organic Matter/Peat. With the implementation of appropriate Project mitigation measures and best management practices (i.e., applicable to all projects within the Terrestrial RSA), the cumulative effects are also predicted to be not significant.

Monitoring programs are recommended for confirming the effectiveness of mitigation measures and predictions made in the assessment, and then implementing adaptive management (if/where applicable) to reduce effects during the lifetime of the Project. These include monitoring during Construction to verify that the Project is built to design specifications, soil salvage monitoring during any land clearing activities, and soil quality monitoring during Operation.

16.4.2 Vegetation and Ecosystems

The Project Area is in an area of the boreal forest with minimal existing anthropogenic and some past wildfire disturbances. The area is dominated by upland jack pine and black spruce forests in various stages of post-fire regeneration, with smaller areas of wetland ecosystems along streams and seepage areas and associated with shallow lakes. One listed plant species was observed during vegetation surveys (i.e., Alaskan clubmoss).

The main Project activities that may affect Vegetation and Ecosystems, Listed Plant Species, and Wetlands are clearing activities during Construction, water management and use, vehicle and aircraft traffic, and the use of equipment during all Project phases. Effects on Vegetation and Ecosystems, Listed Plant Species, and Wetlands include direct disturbance through vegetation clearing and soil disturbance, and indirect effects such as introduction and/or proliferation of invasive plants, edge effects, change to water quantity and quality, and dust deposition.

To mitigate effects of the Project on Vegetation and Ecosystems, Listed Plant Species, and Wetlands, the Project Area is located mostly within previously disturbed areas, minimizing direct and indirect disturbance on vegetation. Denison will clearly delineate the boundaries of the Project to reduce accidental encroachment, conduct appropriate soil salvage and soil management, maintain surface water drainage, implement sediment and erosion control measures and suppress dust (as warranted), and monitor for the introduction and proliferation of invasive plants.

The assessment predicted residual effects on Vegetation and Ecosystems, Listed Plant Species, and Wetlands due to changes in the extent of habitat types, changes in the constituent concentrations of potential concern in plant tissue, changes in the number of listed plants, and changes in the area of wetland ecosystems. The residual effects of the Project are expected to interact with the residual effects of other projects and activities in the Terrestrial RSA resulting in cumulative effects on Vegetation and Ecosystems. The residual effects of the Project and the cumulative effects (interacting with residual effects from other projects and activities) on Vegetation and Ecosystems, Listed Plant Species, and Wetlands are predicted to be not significant.

Monitoring programs are recommended for confirming the effectiveness of mitigation measures and predictions made in the assessment, and then implementing adaptive management (if/where applicable) to reduce effects during the lifetime of the Project. Vegetation and invasive plants will be routinely monitored throughout the life of the Project, soil monitoring during salvaging and stockpiling activities will be undertaken, and progressive reclamation and revegetation of disturbed areas will be monitored. Monitoring will also be employed to understand uptake of constituents of potential concern in plants (if any). Pre-construction surveys for listed plant species will also be undertaken within previously unsurveyed locations in the Project Area.

16.4.3 Ungulates, Furbearers, and Woodland Caribou

The Project is in an area characterized by relatively low human use and provides suitable habitat for a variety of terrestrial wildlife species, including moose, furbearers (such as wolverine, pine marten, mink, and muskrat), and woodland caribou.

The main Project activities that may affect wildlife habitat and mortality are clearing activities during Construction, vehicle and aircraft traffic, and the use of equipment during all Project phases.

To mitigate effects of the Project on wildlife habitat and mortality, the Project Area is mostly within previously disturbed areas, minimizing direct and indirect habitat loss and/or alteration. Denison will conduct site clearing activities outside of the sensitive time periods for wildlife, conduct pre-clearing wildlife sweeps to identify sensitive wildlife habitat or presence of species at risk, minimize noise from Project activities, and optimize transportation and equipment use.

The assessment predicted residual effects on wildlife via direct loss of habitat through vegetation clearing, changes in how wildlife may use their preferred habitats due to sensory disturbance, direct mortality through wildlife-vehicle collisions, and indirect mortality due to the potential for increased harvest and/or predation. The residual effects of the Project are expected to interact with the residual effects of other projects and activities in the Terrestrial RSA resulting in cumulative effects on wildlife. The residual effects of the Project and the cumulative effects (interacting with residual effects from other projects and activities) on terrestrial wildlife are predicted to be not significant.

Monitoring programs are designed to meet regulatory requirements and/or to demonstrate compliance with environmental commitments made in the EIS. Examples include pre-clearing wildlife sweeps and monitoring the success of reclamation and revegetation of disturbed areas. Based on the results of the assessment, no specific follow-up monitoring (to address any uncertainties identified during the assessment process) is required for terrestrial wildlife.

16.4.4 Raptors, Migratory Breeding Birds, and Bird Species at Risk

The Project location, characterized by relatively low human use, provides suitable habitat for a variety of year-round resident and migratory bird species, including Bald Eagle, Osprey, waterbirds, waterfowl, upland game birds, and bird species at risk (such as Common Nighthawk, Short-eared Owl, Yellow Rail, Rusty Blackbird, and Olive-sided Flycatcher).

The main Project activities that may affect bird habitat and mortality are clearing activities during construction, vehicle and aircraft traffic, and the use of equipment during all Project phases.

To mitigate effects of the Project on bird habitat and mortality, Denison will conduct site clearing activities outside of the nesting period, conduct pre-clearing wildlife sweeps to identify the presence of occupied nests or the presence of species at risk, implement no-disturbance setback buffers around active or suspected nests as per guidelines and regulations, minimize noise from Project activities, and optimize transportation and equipment use.

The assessment predicted residual effects on birds via direct loss of habitat, changes in how birds use their preferred habitats due to sensory disturbance, and direct mortality mainly through the possibility for incidental take (i.e., the inadvertent destruction of birds and/or their nests and eggs) and vehicle collisions. The residual effects of the Project are expected to interact with the residual effects of other projects and activities in the Terrestrial RSA resulting in cumulative effects on birds. The residual effects of the Project and the cumulative effects (interacting with residual effects from other projects and activities) on birds are predicted to be not significant.

Monitoring programs are designed to meet regulatory requirements and/or to demonstrate compliance with environmental commitments made in the EIS. Examples include pre-construction nest surveys and monitoring the success of reclamation and revegetation of disturbed areas. Based on the results of the assessment, no specific follow-up monitoring (to address any uncertainties identified during the assessment process) is required for birds.

16.5 Human Health

16.5.1 Human Health

The Project is located at a remote site, with no populated communities in proximity. However, Indigenous Knowledge and Local Knowledge indicate the presence of local cabins and the practice of traditional activities (e.g., hunting, fishing, and gathering) within the RSA for the Human Health VC. The Human Health VC and associated key indicator were evaluated via an environmental risk assessment that included a human health risk assessment and an ecological risk assessment. The selection of human receptors (camp worker, seasonal resident, recreational fisher/hunter, fisher/trapper, and future permanent resident) for evaluation of the Human Health VC was informed by Indigenous Knowledge, Local Knowledge, information from baseline studies, and professional judgement. The assumptions made for the traditional foods diet (i.e., amounts consumed and food types) were informed by an existing English River First Nations' country foods study and through engagement with a local fisher/trapper.

The main Project activities that may affect Human Health are air emissions during Construction, Operation, and Decommissioning, and the release of treated effluent to Whitefish Lake during Operation and Decommissioning. Long-term transport of groundwater constituents to Whitefish Lake in future centuries may also affect Human Health far into the future.

To mitigate effects of the Project on Human Health, Denison will develop and implement a site-wide water management plan, develop site-specific effluent treatment to treat constituents of potential concern to appropriate release limits, monitor and manage effluent, and create and implement a dust management plan.

The assessment of Human Health through the human health risk assessment predicted residual effects on the fisher/trapper receptor (one of six human receptors evaluated) from eating a relatively significant amount of fish near the inlet at Russell Lake. The assessment predicted that the fisher/trapper could ingest an elevated amount of selenium over the Project phases if 183 kg (402 lbs) of fish was consumed annually from Russell Lake. Comparatively, a traditional user's annual fish consumption was predicted to be 27 kg/year from the English River First Nation's Country Food Study (CanNorth 2017) and 88 kg/year for the high consumer for the boreal shield in the First Nations Food, Nutrition and Environment Study for Saskatchewan. The surface water and fish tissue concentrations at Russell Lake remained within an acceptable range. The fisher/trapper receptor is representative of one person who consumes a unique composition and quantity of traditional foods and the residual effect on the fisher/trapper receptor is not predicted to be significant. No residual effects were predicted for all other human receptors due to exposure to radionuclides and non-radionuclides throughout the food chain during the Project phases and far into the future during the future centuries.

For cumulative effects, existing, as well as reasonably foreseeable projects within the Wheeler River system have been considered for potential to interact with the Human Health VC due to air emissions and waterborne effluent. Air emissions from the Project are expected to be localized and unlikely to overlap with the existing or predicted emissions from existing and reasonably foreseeable projects. Potential residual effects from releases of treated mine water from existing and reasonably foreseeable projects are expected to be spatially limited in proximity to the mine site and are not anticipated to extend to the Wheeler River; therefore, no cumulative effects on human health from water and related aquatic pathways are expected.

Monitoring programs are outlined to confirm the effectiveness of mitigation measures and verifying and improving model predictions made in the assessment. Environmental monitoring would follow requirements and guidance in CSA N288.4-19 and would be informed by the results of engagement activities. Examples of monitoring include surface water, sediment, and soil samples, as well as fish tissue, benthic invertebrate tissue, and country food samples such as blueberries from Whitefish Lake, McGowan Lake, Russell Lake, and reference locations, as applicable.

16.5.2 Worker Health and Safety

Workers within the Project Area will be exposed to radiation from uranium-bearing materials, as well as to other workplace hazards typical of mining operations. The existing environment in the Project Area is characterized by background levels of radiation exposure from radioactive elements in the U-238 decay chain, as well as cosmic radiation. Background radiation doses are on the order of 2 millisieverts per annum (mSv/yr). Dose limits are defined in terms of incremental (above background) doses.

The Project will interact with the Worker Health and Safety VC through worker exposure to radiation from uranium-bearing materials in the wellfield and processing plant, mainly during Operation and Decommissioning. These materials include ore cuttings from well drilling, the uranium-bearing solution that carries uranium to the processing plant, precipitates removed from the processed solution, and uranium concentrate (i.e., yellowcake), which is the final product from the processing plant. Radon, a radioactive gas, is released from process materials to workplace air, and uranium concentrate dust is released to air during the dry parts of the process. Expected radiation doses to workers in different job categories were calculated for comparison to the worker dose limit of 20 mSv/yr (averaged over a 5-year period).

Mitigation measures that are part of Project design include a berm around the ore cuttings waste storage area, which provides shielding from radiation exposure, and worker use of powered air purifying respirators in the drying and packaging areas of the process plant. These mitigations were factored in during calculation of worker doses. Other mitigations include monitoring of exposure levels in work areas, personal dose monitoring of every worker, and work planning to manage time in proximity to radiation sources, all in accordance with a radiation protection plan. These mitigations are expected to keep worker radiation doses below the worker dose limit and as low as reasonably achievable. In addition, a health and safety plan will address management of non-radiological work hazards in accordance with federal and provincial regulations.

Radiation doses for all workers were calculated to be lower than the worker dose limit. Based on this result, and considering the use of monitoring and safe work practices under a radiation protection plan and health and safety plan, no residual effects on worker health are anticipated.

Cumulative effects for Worker Health and Safety were not considered since no residual adverse effects were identified.

Monitoring activities during all phases of the Project will include measuring the levels of exposure to radiation, radon, and radioactive dust in the workplace. Administrative (warning) levels and action levels will be defined for these measurements to facilitate work planning, corrective actions, and a safe working environment.

16.6 Land and Resource Use

Two broad categories of land and resource use were assessed relative to the Project: Indigenous Land and Resource Use (ILRU) and Other Land and Resource Use (OLRU). ILRU considered traditional or subsistence practices by Indigenous people including hunting and fishing for domestic purposes, as well as non-commercial trapping of furbearers for food or fur, gathering of natural items for ceremonial practices, herbs, roots, berries, plant medicines, food, and firewood. OLRU considered both recreational and commercial use of resources, including hunting and fishing, commercial trapping, commercial fishing, lodge and outfitting services, ecotourism, forestry, and mining, which may be conducted by either Indigenous or non-Indigenous peoples under the authority of provincial licenses or by resource allocations. It is acknowledged that certain activities in each of these categories are pursued by the same individuals, as resource harvesters often pursue both traditional and commercial harvests simultaneously.

16.6.1 Indigenous Land and Resource Use

The Project is within the Nuhtsiye-kwi Benéne of ERFN, the traditional territory of Kineepik Metis Local #9, and within the Nuhenéné, the traditional territory of the Athabasca Denesų̈łiné. Much of the documented shared use of land and resources by Indigenous communities occurs close to their primary populated communities, although some uses are documented in proximity to the Project footprint and surrounding areas such as Russell Lake and along the Wheeler River. Recorded uses include hunting sites (moose and woodland caribou), the gathering of plants for food or subsistence purposes, trapping of aquatic furbearers (including beaver and muskrat), and fishing (including Walleye, Northern Pike, Lake Trout, Lake Whitefish, and Arctic Grayling). Proximal to the Project, many of the most recent uses were by an ERFN Trapper who passed away prior to the filing of the EIS. These uses are considered as representative of future land use by the ERFN. Other

Indigenous groups also have documented uses on Russell Lake, proximal to the Fox Lake Road, and areas south of the Key Lake Gate. The Key Lake gate on Highway 914 limits access to areas close to the Project site to lease holders (e.g., cabin owners) and some Indigenous communities. The closest areas of more intensive community use are ERFN's cultural camp at kilometre 160 and Kineepik Métis Local #9/Northern Village of Pinehouse's cultural camp at kilometre 67, which are south of the gate along Highway 914.

The various phases of the Project have the potential to induce different effects on ILRU and its KIs: resource availability for harvesting subsistence resources (terrestrial and aquatic resource availability and health of resources), land and waters available for traditional practices, and perceived suitability of land and resources (aesthetic experience, perceived suitability of resources for safe use, and quality of resources of consumption).

The KIs of resource availability, land and waters available for traditional practices, and perceived suitability of land and resources for aesthetics were not carried forward to residual effects assessment and can be eliminated, reduced, or controlled through mitigation measures. Mitigation for these effects is well understood. It is expected that wildlife and fish will still be available and abundant enough to support traditional harvesting practices, the health of the resources is not expected to be affected, and the lands and waters affected by the Project are minimized, in part by the small Project Area, which is 1.69 square kilometres.

The Project is expected to have an adverse effect on the perceived suitability of the lands and resources therein for some resource users in the area closest to the Project Area and on either side of local access roads and the haul road for the Key Lake operation – McArthur River operation. The effects are a result of the Project's presence, the introduction of a different uranium mining method in the region, noise, dust, increased competition for resources, and concern about personal exposure to contaminated water and soils. This effect is anticipated to vary by individual; some may continue activities and others may avoid areas close to the Project.

To mitigate effects of the Project on the perceived suitability of lands and the resources therein, Denison will develop management plans, implement emergency response programs, and minimize the amount of land disturbed by the Project to the greatest extent practicable. Mitigation will reduce risks associated with increased traffic, noise, air quality, the potential for constituents of potential concern to enter the environment, waste management, the introduction of a different mining method, and human health. The mitigation strategies that have been proposed have been successful in similar contexts, such as management of noise, traffic, dust, and competition for resources.

Denison acknowledges that Indigenous communities continue to have an interest in obtaining a greater understanding about the ISR mining method, and will continue to engage meaningfully with them through the life of the Project. Overall, given the extent of the ILRU LSA, adverse effects are low in magnitude, the geographic extent of effects are limited, and the effects are reversible, the residual effects on ILRU are anticipated to be not significant.

The residual effects of the Project are expected to interact with the residual effects of other projects and activities in the ILRU RSA, resulting in potential cumulative effects to Indigenous land use activity in the area. This is largely due to the proposed Highway 914 extension project.

With mitigation measures, the residual effects of the Project and the cumulative effects (interacting with residual effects from other projects and activities) may result in increased competition as additional resource users may access the area from locations further north, as well as from the south as the Key Lake gate would be bypassed. These cumulative changes could exacerbate perceptions of the areas suitability for continued Indigenous land and resource use.

Monitoring or follow-up activities proposed for ILRU relate largely to those programs associated with the biophysical environment.

16.6.2 Other Land and Resource Use

OLRU activities include commercial and recreational activities, which tend to occur in the OLRU LSA and consist of trapping, commercial fishing, and leaseholders and cabin owners. Trapping and commercial fishing take place in the OLRU LSA and was known to be conducted exclusively by the ERFN Trapper who passed away prior to the time of filing the EIS. It is anticipated that the ERFN trapline allocations may be passed to another individual in the future. Lease holders and cabin owners with land tenures can also be found near the Project. The current extent of commercial and recreational uses is limited due to access restrictions at the Key Lake gate, which limit access to those with a lease, commercial license, those who operate outfitting businesses, and members from select Indigenous communities.

The various phases of the Project will have different effects on OLRU and its KIs: change to resource availability (including terrestrial and aquatic resource availability and the health of resources); land available to conduct recreational and commercial harvests (including the availability and accessibility of land and waterways); and changes to the perceived suitability of land and resources (including aesthetics of resource use and perceived suitability of resources for safe use). The KIs of resource availability and land available to conduct recreational and commercial harvests were not carried forward to residual effects assessment as these effects can be eliminated, reduced, or controlled through mitigation measures.

The Project is predicted to have an adverse effect on the perceived suitability of the lands and resources therein for some resource users in the area closest to the Project Area and on either side of local access roads and the haul road for the Key Lake mill operation – McArthur River operation. The perceived suitability of lands and resources for safe use may be affected by the Project's presence, traffic, noise, dust dispersion, air emissions, and the potential for constituents of potential concern to enter to the environment. The introduction of a different uranium mining method in the region may further cause concern for some resource users. This effect is anticipated to vary by individual; some may continue activities and others may avoid areas close to the Project. Typically, the magnitude of perceived effects declines with increasing distance from the Project and Project activities.

To mitigate effects of the Project on the perceived suitability of lands and the resources therein, Denison will develop management plans, implement emergency response programs, and minimize the amount of land disturbed by the Project. Mitigation will reduce risks associated with increased traffic, noise, air quality, the potential for constituents of potential concern to enter the environment, waste management, the introduction of a different mining method, and human health. The mitigation strategies that have been proposed have been successful in similar contexts, such as management of noise, traffic, dust, and competition for resources.

Denison had established a relationship with the ERFN Trapper who recently passed away. If another trapper is interested in taking over the late ERFN Trapper's trapline in the future, Denison will enter into a relationship with them similar to what was contemplated previously with the ERFN Trapper. Given the low magnitude and limited geographic extent of residual effects along with the context that resource users have exhibited resiliency to changing conditions, the overall residual effects of the Project on OLRU are predicted to be not significant.

The residual effects of the Project are expected to interact with the residual effects of other projects and activities in the OLRU RSA, namely the Highway 914 extension project, resulting in potential cumulative effects to commercial and recreational resource users. This is largely due to the Highway 914 extension project.

With mitigation measures, the residual effects of the Project and the cumulative effects (interacting with residual effects from other projects and activities) may result in increased competition as additional resource users may access the area from locations further north, as well as from the south as the Key Lake gate would be bypassed. As most other land and resource use activities are regulated by the Province, it is not expected that direct competition for uses would be affected, however the presence of additional people may reduce the wilderness experience for some users. These cumulative changes could exacerbate perceptions of the area's suitability for continued use.

Monitoring or follow-up activities proposed for OLRU relate largely to those programs associated with the biophysical environment, such as for wildlife and water quality. No additional monitoring or follow-up activities are proposed for OLRU.

16.6.3 Heritage Resources

The Project includes areas that the Government of Saskatchewan's Heritage Conservation Branch classify as being sensitive (i.e., areas that have the potential to contain heritage resources as they are in undisturbed terrain near significant waterbodies, rivers, or streams). Heritage resources consist of physical and cultural heritage sites. Archaeological sites were considered in the Heritage

Resources assessment. Denison completed two Heritage Resources assessments during baseline studies, and two archaeological sites were identified in the Project Area. Since each archaeological site included only a single artifact, the Heritage Conservation Branch determined that the sites were of low interpretive value and work could continue as planned.

Despite the completion of two Heritage Resources assessments during baseline studies, it is possible that additional archaeological sites may be identified during the life of the Project. Project activities that may disturb the ground, including clearing and levelling activities, drilling of holes, infrastructure construction, reclamation, and traffic throughout the life of the Project, may affect archaeological sites.

To mitigate effects on archaeological sites, Denison has developed and implemented a Heritage Resources Management Plan (HRMP). The HRMP outlines the steps that Denison will take if an additional archaeological site is identified during the life of the Project. These steps include having the archaeological site assessed by a qualified archaeologist, holding discussions with local Indigenous leadership, and implementing mitigation measures as directed by the Heritage Conservation Branch. The mitigation measures may include avoidance of the site, systematic testing of the site, an archaeological excavation, and/or construction monitoring.

Residual effects on archaeological sites may involve a decrease in the number of archaeological sites. The assessment predicted that given the low number of archaeological sites identified in the Project Area, and considering measures outlined in the HRMP to make sure any additional archaeological sites are assessed properly, the likelihood of residual effects on Heritage Resources is considered low with a low frequency of occurrence. This resulted in the overall conclusion that residual effects of the Project on Heritage Resources are anticipated to be not significant.

16.7 Quality of Life

16.7.1 Cultural Expression

Cultural Expression provides an understanding of the activities that Indigenous people in the LSA, which is reflective of the same spatial boundaries as Indigenous Land and Resource Use, which are considered as the activities that support Indigenous communities' cultural continuity. The Cultural Expression VC considers changes to the KIs of knowledge transmission and the traditional diet. Knowledge transmission encompasses cultural activities and practices that provide an opportunity for knowledge sharing among family and community members with measurable parameters including changes to cultural practices that support knowledge transmission and changes in the location of cultural practices that support knowledge transmission. The traditional diet includes species such as moose, woodland caribou, fish, and berries, and is of cultural and traditional importance to Indigenous communities. Traditional diet considered the measurable parameters of changes in the availability of country foods included in a traditional diet and changes in the perceived suitability and safety of foods in a traditional diet.

The Project and its activities may change the location of cultural practices that support knowledge transmission and the participation in cultural practices and subsequent knowledge transmission. Indigenous Land and Resource Use changes are expected to persist in proximity to the Project and in the LSA; however, knowledge transmission is often site-specific. For example, cultural camps support the transmission of knowledge on the land. Cultural camps near the Project Area are located south of the Key Lake gate, with the ERFN cultural camp located at kilometre 160 of Highway 914, and cultural camps hosted by Pinehouse Lake held at Gordon Lake, Muskeg Lake, and at kilometre 67 of Highway 914. These locations are not expected to be affected by the Project. The anticipated lack of effect to cultural camps, a small Project footprint, and likely persistence of the undertaking ILRU activities throughout the LSA are expected to minimize potential effects of the Project to knowledge transmission. Further to this, participation in the worker rotation system is not expected to substantially change opportunities for Project employees to participate the traditional land use activities that support cultural activities and associated knowledge transmission.

For traditional diet, the Project may reduce the availability of country foods because of changes to the abundance of harvested resources, restricted access, and avoidance of areas where the Project is located, including areas where hunting, fishing, trapping, and gathering occur. For Indigenous peoples, the traditional diet is often preferred, and it is considered healthy. The Project's potential effects on the availability and abundance of species that are important to a traditional diet (e.g., moose, Walleye) are expected to be low; however, the perceived suitability of country foods was still considered as having potential to be adversely affected by the Project.

The Project may adversely affect traditional diet for residents of the LSA through perceived changes in the suitability and safety of resources that support a traditional diet, particularly for activities that occur in proximity to the Project. As a result, some resource users may change their behaviour and limit the amount of traditional foods in their diet. The availability and abundance of those resources is not expected to substantially change; therefore, such changes may be limited to a small number of users proximal to the Project site. The residual effect to the traditional diet overall is expected to be low in magnitude.

To mitigate effects of the Project on the traditional diet, mitigation measures associated with the Project include adopting culturally sensitive employment policies to reduce the potential effects of Project employment on cultural activities; working with Indigenous communities to understand culturally important periods; reducing the Project footprint to the extent practicable; reducing risks associated to increased traffic, noise, air quality, and the potential for constituents of potential concern to enter the environment; and implementing an environmental monitoring program consistent with Canadian Standards Association for nuclear facilities and mines.

The residual effects of the Project are expected to interact with the residual effects of other projects and activities in the Cultural Expression RSA resulting in potential cumulative effects. This is largely due to the Highway 914 extension project. As the effects of the Highway 914 extension project on harvested resources are not tied to perceived changes in the suitability of harvested resources, no overlap occurs between the effects of the projects on the traditional diet key indicator, specifically changes in the perceived suitability and safety of country foods in a traditional diet. Therefore, no cumulative effect is anticipated for Cultural Expression.

No monitoring or follow-up activities are proposed specific to Cultural Expression. Monitoring and follow-up activities proposed for ILRU will focus on the biophysical environment and the resources that support cultural expression.

16.7.2 Community Well-being

Community well-being can be defined in multiple ways, depending on the community or the people being considered. The assessment focused on ways in which the Project could interact with Community Well-being, and included the KIs of population and demographics, employment and associated income for local workers, and community cohesion. Individuals and families may have experiences associated with the Project that vary in different ways, with the possibility of both positive and negative outcomes.

The Project is not expected to substantially change the population and demographics of communities in the LSA because 1) the Project will rely on a fly-in/fly-out worker rotation system with pick-up points in the LSA and outside of the LSA, thus minimizing any requirement to relocate to access employment and 2) the definition of Residents of Saskatchewan’s North currently requires an extended period of residency in order to qualify. These factors limit the potential for in-migration to the LSA.

Project employment and business opportunities could provide additional income to individuals and households. Additional income could be beneficial as increased income is associated with improved health outcomes, or if used to support traditional harvesting activities (e.g., buying a new quad, repairing a boat) or purchasing healthier foods. Increased income has also been shown in various studies to have certain negative impacts on community cohesion, such as potential for increased use of substances, spending time away from family during worker rotation, with resulting potential increases in household stress levels.

To mitigate effects of the Project on community cohesion, Denison will work with communities to develop culturally sensitive hiring practices and provide supports to individual workers and their families. Supports could include (i) providing multiple centrally located pick-up points for fly-in/fly-out workers to minimize the potential for migration and time spent away from families; (ii) establishing health and wellness programming, life skills and financial literacy programming, an Employee and Family Assistance Program, a no drug and alcohol policy on site; and (iii) implementing culturally sensitive employment policies (e.g., having an Elder on site for counselling). After mitigation, and given the small size of the operation (180 employees during operation), Project residual effects related to income and community cohesion are expected to result in positive and some potentially adverse outcomes. The communities overall are resilient and expected to accommodate the anticipated changes as there is already considerable experience with other similar fly-in/fly-out operations in the region. Overall, the conclusion for changes to income and community cohesion relative to Community Well-being is that the residual effects are expected to be not significant.

The cumulative effects assessment considered the Highway 914 extension project; however, the two projects (the Project and the Highway 914 extension project) have distinct local and regional study areas, meaning the geographic boundaries for each project are unique. Potential changes to community cohesion resulting from employment are unlikely to result in any discernable changes, particularly as the opportunities associated with the all-weather road may involve a broader labour pool. Accordingly, the cumulative effects conclusions are predicted to be not significant.

Monitoring and follow-up would be used to monitor progress on achieving employment and contracting targets and identify opportunities to improve employment and procurement, continue and maintain communication with communities, and contribute to the overall and continual improvement of the Project.

16.7.3 Infrastructure and Services

Infrastructure and services play an important function to the communities in the LSA and beyond. The assessment considered the potential for the various phases of the Project to affect KIs related to Infrastructure and Services VC that were identified as important through Project-related engagement – including traffic, community infrastructure and services, and emergency services capacity. Changes could be caused by increased traffic volumes and potential increases in collisions on roadways requiring the use of emergency services, increased demand on community infrastructure and services (e.g., support for family members of workers participating in the worker rotation system), and increased demand for emergency services as in the event of an accident or malfunction at the mine site or along Highway 914.

Project related traffic volumes are expected to be similar during Construction and Operation and are anticipated to be similar or less during Decommissioning. On Highway 914 between the Key Lake gatehouse and the Northern Village of Pinehouse Lake access road, truck average annual daily traffic (TAADT) is expected to increase between 16% to 40% over the life of the mine. From a total volume basis, this amounts to an additional 14 trucks per day during Construction and 18 trucks per day during Operation (or less than one truck per hour if operating on a 24-hour basis). On Highway 914 from Highway 165 to the Pinehouse Lake access road, TAADT is expected to increase between 6% to 8% over the life of the mine. From a total volume basis, this amounts to an additional 14 trucks per day during Construction and 18 trucks per day during Operation (or less than one truck per hour if operating on a 24-hour basis during construction). On Highway 165 from Highway 155 to

Highway 914, TAADT is expected to increase between 0.7% to 4.0% over the life of the mine. From a total volume basis, this amounts to an additional seven truck per day during Construction and nine trucks per day during Operation. This increased truck traffic is considered low in magnitude.

As the LSA communities are located away from the Project site, most physical Project activities, except for vehicular traffic to move equipment, supplies and personnel, are not predicted to affect Infrastructure and Services in the LSA. The Project site and associated camp will be fully equipped to meet the needs of the Project and its workforce and will operate independently. The extent to which community infrastructure and services and health and emergency services will be affected would vary by community and individual and depend on the capacity of existing facilities and services. Supports provided to employees on site, inclusive of an Employee and Family Assistance Program, are expected to minimize potential effects to community services.

Accidents and malfunctions are the key factor that could increase pressure on emergency services; however, they were determined to be highly unlikely to unlikely in probability (EcoMetrix 2022). As they would be mitigated by various preventative operational protocols and the emergency response plans Denison will implement. Vehicular accidents are the only potential effects pathway for the Infrastructure and Services VC, that could not be effectively addressed on site and may, therefore, require emergency services from communities in the LSA.

Mitigation for Infrastructure and Services broadly includes the use of designated pick-up and drop-off points; appropriate driver training; an Emergency Response Plan in case of a spill; on-site and accessible services and programs for workers and families; ongoing communication between Denison, LSA communities, and relevant authorities; an on-site primary care paramedic; a health and safety management plan; services and programs provided on-site and accessible to workers (including health and wellness programming, health promotion, immunization programs, life skills programming, and workforce education); and an Employee and Family Assistance Program.

The communities are generally resilient and are expected to accommodate the anticipated changes associated with the Project as they have considerable experience with other similar uranium operations in the region. The overall conclusion relative to changes to Infrastructure and Services is not significant.

The cumulative effects assessment considered the Highway 914 extension project, which has the potential to increase traffic volumes along the existing Highway 914. Although estimates of traffic volume increases were not provided in the Highway 914 extension project EIS, it is safe to assume that the cumulative effects could be an increased requirement for maintenance and increased potential for collisions that could result in injury or death to people and wildlife. The Highway 914 extension project implemented the following mitigations:

- reducing project-related traffic during construction;
- implementing speed limits in specific areas of concern;

- installing and maintaining signage along the highway; and
- conducting regular inspection and maintenance activities on the highway and associated components.

Although the cumulative changes to traffic may be discernable to users of the highway, it is anticipated that the overall increases in traffic can be effectively managed.

With respect to community infrastructure and services, both projects (the Project and the Highway 914 extension project) are removed from communities, and thus the potential for changes in demand could stem from (a) employment and (b) emergency response. With respect to employment, the Highway 914 extension project may involve a broader labour pool, and as such cumulative effects are not anticipated. For emergency response, the Highway 914 extension project would allow for connections to community-based emergency services beyond the LSA, thus potentially reducing capacity constraints on any one community. Accordingly, the cumulative effects conclusions are predicted to be not significant for Infrastructure and Services.

With the application of mitigation measures, the assessment of cumulative effects and determination of significance for community emergency services capacity does not change with consideration of the Highway 914 extension project. For monitoring and follow-up, vehicular accidents will be monitored on Highways 165 and 914 for noticeable increases. Denison will also continue to liaise with communities, service providers, mine/mill operators, and emergency response providers for the duration of the Project.

16.8 Economics

The various phases of the Project will have different effects on Economy and its KIs: employment and training, income, the traditional economy, government revenues, and business opportunities.

The Project is expected to create employment and business opportunities and increase income for workers and businesses in the LSA. Opportunities include an estimated workforce during the Construction period of approximately 300 people and during the Operations phase of 180 people. Mining positions are higher paying than many other industrial positions. Residents and communities in the LSA will be given first priority for employment and training and business opportunities, followed by Indigenous and/or other communities in the RSA. The Project is also anticipated to positively affect the governments of Saskatchewan and Canada through payments (e.g., uranium royalties, corporation income tax, personal income tax) that are directly and indirectly linked to the Project activities. Because the Project is expected to positively affect employment and training, income, business opportunities, and government revenues, these effects were not carried through the residual effects evaluation.

Changes associated with Project employment may also affect the traditional economy of residents in the LSA through: (1) the physical presence of the Project and its associated activities and how these may interact with traditional activities and (2) participation in the wage economy and how this can contribute to an individual’s ability to partake in traditional activities, including that the commuter-rotation system may result in some individuals having less time to participate in the traditional economy. The Project is not expected to have a significant effect on Indigenous and other land and resource use close to the Project site; these types of land and resource use activities near existing uranium operations have persisted in proximity to these sites. With respect to traditional resource users in the LSA, there is less certainty regarding the extent to which participation in the workforce may affect individual traditional resource use behaviours. It is likely to vary by individual, and in many instances traditional resource use may be positively supported by the income gained through employment.

To maximize potential positive effects of the Project for the Economy VC, mitigation includes the implementation of a workforce development plan to initially prioritize Indigenous and non-Indigenous Communities of Interest in the LSA for employment and training opportunities; establishment of a procurement approach through all phases of the Project with a focus on businesses based within the LSA communities, followed by Indigenous and/or businesses in the Regional Study Area; and development of the Project’s Surface Lease Agreement and Human Resource Development Agreement.

Generally, the mitigation measures designed to protect Indigenous land and resource use measures are expected to be protective of participation in the traditional economy. For certain specific cases, there may be a need for one-off arrangements (i.e., a trapper compensation agreement if/when an existing trapline is passed to another individual), to be responsive to other considerations potentially brought forward by select Indigenous communities.

For the most part, effects of the Project are expected to be positive to the Economy VC and have the potential to contribute to both the LSA and RSA and beyond. The only potential residual adverse effects relate to the traditional economy, which can be mitigated in large part by measures related to potential changes to land and resources use. Any residual adverse effects will occur in the LSA, and are expected to be potentially frequently occurring (due to the daily nature of work) but negligible to low in magnitude, medium-term in duration, and reversible after Decommissioning.

The cumulative effects assessment, which involved the Highway 914 extension project, considered the same factors as changes to ILRU. Cumulatively, the magnitude of changes to traditional economy are associated largely with changes resulting from the Highway 914 road extension project, as easing access would result in an increase of users in the area potentially putting pressure on the items harvested as part of the traditional economy, particularly relative to existing conditions in which access restrictions are currently in place.

Monitoring would be used to assess progress on achieving employment and contracting outcomes. Follow-up items will be focussed on the continuation and maintenance of communication about topics of importance with Indigenous and non-Indigenous communities. Monitoring relative to the traditional economy includes those activities associated with ILRU.

16.9 Conclusions

On the basis of the Project information and related evaluation and assessment of effects, Denison believes that the Project can be constructed, operated, and decommissioned in a manner that is not likely to cause significant adverse effects to the biophysical or human environments.

16.10 References

CanNorth. 2017. *English River First Nation Country Foods Study – Final Report* (No. Project No. 2147). Canada North Environmental Services.

Ecometrix Incorporated (Ecometrix). 2022. *Assessment of Accidents and Malfunctions – Technical Supporting Document for the Wheeler River Project*. Report Prepared for Denison Mines, May 2022. Ref. 20-2065.

Appendix 16-A Summary of Residual Effects

See file “S16_App 16-A Summary of Residual Effects_Wheeler River.pdf”

Appendix 16-B Summary of Cumulative Effects

See file ”S16_App 16-B Summary of Cumulative Effects_Wheeler River.pdf”

Appendix 16-C Summary of Monitoring and Follow-up Programs

See file "S16_App 16-C Summary of Monitoring & Follow-up Programs_Wheeler River.pdf"