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Annual Program Report

Regulatory Oversight Report for Uranium Mines, Mills, Historic, and Decommissioned Sites in Canada: 2020

Public Meeting

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CNSC Staff

Rapport annuel sur les programmes

Rapport de surveillance réglementaire des mines et usines de concentration d'uranium et des sites historiques et déclassés au Canada : 2020

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Summary

This Commission Member Document (CMD) is on the *Regulatory Oversight Report for Uranium Mines, Mills, Historic, and Decommissioned Sites in Canada: 2020*.

This CMD addresses the Commission's action outlined in the Record of Decision for CNSC staff to continue working with the licensees to increase transparency and make relevant preliminary decommissioning plan information available to the public, with the exception of the propriety information.

There are no actions requested of the Commission. This CMD is for information only.

Résumé

Le présent document à l'intention des commissaires (CMD) porte sur le *Rapport de surveillance réglementaire des mines et usines de concentration d'uranium et des sites historiques et déclassés au Canada : 2020*.

Le présent CMD concerne les mesures prises par la Commission qui figurent dans le compte rendu des décisions et qui prévoient que le personnel de la CCSN poursuivra son travail auprès des titulaires de permis afin d'accroître la transparence et de mettre à la disposition du public les renseignements pertinents issus des plans préliminaires de déclassement, à l'exception de l'information exclusive.

Aucune mesure n'est requise de la Commission. Ce CMD est fourni à titre d'information seulement

Signed/signé le

September 10, 2021

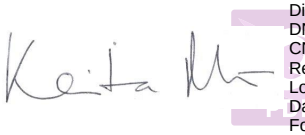

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TABLE OF CONTENTS

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PLAIN LANGUAGE SUMMARY

The *Regulatory Oversight Report for Uranium Mines, Mills, Historic, and Decommissioned Sites in Canada: 2020* provides information about the CNSC's work to verify the safety and protection of people and the environment around all uranium mines, mills, historic, and decommissioned sites in Canada. All operating uranium mines and mills are located in northern Saskatchewan. The uranium mines and mills continued to operate safely in 2020. The historic and decommissioned sites remained stable from 2018 to 2020. Monitoring continues to show that the country foods and water surrounding the mines and mills remains safe to eat and drink. There were no releases that could have harmed human health or the environment.

This report provides information on the following uranium mines and mills in Saskatchewan for the 2020 reporting period:

- Cigar Lake –uranium mine (operating)
- McArthur River – uranium mine (in care and maintenance)
- Rabbit Lake – uranium mine and mill (in care and maintenance)
- Key Lake – uranium mill (in care and maintenance)
- McClean Lake – uranium mine and mill (operating).

This report provides information on the following historic and decommissioned sites in Canada for the 2018 to 2020 reporting period:

Historic

- Gunnar legacy uranium mine (Saskatchewan)
- Madawaska closed uranium mine (Ontario).

Decommissioned

- Former Lorado mill site (Saskatchewan)
- Beaverlodge mine site (Saskatchewan)
- Cluff Lake uranium mine and mill (Saskatchewan)
- Rayrock closed mine (Northwest Territories)
- Port Radium closed mine (Northwest Territories)
- Agnew Lake tailings management facility (Ontario)
- Bicroft tailings storage facility (Ontario)
- Dyno closed mine (Ontario)
- Elliot Lake historic sites (Ontario)
- Denison and Stanrock closed mines (Ontario)
- Deloro mine (Ontario).

When a site is in a state of care and maintenance, a mine and/or mill is not mining, milling or processing uranium ore, and is not producing uranium concentrate (yellowcake). These facilities still have sufficient staff on site to complete ongoing maintenance, to maintain water treatment systems, and conduct environmental monitoring programs for the protection of workers, the public and the environment.

Each year, CNSC inspectors conduct inspections at uranium mines and mills. The number of inspections and the focus of the inspections depend on performance and operating status of the mine or mill.

Due to the COVID-19 pandemic, all CNSC staff were directed to work from home. The majority of inspections of uranium mines and mills were conducted remotely in 2020 due to measures taken against the COVID-19 pandemic. The CNSC uses a risk-informed approach when planning inspections. CNSC inspectors used a combination of video conferencing, email and document/photograph review to conduct these remote inspections. Onsite inspections were conducted when there was a risk-informed need and could be done safely, or postponed if there was no risk-informed need or could not be done safely. In 2020, CNSC staff performed a total of 17 inspections across the 5 active mines and mills. From 2018 to 2020, CNSC staff performed a total of 14 inspections across the 13 historic and decommissioned sites. As a result of the inspections, 11 non-compliances were issued at active sites and 1 non-compliance was issued at a historic and decommissioned site. All concerns raised during the inspections have been addressed by the operators.

Although the CNSC evaluates operating nuclear facilities across 14 functional areas, this report focuses on the following 3 areas:

- Radiation protection: In 2020, the maximum individual radiation dose to a worker at any of the 5 uranium mine and mill facilities was 9% of the annual regulatory limit. No workers exceeded their regulatory radiation dose limit.
- Environmental protection: Each mine and mill facility uses water as part of the mining and milling process. All water used in the operation must be treated before being discharged back to the environment. All discharged water met the federal or provincial discharge requirements, ensuring that the persons near the facility are safe. Licensees also conducted air sampling around their sites as well as vegetation sampling, with all results being well below the regulatory limits. In addition, CNSC licensees are required to report any unauthorized release of hazardous substances or nuclear substances to the environment to the CNSC and other relevant regulatory authorities. In 2020, there were 6 unauthorized releases reported. These amounts were within the normal range of releases for uranium mines and mills. All releases were corrected by the mine or mill operators and there were no lasting impacts to the environment as a result of these releases.
- Conventional health and safety: Licensees of all mining and milling operations must report any lost time, workplace-related injuries to the CNSC and provincial agencies. In 2020 there were 2 injuries that required reporting. This is consistent with previous years and injury data from other mining sectors.

As an agent of the Government of Canada, the CNSC recognizes and understands the importance of building relationships with Indigenous peoples in Canada. In 2020, CNSC staff efforts continued to support their ongoing commitment to meeting consultation and engagement obligations and continuing to build relationships with Indigenous peoples with interests in Canada's uranium mines and mills. As a result of recommendations from the Commission, CNSC staff continue to meet with Indigenous groups and communities before the public consultation period to provide information and seek opportunity for improvement on the regulatory oversight report.

In summary, CNSC staff confirm that:

- workers at each facility were safe and properly protected
- there were no releases that could harm the environment or health and safety of people
- all water released from the facility was safe
- airborne radiation was not increased as a result of these facilities
- fish and plants were safe to eat
- COVID-19 did not affect the CNSC's ability to verify the safety of uranium mines, mills, historic, and decommissioned facilities.

1 INTRODUCTION

1.1 Background

The Canadian Nuclear Safety Commission (CNSC) regulates Canada's uranium mines and mills to protect health, safety, security and the environment; to implement Canada's international commitments on the peaceful use of nuclear energy; and to disseminate objective scientific, technical and regulatory information to the public. This mandate is derived from the *Nuclear Safety and Control Act* (NSCA) [1]. Licensees must comply with the NSCA, the regulations made thereunder, and licence conditions imposed by the Commission which includes specific licence conditions as well as their licensing basis.

Each year the CNSC produces a regulatory oversight report on the operating performance of Canada's uranium mine and mill licensees and licensed facilities. This report includes data for the 2020 calendar year for uranium mines and mills. Every third year, the CNSC report also includes updates on historic and decommissioned uranium mine and mill sites. Data for historic and decommissioned sites was last presented in the *Regulatory Oversight Report for Uranium Mines, Mills, Historic and Decommissioned Sites in Canada: 2017* [2] and will be presented again in this report, covering the calendar years of 2018 to 2020.

This report:

- describes the CNSC's regulatory efforts, public information, Indigenous, and community engagement activities, and Independent Environmental Monitoring Program (IEMP)
- includes information on licensee operation, licence changes, major developments at licensed facilities, as well as any significant events
- presents the performance rating for each safety and control area (SCA) for uranium mine and mill facilities regulated by the CNSC
- presents performance data on the radiation protection, environmental protection and conventional health and safety SCAs for each licensed facility.

This report summarizes CNSC staff's assessment of the following regulated uranium mine and mill facilities:

- Cigar Lake Operation
- McArthur River Operation
- Rabbit Lake Operation
- Key Lake Operation
- McClean Lake Operation.

This report summarizes CNSC staff's assessment of the following historic and decommissioned facilities:

Historic

- Gunnar legacy uranium mine (Saskatchewan)
- Madawaska closed uranium mine (Ontario).

Decommissioned

- Former Lorado mill (Saskatchewan)
- Beaverlodge mine site (Saskatchewan)
- Cluff Lake uranium mine and mill (Saskatchewan)
- Rayrock closed mine (Northwest Territories)
- Port Radium closed mine (Northwest Territories)
- Agnew Lake tailings management facility (Ontario)
- Bicroft tailings storage facility (Ontario)
- Dyno closed mine (Ontario)
- Elliot Lake historic sites (Ontario)
- Denison and Stanrock closed mines (Ontario)
- Deloro mine (Ontario).

Throughout the review period, CNSC staff continued to conduct compliance verification activities, including inspections, technical assessments, reviews of reports submitted by licensees, event and incident reviews and ongoing exchanges of information with the licensees of all uranium mine and mill facilities.

1.2 CNSC Regulatory Efforts

1.2.1 Licensing

The CNSC regulates each uranium mine and mill under a separate licence. A licence granted by the Commission defines licence terms, licensed activities and licence conditions. Tables summarizing the uranium mine and mill licences can be found in appendix A. Each uranium mine and/or mill licence issued by the Commission is accompanied by a licence conditions handbook (LCH) which contains compliance verification criteria used by CNSC staff to determine compliance with the conditions set out in the licence. All changes made to the LCH during this review period are also provided in appendix A.

1.2.2 Regulatory Developments

CNSC staff continue to modernize the regulatory framework with the CNSC's series of regulatory and guidance documents. Licensees continue to be in compliance with the regulatory documents or applicable standards identified in their LCHs during the transition process. The licensees are on track for meeting all established deadlines. CNSC staff continue to monitor progress through regular licensing meetings.

Table 1.1 lists updates made to the CNSC regulatory documents since 2018, including the implementation status, that apply to the uranium mine and mill licensees.

Table 1.1: Regulatory documents applicable to uranium mine and mill facilities

Regulatory document	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
REGDOC-2.2.2, *Personnel Training*, Version 2 December 2016	Implemented as part of 2021 licence renewal	Implementation to be completed October 2022	Implementation to be completed October 2022	Implementation to be completed October 2022	Implemented
REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response*, Version 2 February 2017	Implemented as part of 2021 licence renewal	To be implemented as part of next LCH update	To be implemented as part of next LCH update	Implemented as part of 2021 LCH update	Implemented
REGDOC-2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures*, Version 1.1, April 2017	Implemented as part of 2021 licence renewal	To be implemented as part of next LCH update	To be implemented as part of next LCH update	Implemented as part of 2021 LCH update	Implemented
REGDOC-1.6.1, *Licence Application Guide: Nuclear Substances and Radiation Devices*, Version 2, May 2017	Implemented as part of 2021 licence renewal	Implemented	To be implemented as part of next LCH update	Implemented as part of 2021 LCH update	Implemented
REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills*, January 2018	Implemented as part of 2021 licence renewal	Implemented	To be implemented as part of next LCH update	Implemented as part of 2021 LCH update	Implemented

Regulatory document	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
REGDOC-2.13.1, *Safeguards and Nuclear Material Accountancy* February 2018	Implemented as part of 2021 licence renewal	To be implemented as part of next LCH update	To be implemented as part of next LCH update	Implemented as part of 2021 LCH update	Implemented
REGDOC-2.5.4, *Design of Uranium Mines and Mills: Ventilation Systems* March 2018	Implemented as part of 2021 licence renewal	Implemented	To be implemented as part of next LCH update	Implemented as part of 2021 LCH update	Implemented
REGDOC-2.1.2, *Safety Culture* April 2018	Implementation to be completed June 2022	Implementation to be completed June 2022	Implementation to be completed June 2022	Implementation to be completed June 2022	Implemented
REGDOC-3.2.1, *Public Information and Disclosures* May 2018	Implemented as part of 2021 licence renewal	To be implemented as part of next LCH update	To be implemented as part of next LCH update	Implemented as part of 2021 LCH update	Implemented
REGDOC-2.11.1, *Waste Management, Volume III: Assessing the Long-Term Safety of Radioactive Waste Management* May 2018	Not applicable	Not applicable	Gap analysis to be requested	Gap analysis to be requested	Implemented
REGDOC-2.11.1, *Waste Management, Volume II: Management of Uranium Mine Waste Rock and Mill Tailings* November 2018	Implemented as part of 2021 licence renewal	To be implemented as part of next LCH update	To be implemented as part of next LCH update	Implemented as part of 2021 LCH update	Implemented

1.2.3 Compliance

The CNSC determines licensee compliance through verification, enforcement and reporting activities. CNSC staff develop compliance plans for each facility commensurate with their associated risk and implement these plans by conducting regulatory activities which include onsite and remote inspections, technical assessments of licensee programs, processes and reports. Changes to compliance plans are made on an ongoing basis in response to events, facility modifications and changes in licensee performance.

On March 15, 2020, the CNSC activated the Business Continuity Plan (BCP) in response to the COVID-19 pandemic. Effective March 16, all CNSC staff were directed to work from home. Where possible, in 2020, inspections of uranium mines and mills scheduled after March 16 were conducted remotely.

Tables 1.2 and 1.3 present data on CNSC staff inspections conducted at uranium mines, mills, historic, and decommissioned sites during the respective reporting period. Instances of non-compliance noted during these inspections were provided to the licensees in detailed inspection reports and recorded in the CNSC Regulatory Information Bank in order to ensure that corrective actions were tracked to completion. Examples of non-compliance include: failure to wear radiation monitoring equipment, non-compliance with the *National Fire Code* [3], failure to follow procedures, additional training needs identified, and incorrect or incomplete labelling or signage.

Table 1.2: Compliance inspections at uranium mines and mills

	2016	2017	2018	2019	2020
Number of inspections	30	30	26	20	17
Instances of non-compliance	41	23	31	23	11

Table 1.3: Compliance inspections at historic and decommissioned sites

	2016	2017	2018	2019	2020
Number of inspections	18	12	9	8	1
Instances of non-compliance	10	12	1	0	0

All instances of non-compliance identified were of low safety significance. Safety significance is determined based on comparison to criteria developed and used in the CNSC Regulatory Information Bank. Examples of the criteria are included in the appendices to this report in tables H-2, I-2, J-2 and K-2. Additional details on the inspections covered in this reporting period can be found in appendix B. CNSC staff assessed the licensees' corrective actions taken in response to the identified instances of non-compliance and verified that these actions were appropriate and acceptable. All instances of non-compliance were addressed appropriately by the licensees to meet all regulatory requirements and have been closed by CNSC staff.

Other regulatory bodies that conduct inspections at the facilities include the Saskatchewan Ministry of Environment, the Saskatchewan Ministry of Labour Relations and Workplace Safety, and Environment and Climate Change Canada. These regulatory bodies focus primarily on the areas of conventional health and safety and environmental protection. CNSC staff take into account the findings from these regulatory bodies when assessing licensees' performance. When logistically reasonable, joint inspections are conducted with other federal, provincial or territorial regulatory agencies. No joint inspections occurred in 2020.

1.2.4 Safety and Control Area Framework

SCAs are the technical topics that CNSC staff use across all regulated facilities and activities to assess, evaluate, review, verify, and report on regulatory requirements and performance. The CNSC's SCA framework, which staff use to evaluate licensee safety performance, includes 14 SCAs. Each SCA is subdivided into specific areas that define its key components. Appendix C provides definitions of these SCAs and their specific areas.

CNSC staff use the following 3 ratings, defined in appendix D, to grade licensee performance in each applicable SCA:

- satisfactory (SA)
- below expectations (BE)
- unacceptable (UA)

This report contains CNSC staff's performance ratings for all applicable SCAs, with a focus on 3 SCAs that cover many of the key performance indicators for mining and milling operations: radiation protection, environmental protection, and conventional health and safety.

For 2020, all SCA performance ratings for uranium mines and mills were rated satisfactory.

CNSC staff concluded, based on the results of regulatory oversight activities, that uranium mine and mill facilities met the following requirements:

- Radiation protection measures were effective and radiation doses received by workers remained consistent with the as low as reasonably achievable (ALARA) principle, which considers social and economic factors. As a result:
  - no worker doses exceeded regulatory effective dose limits
  - where action level exceedances occurred, they were reported and investigated to determine the causes, and corrective actions were identified by the licensee and verified by the CNSC.
- Environmental protection programs were effective, and as a result, emissions and effluents remained well below regulatory limits:
  - where action level exceedances occurred, they were reported and investigated. Corrective measures were implemented by the licensee and verified by CNSC staff.
- Conventional health and safety programs continued to protect workers:
  - where a lost-time injury (LTI) was reported, corrective measures were implemented by the licensee and verified by CNSC staff.

Appendix E provides the uranium mines and mills SCA performance ratings for the previous 5 years, from 2016 to 2020.

1.2.5 Independent Environmental Monitoring Program

The CNSC requires that each nuclear facility licensee develops, implements and maintains an environmental monitoring program to demonstrate that the public and the environment are protected from any releases to the environment relating to the facility's nuclear activities. CNSC staff evaluate and assess the results of these monitoring programs to determine compliance with the applicable requirements and limits, as set out in the regulations that govern Canada's nuclear industry.

The CNSC implements an Independent Environmental Monitoring Program (IEMP) to independently verify that all persons and the environment around licensed nuclear facilities are protected. The IEMP is a regulatory tool that complements and informs the CNSC's ongoing compliance verification program. The IEMP does not rely on licensees to provide samples; CNSC staff or independent contractors obtain samples from publicly accessible areas around nuclear facilities, then measure and report the amounts of radiological and hazardous substances present in these samples to the Commission and/or the public.

In August 2020 samples of fish, blueberries, Labrador tea and surface water were collected in publicly accessible areas in the vicinity of Cameco Corporation's (Cameco) Cigar Lake Operation. The surface water quality and fish chemistry were consistent with the results from Cameco's environmental monitoring program and indicate that the public and the environment in the vicinity of the Cigar Lake Operation are protected and that there are no expected health impacts from the consumption of fish, water, blueberries and Labrador tea. The full results from the IEMP sampling are available on the CNSC's IEMP web page.

1.3 Public Information and Indigenous Engagement

CNSC's REGDOC-3.2.1, *Public Information and Disclosure* [4] sets out the requirements for public information and disclosure. The primary goal of the program 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 is shared with the public in a format relevant to the audience. The program includes a commitment and protocol for ongoing, timely dissemination of information related to the licensed facility. As many of the mine and mill sites are located in northern Saskatchewan, this dissemination of information frequently includes and is accompanied by Indigenous engagement activities. As an agent of the Government of Canada, the CNSC recognizes and understands the importance of consulting and building relationships with Indigenous peoples in Canada. CNSC staff are committed to building long-term relationships with Indigenous groups who express an interest in CNSC-regulated facilities within their traditional and/or treaty territories. By pursuing informative and collaborative ongoing interactions, the CNSC's goal is to build partnerships and trust.

The CNSC's Indigenous engagement practices, which include information sharing and funding support (through the CNSC's Participant Funding Program [PFP]) to assist Indigenous peoples in a process to meaningfully participate in Commission proceedings and ongoing regulatory activities, are consistent with the principles of upholding the honour of the Crown and reconciliation.

A list of Indigenous communities and groups whose traditional and/or treaty territories are in proximity to uranium mines, mills, historic, and decommissioned sites are available in appendix N.

1.3.1 Public Information and Disclosure Programs

In 2020, licensees faced many challenges due to the COVID-19 pandemic and had to adapt their public information programs accordingly. This included moving away from traditional in-person meetings, tours and events, and offering webinars and increased digital communications whenever possible. While many of the uranium mines and mills were in care and maintenance during 2020, licensees were still required to maintain their public information and disclosure program and disclose important information to the public.

Upon review, CNSC staff determined that the public information and disclosure programs implemented by Cameco and Orano Canada Inc., complied with CNSC's REGDOC-3.2.1 [4], and that they provided regular information and engagement opportunities on the status of their facilities to key audiences, by adapting to a virtual environment. This included:

- holding and attending virtual meetings to discuss the effect of COVID-19 on operations, licence renewals and preliminary decommissioning plans
- providing website updates on the pandemic and other items of interest
- increasing their social media presence.

Licensees continue to implement their respective public information and disclosure programs to ensure their audiences are receiving the appropriate information at the right time in a way that is meaningful to the community. In 2020, both licensees provided pertinent information related to health, safety and environment through methods adapted to the pandemic reality.

1.3.2 Indigenous Consultation and Engagement

CNSC staff engagement activities – Saskatchewan

CNSC staff worked with Indigenous groups and organizations in northern Saskatchewan to identify opportunities for formalized and regular engagement throughout the lifecycle of these sites, including meetings and facilitated workshops. There were no Northern Saskatchewan Environmental Quality Committee (EQC) meetings conducted in 2020 because of the COVID-19 pandemic. The majority of engagement and consultation with Indigenous groups in northern Saskatchewan in 2020 occurred via remote means due to public health recommendations related to COVID-19.

As a result of recommendations from the Commission, CNSC staff continue to hold an annual meeting with Indigenous groups and communities in northern Saskatchewan before the public consultation period to provide updated information on, and seek opportunities for improvement of, the regulatory oversight report such as the plain language summary that is now included. Indigenous groups with an interest in Canada's uranium mines and mills are also provided a copy of the regulatory oversight report for review each year.

In October of 2020, CNSC staff hosted a virtual meeting and workshop with Indigenous groups with interests in the uranium mines and mills sites in northern Saskatchewan to discuss areas, sites and projects including: Beaverlodge Project (Cameco), McArthur River Operation (Cameco), Cigar Lake Operation (Cameco), Rabbit Lake Operation (Cameco), Key Lake Operation (Cameco), Cluff Lake Project (Orano), McClean Lake Operation (Orano) as well as the Gunnar legacy uranium mine (SRC) and the former Lorado mill site (SRC). CNSC staff also provided an update to the Indigenous groups on the Canadian Uranium Workers Study and informed communities of how they may become involved in the study, if interested.

In addition, CNSC staff also carried out the following engagement activities with Indigenous groups in northern Saskatchewan:

- Northern community tour and an update from the CNSC on the regulatory oversight work in relation to Gunnar and Lorado projects on SRC Project CLEANS in winters of 2018, 2019 and 2020 (includes the communities of Hatchet Lake First Nation/Wollaston Post, Black Lake First Nation, Stony Rapids, Fond du Lac First Nation and Uranium City). This activity was conducted in person.
- Provided updates of upcoming regulatory activities including Cameco's Cigar Lake Operation licence renewal and Orano's McClean Lake Operation application for a licence amendment in 2021. This activity was conducted virtually.
- Regular meetings with: the Ya'thi Néné Lands and Resources Office, Clearwater River Dene Nation, the Métis Nation-Saskatchewan and English River First Nation. This activity was conducted virtually.
- Notice of the PFP opportunity for the annual uranium mines and mills regulatory oversight report to all potentially interested Indigenous groups. This activity was conducted virtually.
- Update on the IEMP to verify that the public, Indigenous groups, and the environment around nuclear facilities are safe. This activity was conducted virtually.
- Consulted with the Ya'thi Néné Lands and Resources Office and with the Métis Nation-Saskatchewan regarding the IEMP program. This activity was conducted virtually.
- Discussed areas of interest including the environmental assessment for NexGen Energy Ltd.'s Rook I Project. This activity was conducted virtually.

CNSC staff engagement activities – Southern Ontario

Since 2018, CNSC staff provided updates to potentially interested Indigenous communities regarding the Madawaska, Bicroft, Dyno and Deloro sites, where appropriate. The majority of communications and engagement with these sites involved providing information updates with the Métis Nation of Ontario and Curve Lake First Nation, with whom the CNSC has signed a Long-Term Engagement Terms of Reference.

CNSC staff engagement activities – Elliot Lake, Ontario Region

For the sites located in the Elliot Lake, Ontario region, CNSC staff engaged with and provided updates to potentially interested Indigenous groups regarding the Agnew Lake, Elliot Lake, Denison and Stanrock sites.

In support of the request for a licence renewal with an amendment to allow the acceptance of niobium waste at the Agnew Lake site, CNSC staff identified First Nation and Métis groups who may have an interest in the Agnew Lake site. CNSC staff sent letters of notification in February 2019 and updated letters in July 2020 to the groups identified for this area (appendix N), providing information and seeking input regarding the proposed licence application. In addition, CNSC staff participated in a meeting with Sagamok First Nation in February 2020 and offered to meet with other interested groups to discuss the licence amendment application upon request. To date, no concerns regarding potential impacts on Indigenous and/or Treaty rights have been raised.

In 2018, CNSC staff engaged with interested regional Indigenous groups to share the results of the IEMP sampling campaign conducted in this region to date. The IEMP collected samples from the Elliot Lake historic mine sites area in 2018 and concluded that the public and the surrounding environment are protected and there are no health or environmental impacts arising from the sites.

CNSC staff engagement activities – Northwest Territories

Since 2018, CNSC staff participated in a number of engagement activities led by Crown Indigenous Relations and Northern Affairs Canada (CIRNAC) to answer questions and provide updates to the interested Indigenous communities regarding the Rayrock and Port Radium sites, upon request.

In collaboration with CIRNAC, CNSC staff engaged with the community of Délįnę in the Sahtu Settlement Area of the Northwest Territories for the Port Radium site and the Tlicho communities for the Rayrock site in 2017 and 2019.

Licensee engagement activities

CNSC staff continue to monitor the engagement work conducted by the licensees of the operating uranium mine, mill, historic, and decommissioned sites to verify that they actively engage and communicate with Indigenous groups who have an interest in their facilities and sites. CNSC staff confirmed that the licensees have established Indigenous engagement and outreach programs and engage with Indigenous groups that have interests in their facilities and sites, including information updates and engagement activities as appropriate. Due to the COVID-19 pandemic, many of the licensees continued to host meetings and to discuss their operations with Indigenous groups virtually and invited them to participate in virtual tours, information sessions and facilitated workshops. CNSC staff encourage the licensees to continue to remain flexible and responsive to the requests and needs of the Indigenous communities and groups that have an interest in their sites, facilities and proposed projects.

SECTION 1 – OPERATING URANIUM MINES AND MILLS

2 OVERVIEW

This section of the report focuses on the regulatory performance of the 5 active uranium mines and mills in Canada in 2020. During this timeframe, 3 of 5 of these facilities were in a state of care and maintenance. The facilities listed are located within the Athabasca Basin of northern Saskatchewan and are shown in figure 2.1. Active sites are shown in red, and facilities in a status of care and maintenance are shown in black.

- Cigar Lake Operation (mine)
- McArthur River Operation (mine – care and maintenance)
- Rabbit Lake Operation (mine and mill – care and maintenance)
- Key Lake Operation (mill – care and maintenance)
- McClean Lake Operation (mine and mill)

Figure 2.1: Location of uranium mines and mills in Saskatchewan

The Cigar Lake, McArthur River, Key Lake and Rabbit Lake facilities are operated by Cameco Corporation (Cameco), while the McClean Lake facility is operated by Orano Canada Inc. (Orano). In 2016, the Rabbit Lake mine and mill entered into a state of care and maintenance and has remained in said state since that time.

On November 8, 2017, Cameco notified the CNSC that effective January 2018, it would be temporarily suspending production at the Key Lake and McArthur River operations. This included all activities directly related to mining and processing uranium ore. On July 25, 2018, Cameco notified the CNSC of its decision to suspend production indefinitely at the Key Lake and McArthur River operations until economic conditions improve. CNSC inspectors confirmed that staffing levels remain appropriate and that workers have the capability and the time needed to perform all expected functions while the facilities are in care and maintenance.

Where the licensee reduces a service, such as ventilation volumes, CNSC staff evaluate how the reduction will impact workers in the area. CNSC staff also verify that sufficient protective measures, such as alarming detectors, are in place to warn of potentially unsafe situations. Licensees continue to train workers to understand both the safety implications of the monitors and the actions they need to take if any condition triggers an alarm. CNSC staff review changes which may impact licensed activities to determine that the licensee maintains an equivalent level of safety.

In 2020, CNSC staff continued routine compliance verification inspections at all facilities to determine that the licensee continues to meet regulatory expectations. The 2020 uranium production data for uranium mine and mill facilities are shown in table 2.1. CNSC staff concluded that all facilities operated within their authorized annual production limits in 2020.

Table 2.1: Uranium mines and mills, mining and milling production data, 2020

Production data	Cigar Lake	McArthur River[1]	Rabbit Lake[1]	Key Lake[1]	McClean Lake[2]
Mining – ore tonnage (Mkg/year)	24.6	N/A	N/A	N/A	0
Mining – average ore grade mined (%U)	14.6	N/A	N/A	N/A	N/A
Mining – U mined (Mkg U/year)	3.61	N/A	N/A	N/A	0
Milling – mill ore feed (Mkg/year)	N/A	N/A	N/A	N/A	26.3
Milling – average mill feed grade (%U)	N/A	N/A	N/A	N/A	14.56
Milling – mill recovery (%U)	N/A	N/A	N/A	N/A	98.81
Milling – U concentrate produced (Mkg U/year)	N/A	N/A	N/A	N/A	3.88
Authorized annual production (Mkg U/year)	9.25	9.6	4.25	9.6	9.23

[1] McArthur River, Rabbit Lake and Key Lake are currently in a safe state of care and maintenance.
[2] McClean Lake mill processing ore from Cigar Lake.
N/A = Not applicable.
Mkg = 1,000,000 kg

Licensees are required to develop preliminary decommissioning plans and secure associated financial guarantees to ensure that work activities are covered financially and that work is guaranteed to completion with no liability to the government. Financial guarantee values for the mine and mill facilities range from approximately C$42 million at the McArthur River Operation to C$223 million at the Key Lake Operation. The values of the financial guarantees for each uranium mine and mill are listed in appendix F. Financial guarantees cover all costs necessary to fully decommission and remediate a uranium mine and/or mill to ensure the protection of people and the environment.

2.1 Regulatory Efforts

The CNSC regulates the 5 uranium mine and mill operations under separate licences issued by the Commission. Appendix A provides an outline of these licences and their respective licensing information.

In 2020, CNSC staff performed a total of 17 inspections at the uranium mines and mills, (outlined in appendix B). As a result of these inspections, 11 instances of non-compliance were identified, all of low safety significance. Examples of non-compliance include: failure to wear radiation monitoring equipment; non-compliance with the *National Fire Code* [3]; failure to follow procedures; identification of additional training needs; and incorrect or incomplete labelling or signage.

CNSC staff assessed all corrective actions taken by licensees in response to non-compliances and concluded that these actions were appropriate and acceptable. All non-compliances are considered closed.

2.1.1 Effects of COVID-19 on regulatory efforts

On March 15, 2020, the CNSC activated the BCP in response to the COVID-19 pandemic. Effective March 16, all CNSC staff were directed to work from home. CNSC management immediately suspended all CNSC staff in-person activities at nuclear fuel cycle facilities and identified activities that were considered critical in order to support continued safe operation of licensed facilities and delivery of the CNSC mission and mandate. Files scheduled to be presented to the Commission and the associated timelines for submission to the Secretariat were reviewed to confirm any impact and plan any mitigation measures.

In April of 2020, CNSC staff reviewed all planned onsite compliance activities on a risk-informed basis to determine an appropriate path forward. CNSC staff identified planned compliance activities well suited to be delivered by other means (remote verification methods, desktop review of documents and licensee submissions, etc.) and adjusted planned activities accordingly.

The CNSC developed a pandemic-related “Pre-Job Brief” as additional instructions to be delivered by CNSC management to inspectors prior to performing any oversight activities onsite. The CNSC provided personal protective equipment to inspectors prior to any onsite activity. The “Pre-Job Brief” clearly outlined the rights of individual employees to not attend an in-person inspection if they did not feel it was safe.

Compliance activities of uranium mine and mill facilities continued remotely and onsite verification activities will resume on a risk-informed basis in observance of relevant COVID-19 health protocols. CNSC staff continued to conduct oversight activities during the COVID-19 pandemic to assess the protection of the environment, and the health and safety of workers and the public. In 2020, 81% of inspections were conducted remotely. Where remote inspections were not possible, in-person inspections were conducted, provided a safety case could be made. Due to these measures and the low risk of these sites, 1 inspection was deferred from 2020. Specific compliance activities are detailed in appendix B.

2.2 Performance

CNSC staff use expert professional judgment to rate SCA performance at uranium mine and mill facilities. Ratings are based on the review of key performance indicators (e.g., accident/event occurrences, responses to accidents/events, desktop review of reports, dose information, environmental [radiological and non-radiological] results) and the results of compliance activities, such as inspections and technical assessments.

The performance ratings are compared across the 5 mines and mills and to the rating definitions in appendix D to ensure that consistent ratings are assigned. The SCA performance ratings for the mine and mill facilities are presented in table 2.2; the SCA ratings for each facility from 2016 to 2020 are in appendix E.

Table 2.2: Uranium mines and mills, SCA performance ratings, 2020

Safety and control area	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

SA = satisfactory

This report provides details about 3 SCAs that cover many of the key performance indicators for these facilities. The SCAs covered are radiation protection, environmental protection, and conventional health and safety. Additional SCAs are covered in each active site's respective section of this report.

Licensees develop and maintain management systems that include integrated links to all 14 SCAs. Management systems are the framework that establish the processes and programs required to determine that an organization achieves its safety objectives, continuously monitors performance, identifies inadequacies, fosters a healthy safety culture and continually improves that culture. Throughout 2020, CNSC staff reviewed and assessed program performance and key performance indicators through regular compliance verification activities.

For 2020, CNSC staff concluded that the overall performance of the uranium mines and mills was satisfactory.

2.3 Radiation Protection

Uranium mine and mill licensees in Canada are required to implement and maintain radiation protection programs. Each program must verify that contamination levels and radiation doses received by individuals are monitored, controlled, maintained below regulatory limits and are kept consistent with the as low as reasonably achievable (ALARA) principle, considering economic and social factors.

For 2020, CNSC staff rated the radiation protection SCA at all 5 facilities as satisfactory based on regulatory oversight activities.

Radiation protection ratings

Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
SA	SA	SA	SA	SA

SA = satisfactory

Radiological hazard control

Sources of radiation exposure at uranium mines and mills include:

- gamma radiation
- long-lived radioactive dust
- radon progeny
- radon gas

CNSC staff's compliance activities confirmed these hazards were controlled by the licensees' radiation protection programs, including practices relating to the effective use of time, distance and shielding, source control, ventilation, contamination control and personal protective equipment.

Radiation protection program performance

During 2020, CNSC staff conducted regulatory oversight activities for the radiation protection SCA for all 5 facilities. These activities were carried out to verify that licensees were complying with regulatory requirements for the implementation of radiation protection programs.

Administrative levels are identified for all radiological hazard types, apply to normal operating conditions and are followed to ensure optimal conditions for workers. Licensees are responsible for identifying the parameters of their programs that represent timely indicators of potential losses of control. For this reason, action and administrative levels are licensee-specific and may change over time, depending on operational and radiological conditions. If an action level is reached, it may indicate the loss of control of part of a licensees' radiation protection program. The licensee is then required to establish the cause, notify the CNSC and if applicable, restore the effectiveness of the radiation protection program.

Radiation protection programs include codes of practice that outline licensee administrative levels and action levels for exposures and doses of radiation. Administrative levels include a list of specific actions to be taken by the licensee based on radiological monitoring in the workplace. The radiation protection programs include actions to be taken under specific conditions, for example:

- "continue to work while monitoring or investigating a parameter"; or
- "leave the area and initiate an investigation".

As radiation levels or worker exposure levels increase, the required protective actions become more stringent, which is consistent with a risk-informed approach.

The 5 uranium mines and mills have the same individual nuclear energy worker (NEW) radiation dose action level of 1 millisievert (mSv) per week and 5 mSv per quarter of a given year.

CNSC staff confirmed that during the reporting period, the radiation protection programs and practices at uranium mines and mills remained effective at controlling radiological exposure to workers.

Application of ALARA

The radiation protection programs established by uranium mine and mill licensees include responsibilities and processes for ensuring that exposures to workers are consistent with the ALARA principle.

Through inspections, CNSC staff verified that key elements of these ALARA programs (e.g., management control over work practices, personnel qualification and training, control of occupational and public exposure to radiation, planning for unusual situations) were effectively implemented by uranium mine and mill facilities in 2020.

This report includes the reporting of annual collective dose values for NEWs for each mine and mill (see sections 3.2, 4.2, 5.2, 6.2 and 7.2). The collective dose value is the sum of the effective doses received by all NEWs at a uranium mine and mill in 1 year. Collective dose is a radiation protection performance indicator that provides the total exposures associated with each operation. It supplements other performance statistics, like average dose, which have been affected by factors including changes in the number of workers or workers who receive radiation exposures over very short periods of time. Collective dose shows the effect of increased or reduced facility activities, for example, due to care and maintenance status or as a response to the COVID-19 pandemic.

Worker dose control

In accordance with the *Radiation Protection Regulations* [5], licensee radiation protection programs include processes and criteria to provide assurance that all individuals identified as NEWs under section 2 of the NSCA [1] are appropriately designated and trained. This includes licensees' employees and contractors. Radiation exposures are ascertained through approved dosimetry methods and workers are notified of the results.

Figure 2.2 shows a continuous air monitor, alphaNUCLEAR PRISM, used in mine and mill operations to measure radon gas and radon progeny.

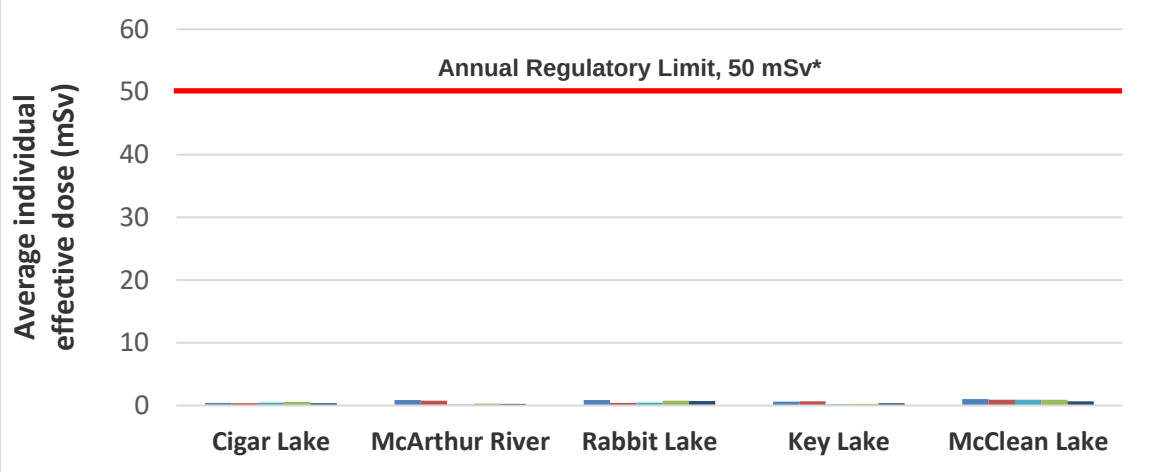
Figure 2.2: AlphaNUCLEAR PRISM at an underground mine

Source: CNSC

At all uranium mines and mills, NEWs are issued optically stimulated luminescence dosimeters that measure external gamma radiation exposure. Where required, workers also wear personal alpha dosimeters (PADs) to measure internal alpha radiation exposure from radon progeny and radioactive dust. Optically stimulated luminescence dosimeters and PAD readings are measured by CNSC-licensed dosimetry service providers. Where direct monitoring through dosimeters is not warranted or practical, dose estimation methods authorized under the *Radiation Protection Regulations* [5] (such as area/group monitoring and time cards) are used in keeping with CNSC regulatory guidance. CNSC staff confirmed that all licensees for the facilities discussed in this section of the report met the regulatory requirements for the use of licensed dosimetry during the reporting period.

Figures 2.3 and 2.4 show the average individual effective dose and maximum individual effective dose during the 5-year period from 2016 to 2020 for the 5 facilities. In 2020, no worker at any facility exceeded the regulatory individual effective dose limit of 50 mSv in 1 year and 100 mSv in a 5-year dosimetry period.

Figure 2.3: Uranium mines and mills, average individual effective dose to nuclear energy workers, 2016–20

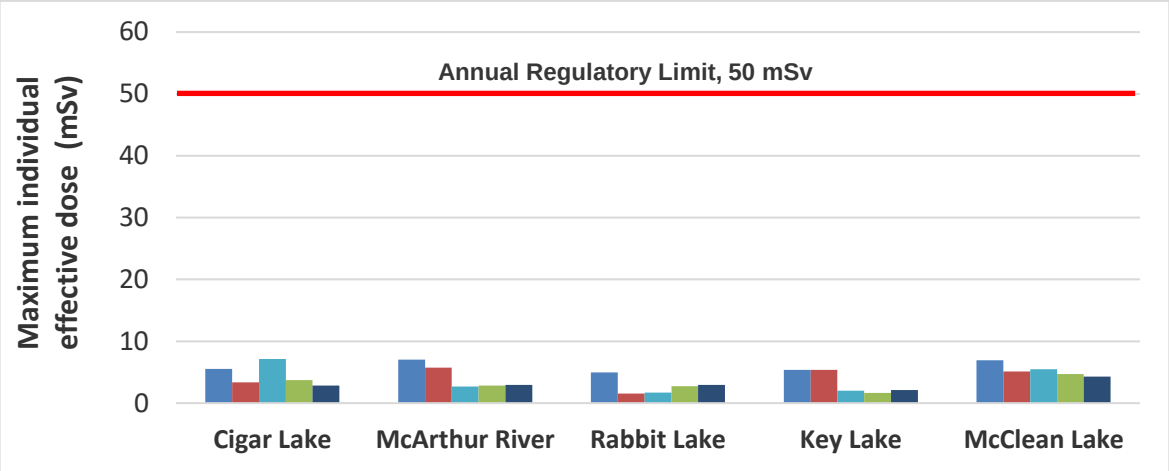


	Cigar Lake (mSv)	McArthur River (mSv)	Rabbit Lake (mSv)	Key Lake (mSv)	McClean Lake (mSv)
2016	0.39	0.85	0.85	0.62	1.04
2017	0.34	0.79	0.40	0.66	0.91
2018	0.47	0.15	0.46	0.19	0.90
2019	0.57	0.33	0.75	0.27	0.93
2020	0.38	0.27	0.70	0.35	0.67

* The annual regulatory limit illustrated applies to individual effective dose and is shown for reference only.

Increases and decreases over time in the effective dose to NEWs are explained in the facility-specific sections of this report, in the subsection on worker dose control.

Figure 2.4: Uranium mines and mills, maximum individual effective dose to nuclear energy workers, 2016–20



	Cigar Lake (mSv)	McArthur River (mSv)	Rabbit Lake (mSv)	Key Lake (mSv)	McClean Lake (mSv)
2016	5.53	7.02	4.95	5.37	6.94
2017	3.36	5.73	1.56	5.39	5.12
2018	7.28	2.67	1.70	2.02	5.50
2019	3.70	2.82	2.73	1.64	4.70
2020	2.82	2.94	2.93	2.11	4.28

The highest maximum individual effective dose to a worker at a uranium mine or mill in 2020 occurred at the McClean Lake Operation. The worker at McClean Lake was assigned a dose of 4.28 mSv, this value is 8.6 % of the annual dose limit of 50 mSv.

Appendix G displays the number of NEWs with the corresponding average individual effective dose and maximum individual effective dose for each facility from 2016 to 2020.

Estimated dose to the public

Uranium mine and mill operations are located in remote areas, away from local populations. The *Radiation Protection Regulations* [5] set out a public radiation dose limit of 1 mSv per year above natural background radiation to ensure the protection of health and the public.

Radiological exposures measured at the boundaries of these remote licensed facilities are close to measured background radiation levels. As published in the CNSC fact sheet on natural background radiation, the background radiation level for Canada is approximately 1.8 mSv.

In 2020, CNSC staff were satisfied that uranium mine and mill licensees controlled radiation doses to persons at levels well below the regulatory limits and kept doses ALARA. This conclusion was based on the outcome of inspections, as well as reviews of licensees' radiation protection programs, radiological hazard control, worker dose control and application of the ALARA principle.

2.4 Environmental Protection

The environmental protection SCA covers programs that identify, control and monitor releases from facilities of radioactive and hazardous substances and the effects on the environment as a result of licensed activities.

Based on regulatory oversight activities, CNSC staff rated the 2020 performance of all 5 uranium mine and mill facilities for the environmental protection SCA as satisfactory. CNSC staff concluded the licensees' environmental protection programs were effectively implemented and met all regulatory requirements.

Environmental protection ratings

Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
SA	SA	SA	SA	SA

SA = satisfactory

2.4.1 Environmental management system

The CNSC requires licensees to develop and maintain environmental management systems that provide a framework for integrated activities related to environmental protection at their operation. Environmental management systems are described in approved environmental management programs and include activities such as establishing annual environmental objectives, goals and targets. The licensees conduct internal audits of their programs as identified in their CNSC-approved management system program. CNSC staff confirmed the licensees' objectives, goals and targets through regular compliance verification activities. Facility-specific details are provided in sections 3.3, 4.3, 5.3, 6.3 and 7.3 of this report.

2.4.2 Effluent and emissions control

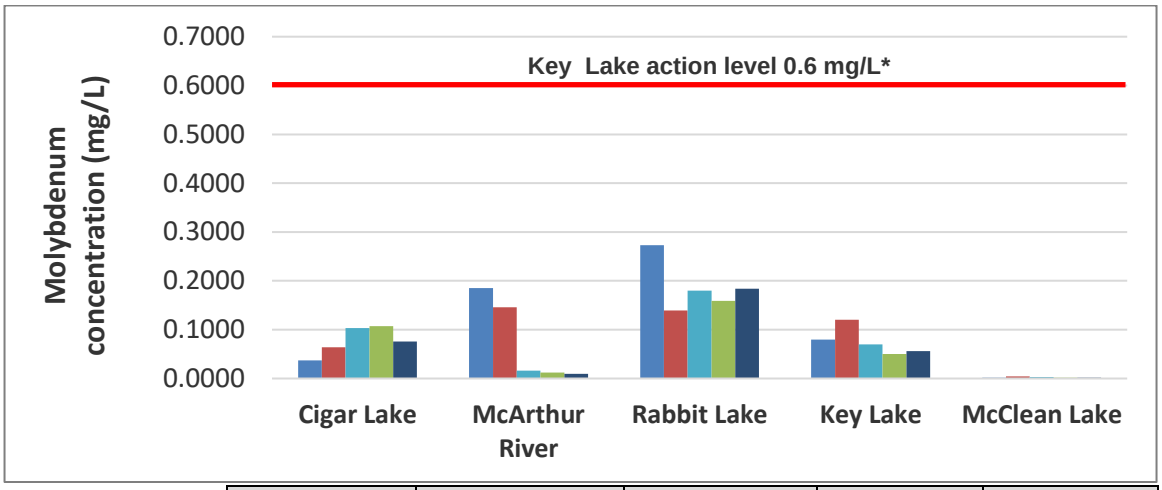
Effluent and emissions control programs are associated with an environmental code of practice that sets out administrative levels and action levels for select contaminants of potential concern (COPC) with the potential for adverse environmental effects. An administrative level represents the upper range of design specifications for a specific parameter. Reaching an administrative level triggers an internal review by the licensee. Exceedance of an action level indicates a potential loss of control of the environmental protection program, which is based on the approved facility design envelope; it triggers actions that the licensee must take to correct the problem. These triggers require notification to the CNSC, an immediate investigation, subsequent corrective actions and preventive measures in order to restore the effectiveness of the environmental protection program. It is important to recognize that an exceedance of an action level does not imply a potential risk to the environment, but identifies that the operating parameter may be outside the facility design envelope. Facility action levels are determined using actual operating data and following the methodology described in CSA Group standard N288.8-17 *Establishing and Implementing Action Levels for Releases to the Environment from Nuclear Facilities* [6].

Treated effluent released to the environment

Environmental risk assessments (ERAs) identified releases of molybdenum, selenium and uranium with the potential for adverse environmental effects at uranium mines and mills. As a result, improved engineering controls and treatment technologies to reduce effluent releases of these contaminants were implemented where required. In 2020, the treatment technologies implemented continued to keep these contaminant concentrations stable; below regulatory limits. Figures 2.5 to 2.7 show the 2020 average annual effluent concentrations for molybdenum, selenium and uranium at the 5 mine and mill facilities.

In the absence of federal or provincial effluent discharge limits for molybdenum, the CNSC required licensees to develop facility-specific effluent controls within the codes of practice of their environmental protection programs. The 2016 to 2020 average concentrations of molybdenum in effluent for the 5 facilities were below the Key Lake Operation code of practice action level. The Key Lake and McArthur River action levels of 1.0 mg/L for molybdenum is the most stringent of the 5 operations and is shown in figure 2.5 for reference only.

Figure 2.5: Annual average concentration of molybdenum in effluent released to the environment, 2016–20



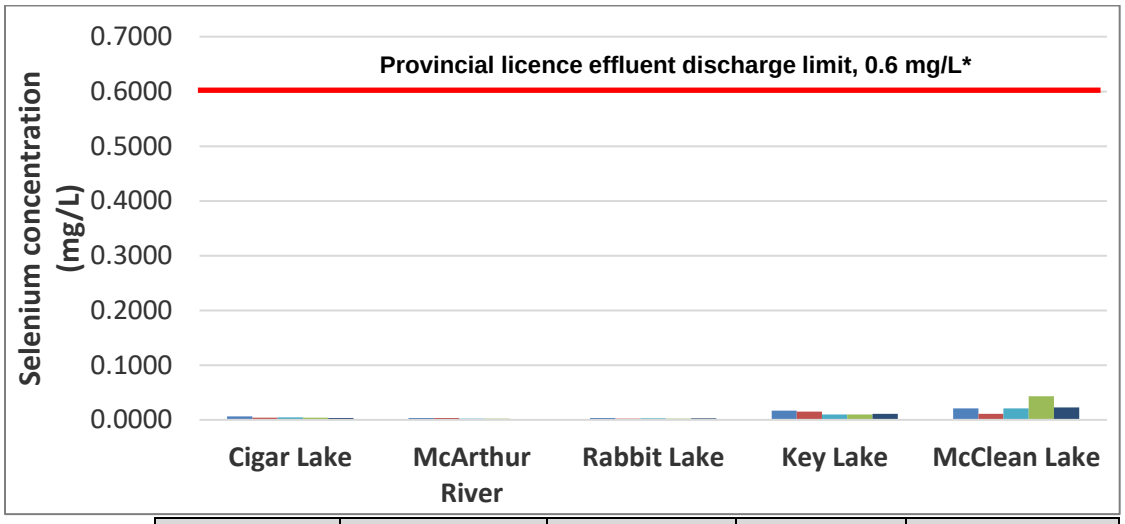
	Cigar Lake (mg/L)	McArthur River (mg/L)	Rabbit Lake (mg/L)	Key Lake (mg/L)	McClean Lake (mg/L)**
2016	0.0369	0.1851	0.2730	0.0800	0.0020
2017	0.0640	0.1460	0.1390	0.1200	0.0040
2018	0.1030	0.0164	0.1800	0.0700	0.0030
2019	0.1069	0.0120	0.1590	0.0500	0.0020
2020	0.0756	0.0097	0.1840	0.0560	0.0020

* Key Lake Action Level: 1.0 mg/L
** McClean Lake only - values from JEB water treatment plant are included.

Figures 2.6 and 2.7 show that concentrations in treated effluent released to the environment by mine and mill facilities from 2016 to 2020 remained below Saskatchewan's licensed effluent maximum monthly mean discharge limits of 0.6 mg/L and 2.5 mg/L for selenium and uranium, respectively. As indicated in figure 2.7, the CNSC identified an interim objective for uranium of 0.1 mg/L. This was derived from the treatment technologies in place at the uranium mines and mills and based on what would be achievable by the uranium metal mining sector. The interim objective was applied to all uranium mine and mill facilities since it was the most stringent and has been consistently met since 2016.

The interim objective for uranium in effluent is in place until the CNSC requirements for release limits are provided in CNSC's REGDOC-2.9.2, *Controlling Releases to the Environment* which was available for public consultation from May 2021 to July 2021. CNSC staff are finalizing this regulatory document based on feedback received.

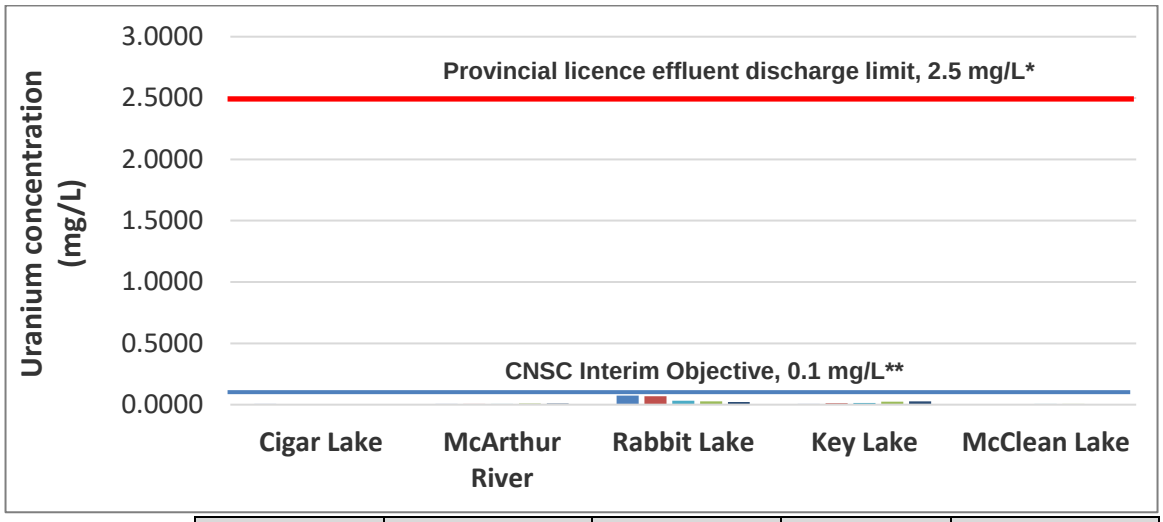
Figure 2.6: Annual average concentration of selenium in effluent released to the environment, 2016–20



	Cigar Lake (mg/L)	McArthur River (mg/L)	Rabbit Lake (mg/L)	Key Lake (mg/L)	McClean Lake (mg/L)
2016	0.0062	0.0037	0.0035	0.0170	0.0210
2017	0.0042	0.0036	0.0024	0.0150	0.0110
2018	0.0044	0.0023	0.0026	0.0100	0.0210
2019	0.0041	0.0024	0.0023	0.0100	0.0430
2020	0.0034	0.0003	0.0026	0.0110	0.0230

* Provincial effluent limit: 0.6 mg/L.

Figure 2.7: Annual average concentration of uranium in effluent released to the environment, 2016–20



	Cigar Lake (mg/L)	McArthur River (mg/L)	Rabbit Lake (mg/L)	Key Lake (mg/L)	McClean Lake (mg/L)
2016	0.0063	0.0055	0.0730	0.0060	0.0040
2017	0.0018	0.0056	0.0700	0.0110	0.0040
2018	0.0005	0.0071	0.0320	0.0130	0.0070
2019	0.0004	0.0086	0.0270	0.0243	0.0050
2020	0.0002	0.0084	0.0210	0.0259	0.0030

* Provincial effluent limit: 2.5 mg/L
** CNSC interim objective: 0.1 mg/L

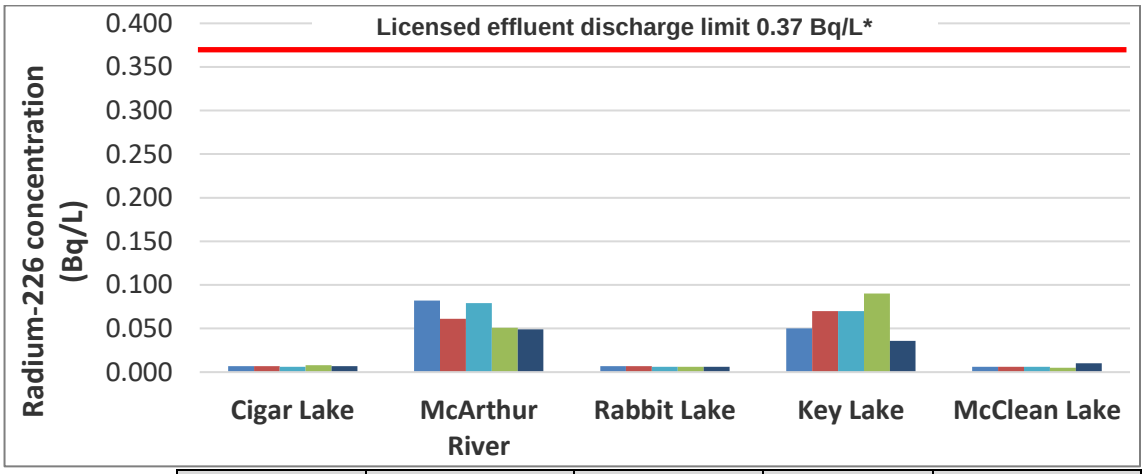
Appendix L shows the total annual release of relevant radionuclides to the environment from these facilities from 2016 to 2020.

The uranium mines and mills, like other industrial activities in Canada, must respect the reporting requirements of the *National Pollutant Release Inventory* (NPRI) [7]. There was a 2016 request from non-government organizations to include radionuclides as reportable substances under the NPRI. Environment and Climate Change Canada reviewed this request and determined that radionuclides were not reportable substances under the NPRI as releases were monitored and reported by another government agency, the CNSC [4].

To increase public access to data on releases of radionuclides to the environment from nuclear facilities, the CNSC provides this information in the appendices of this regulatory oversight report along with maintaining and annually updating downloadable databases on the CNSC Open Government Portal.

In addition to the above COPCs with the potential for adverse environmental effects, a graph showing concentrations of radium is provided in figure 2.8. From 2016 to 2020, the annual average effluent concentrations of radium-226 for the 5 facilities were well below the CNSC's licence-authorized monthly mean effluent discharge limit of 0.37 Bq/L.

Figure 2.8: Annual average concentration of radium-226 in effluent released to the environment, 2016–20



	Cigar Lake (Bq/L)	McArthur River (Bq/L)	Rabbit Lake (Bq/L)	Key Lake (Bq/L)	McClean Lake (Bq/L)
2016	0.007	0.082	0.007	0.050	0.006
2017	0.007	0.061	0.007	0.070	0.006
2018	0.006	0.079	0.006	0.070	0.006
2019	0.008	0.051	0.006	0.090	0.005
2020	0.007	0.049	0.006	0.036	0.010

*Effluent discharge limit: 0.37 Bq/L

Uranium mine and mill facilities also analyze treated effluent for concentrations of other regulated contaminants and COPC such as arsenic, copper, lead, nickel, zinc, total suspended solids (TSS) and pH. Table 2.3 shows the annual average parameter concentration values in effluent for these substances released in 2020, as well as the discharge limits described in the *Metal and Diamond Mining Effluent Regulations* (MDMER) [8] made under the *Fisheries Act* [9]. All metal mines and mills in Canada are subject to the MDMER. The CNSC incorporates the effluent limit requirements of the MDMER in uranium mine and mill licences. In 2020, all treated effluent released to the environment from licensed mining and milling activities for the above substances met the effluent discharge limits.

Table 2.3: Annual average parameter concentration values in effluent released to the environment, 2020

Parameters	MDMER discharge limits	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
Arsenic (mg/L)	**0.5**	0.0627	0.0001	0.0090	0.0113	0.036
Copper (mg/L)	**0.3**	0.0011	0.0006	0.0002	0.001	0.002
Lead (mg/L)	**0.2**	0.0002	0.0001	0.0001	0.0002	0.0005
Nickel (mg/L)	**0.5**	0.0011	0.0014	0.0013	0.153	0.013
Zinc (mg/L)	**0.5**	0.0509	0.0019	0.0005	0.006	0.001
Molybdenum (mg/L)	**N/A**	0.0756	0.0097	0.1840	0.056	0.002
Selenium (mg/L)	**N/A**	0.0034	0.0003	0.0026	0.011	0.023
TSS (mg/L)	**15**	2	1	1	2.3	1
pH annual mean value	**6.0–9.5**	7.18	7.42	7.23	6.6	7.14

CNSC staff will continue to review effluent quality results to verify that effluent treatment performance remains effective.

Treated mining/milling effluent: A comparison of the uranium mining sector to other metal mining sectors across Canada

As noted earlier, metal mines and mills in Canada are subject to the MDMER [8] made under the federal *Fisheries Act* [9]. Compliance with MDMER limits provides a good comparison of the effluent treatment in the mining sector to other metal mining sectors across Canada. The quality of the effluent treatment at the uranium mine and mill facilities compares favorably to that in other mining sectors of base metal, precious metal and iron mines.

The data used for this comparison are acquired from Environment and Climate Change Canada (ECCC). Figure 2.9 and tables 2.4 and 2.5 provide the sector-specific MDMER [8] information available for 2018 for effluent constituents of molybdenum, selenium and uranium. ECCC effluent quality data for 2017 and 2018 for arsenic, copper, nickel, lead, zinc, pH, TSS and acute lethality testing was not available at the time of writing this report. A comparison of these parameters for the most recent available MDMER data (2016) is presented in the *Regulatory Oversight Report for Uranium Mines, Mills, Historic and Decommissioned Sites in Canada: 2017* [2]. This 2017 regulatory oversight report concluded that the uranium sector was similar or better than the other 3 metal mining sectors with regard to the following performance indicators: effluent concentrations, compliance with regulatory limits and toxicity test results.

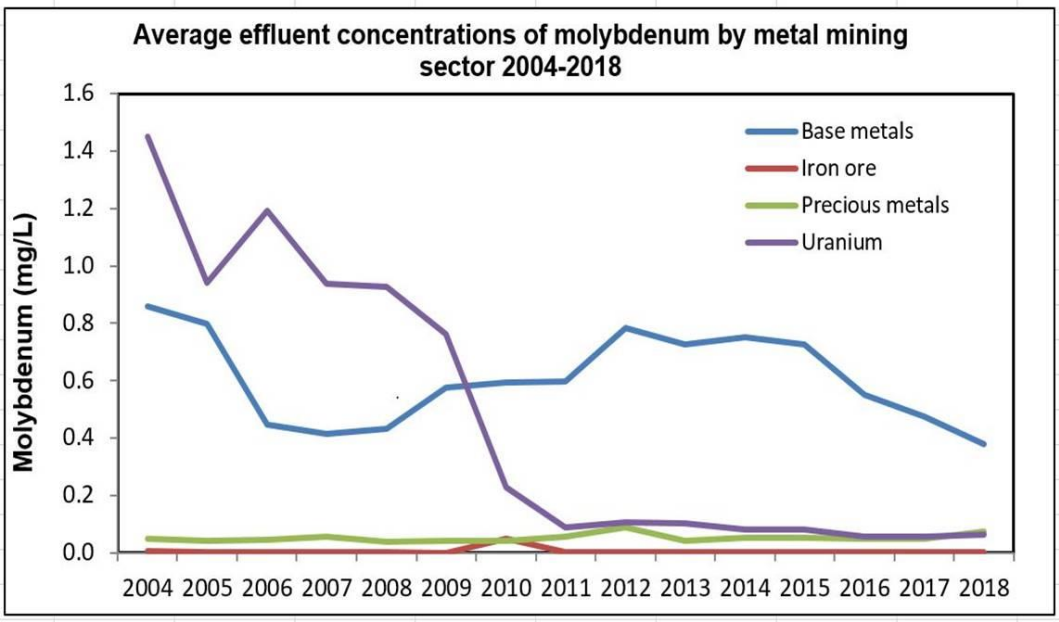
The mines that released treated effluent reporting under MDMER [8] are grouped into 4 metal mining sectors based on the primary metal produced. The metal mining sectors are:

- uranium – 5 facilities
- base metals (such as copper, nickel, molybdenum or zinc) – 47 facilities
- precious metals (such as gold or silver) – 56 facilities
- iron – 8 facilities.

Molybdenum is a parameter requiring routine monitoring of treated effluent subject to MDMER [8]. Ecological risk assessments completed in the mid-2000s indicated that releases of molybdenum posed a risk to biota that warranted adaptive management. Following a request from the Commission, licensees added administrative controls and treatment technology upgrades to their effluent management systems. The success of these actions is evident in figure 2.9, which shows that molybdenum releases in the uranium mining sector have decreased substantially.

In 2020, molybdenum concentrations in uranium mining effluent were similar to those measured in precious metal and iron mine effluent, and lower than those measured in base metal mine effluent.

Figure 2.9: Average treated effluent concentration of molybdenum by metal mining sector, 2004–18



In mid-2012, the requirement to monitor selenium was added to the *Metal Mines Effluent Regulations* (MMER). Table 2.4 summarizes the average selenium concentration in treated effluent from each mining sector using data collected since 2012. The selenium concentration in uranium sector effluent was similar to that of other metal mining sectors in Canada.

Table 2.4: Average selenium concentration in treated effluent by metal mining sector, last half of 2012 and all of 2013–18

Year	Metal mining sector			
	Uranium (mg/L)	**Base metals (mg/L)**	**Precious metals (mg/L)**	**Iron (mg/L)**
2012/2013	0.003	0.005	0.005	0.001
2014	0.004	0.006	0.005	0.001
2015	0.004	0.005	0.004	0.004
2016	0.008	0.006	0.003	0.003
2017	0.004	0.008	0.004	0.001
2018	0.006	0.006	0.004	0.003

Uranium concentrations were added as a parameter to be monitored and reported under the MDMER [8] in 2018. Table 2.5 presents the average uranium concentrations in treated effluent by metal mining sector. As shown in table 2.5, the uranium sector had an average uranium concentration of 0.0119 mg/L in 2018. Uranium mines have elevated natural uranium concentrations compared to other conventional mining operations. For context, action levels in the environmental code of practice range from 0.08 mg/L to 0.35 mg/L, and the Saskatchewan regulatory limit for uranium is 2.5 mg/L. CNSC staff continue to verify that releases of uranium are controlled and reduced to the extent practicable by reviewing effluent quality data, scrutinizing proposed facility changes that could affect effluent quality and validating the effectiveness of the licensees' programs to minimize the release of contaminants.

Table 2.5: Average uranium concentration in treated effluent by metal mining sector, 2017–18

Year	Metal mining sector			
	Uranium (mg/L)	**Base metals (mg/L)**	**Precious metals (mg/L)**	**Iron (mg/L)**
2017	0.0185*	0.0062	0.0027	0.0002
2018	0.0119*	0.0027	0.0010	0.0036

* Data not available from Environment and Climate Change Canada; value calculated from licensee annual reports.

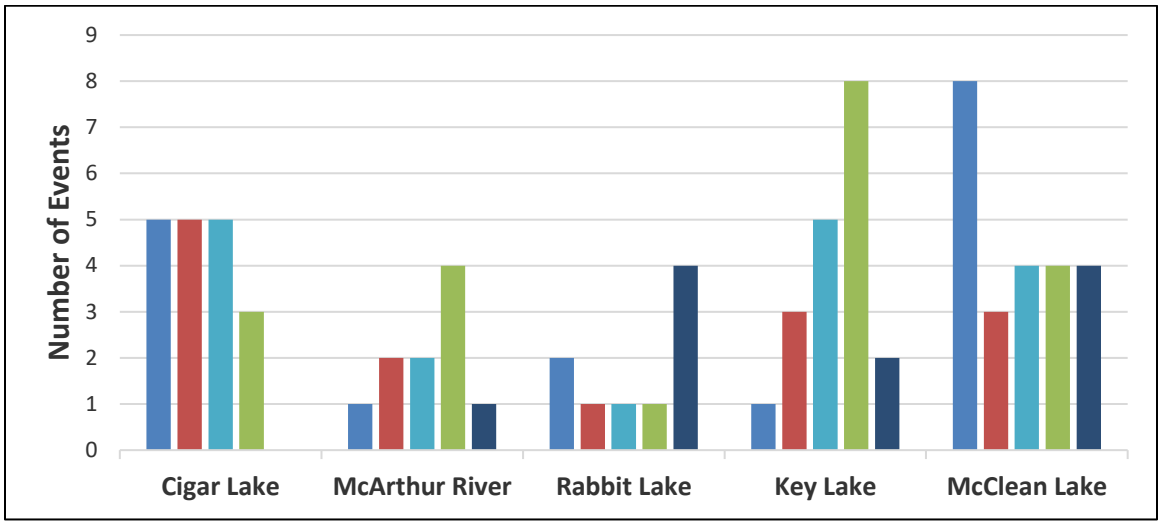
Uncontrolled releases

Licensees are required to report to the regulatory authorities, including the CNSC, any unauthorized releases (spills) of hazardous or radioactive substances to the environment.

Figure 2.10 shows the number of environmental reportable spills for uranium mine and mill facilities during the 2016 to 2020 reporting period. In each case, CNSC staff reviewed and evaluated the licensee's actions to verify effective remediation and prevention, and were satisfied with actions taken by the licensee. CNSC staff rated all 2020 spills as "low significance" resulting in no residual impact on the environment.

The facility-specific sections and appendix I describe each reportable spill and the licensee's corrective actions response. The CNSC's spill rating definitions are also found in appendix I-2.

Figure 2.10: Uranium mines and mills reportable environmental spills, 2016–20



	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
2016	5	1	2	1	8
2017	5	2	1	3	3
2018	5	2	1	5	4
2019	3	4	1	8	4
2020	0	1	4	2	4

Air emissions released to the environment

Uranium mines and mills environmental programs include monitoring the effects of operations on the surrounding air and soil. Licensees measure airborne particulate levels and concentrations of regulated contaminants and COPC, as well as the concentration of radon gas in ambient air. Soil and vegetation may be affected by atmospheric deposition of particulate containing adsorbed metals and radionuclides associated with onsite activities. Licensees monitor contaminant concentrations in soil and terrestrial vegetation to verify that operational impacts are below regulatory limits.

Facilities with milling operations monitor atmospheric emissions from acid plants, yellowcake dryers, calciner operations, packaging, grinding and ammonium sulphate operations. Other measured parameters (e.g., ambient radon and stack testing for sulphur dioxide, uranium and heavy metals) verify facility design and evaluate the operation's performance against predictions made in ERAs.

CNSC staff verified that the mines and mills demonstrated satisfactory performance mitigating and monitoring the effects of their operations on the surrounding air and soil. Soil monitoring results around the facilities indicated that all measured parameters come within background level. As would be expected, air monitoring for radon gas near tailings management facilities and waste rock piles shows results higher than the regional background level of 25 Bq/m3. However, the concentrations fall to background levels within a short distance – less than 2 kilometres from the facility. The monitoring results indicate negligible impacts to the environment from atmospheric releases and confirm that all uranium mines and mills are in compliance with their environmental programs and provincial standards.

2.4.3 Assessment and monitoring

In accordance with the *Uranium Mines and Mills Regulations* [10], each uranium mine and mill licensee has an environmental monitoring program that monitors concentrations of nuclear and hazardous substances in the environment, and characterizes and monitors effects to the environment associated with the licensed facility. Nuclear and hazardous substances associated with monitoring programs are selected based on regulated COPCs identified through the licensee's ERA. COPCs identified through the ERA that have the potential for adverse environmental effects are managed through increased monitoring, inclusion in the environmental code of practice and further study or implementation of additional controls by licensees. CNSC staff review and evaluate environmental monitoring programs as criteria for assessing environmental performance.

The results of the licensee's environmental monitoring programs relative to the ERA predictions are provided in an environmental performance report (EPR) that is typically completed every 5 years and provides environmental data collected over the previous 5-year period. CNSC staff and the Saskatchewan Ministry of Environment staff review the EPRs once these reports are released.

2.4.4 Environmental risk assessment

The CNSC uses facility-specific ERAs developed by licensees as a regulatory tool throughout the lifecycle of uranium mine and mill facilities. Applicants use ERAs during initial environmental assessments for new facilities and for changes to existing facilities or activities at licensed operations where applicable. The ERA identifies the need for mitigation technologies or practices and predicts:

- physical disturbances
- releases to the atmosphere
- releases to surface water
- air quality
- soil and sediment quality
- surface water quality
- groundwater quality
- changes to the physical environment
- biological and human health effects.

ERAs are reviewed at a minimum every 5 years, and if necessary, are updated. ERAs are updated based on changes to operational activities, revised predictions, environmental monitoring data collected over the previous 5 years and the latest science. Table 2.6 shows the year of the most recent ERA submitted for each uranium mine and mill and the year the next ERA updates will be submitted to the CNSC for review. CNSC staff regularly review ERAs to determine the potential risks to human health and the environment and to verify that mitigation measures are adequate.

Table 2.6: ERAs – current and upcoming submissions

	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
Current ERA	2017	2020	2020	2020	2016
Upcoming ERA	2022	2025	2025	2025	2025*

* Deferred to align environmental monitoring and reporting frequencies, subject annual adequacy refers, as approved by the CNSC on August 12, 2020.

2.4.5 Protection of people

Each licensee must demonstrate that the public is protected from exposures to radiological and hazardous substances released from an operation. Protection of people is assessed in the ERA, which contains a human health risk assessment (HHRA). The HHRA assesses hazardous and radiological releases from facilities, and it models the resultant concentrations of contaminants in air, water, soil and traditional foods (such as fish, waterfowl and moose). The concentrations of contaminants consumed by a typical local resident are assessed against human health benchmarks in the HHRA. For all facilities, the HHRAs confirm that the concentrations of contaminants for a typical local resident are well below concentrations that could cause health effects. Therefore, it has been determined that the health of persons in areas surrounding the facilities is protected.

Doses to members of the public are calculated based on an individual expected to have the highest possible exposure using conservative assumptions. Calculated dose values are determined for both camp workers (e.g. cook) and persons that are expected to be in close vicinity to the licensed site (such as trappers and local residents). To be conservative, the dose calculations assume that local Indigenous residents (including adult, child, and toddler) obtain their dietary components throughout the year from the local area.

CNSC staff reviewed the HHRAs submitted by the uranium mines and mills and concluded that the estimated doses are a small fraction of the regulatory public dose limit of 1 mSv/year.

Eastern Athabasca Regional Monitoring Program

The Eastern Athabasca Regional Monitoring Program (EARMP) is a well-recognized environmental monitoring program designed to gather data on long-range environmental information and potential cumulative impacts downstream from uranium mining and milling operations. The program was initiated in 2011 with funding from the Saskatchewan government and the uranium mining industry (Cameco and Orano) as a sub-element of the Province of Saskatchewan's Boreal Watershed Initiative, which ended in 2017. The CNSC became a funding partner in 2017 to 2018 to support the publication of an EARMP final report (2011 to 2017) with a 5-year long-term funding agreement (2018–2019 to 2022–2023) signed in 2018 between the Saskatchewan Government, the CNSC and industry. The community program monitors the safety of traditionally harvested country foods by analyzing water, fish, berries and wild meat (e.g., grouse, rabbit, caribou and moose) from representative northern Saskatchewan communities. The program contractor is an Indigenous-owned business in northern Saskatchewan. Samples are collected from areas identified by community members, with members either assisting in sample collection or providing samples from their own harvesting activities.

Harvesting and consuming traditional country foods are an important part of the culture in northern Saskatchewan. The intent of EARMP is to provide confidence and transparent communication with community members that traditional country foods remain safe to eat today and for future generations. The program has demonstrated that concentrations of contaminants of potential concern (COPC) have been relatively consistent over time and are within the regional reference range indicating no evidence of long-range transport of contaminants associated with uranium mining.

Evaluation of country food data from previous years confirms uranium mines and mills are not affecting the safety of country foods at nearby communities. The results indicated that radiological and non-radiological exposures to residents consuming country foods were similar to exposures of the general Canadian population. The EARMP has proven to be a productive means of involving the community in monitoring the health of their local environment and provides them with confidence in the safety of their traditional foods. The conclusion of the EARMP is that water and country foods are considered safe for consumption.

The annual reports and data are available at earmp.ca. The CNSC continues to support the EARMP and CNSC staff are working to further collaborate on this valuable program.

2.5 Conventional Health and Safety

The conventional health and safety SCA covers the implementation of a program to manage workplace safety hazards and protect personnel and equipment. Uranium mines and mills must develop, implement and maintain effective safety programs to promote safe and healthy workplaces and to minimize occupational injuries and illnesses.

For 2020, CNSC staff rated the conventional health and safety SCA at uranium mine and mill facilities as satisfactory, following acceptable performance in health and safety practices, awareness and performance.

Conventional health and safety ratings

Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
SA	SA	SA	SA	SA

SA = satisfactory

Practices

The CNSC requires licensees to identify potential safety hazards, assess associated risks, and introduce the necessary materials, equipment, programs and procedures to effectively manage, control and minimize these risks. CNSC staff work in collaboration with the Saskatchewan Ministry of Labour Relations and Workplace Safety to provide regulatory oversight of conventional health and safety in uranium mines and mills. CNSC staff's compliance verification activities include inspections and reviews of compliance reports and health and safety events.

CNSC staff confirmed that licensees at uranium mines and mills implemented effective conventional health and safety practices in their activities. In addition to CNSC staff's regulatory oversight, the Saskatchewan Government conducts regular inspections of occupational health and safety, mine safety and fire protection through an agreement with the Government of Canada.

Awareness

CNSC staff observed how the implementation of conventional health and safety programs continued to provide workers with education, training, tools and support (see figure 2.11). Each facility licensee promotes the idea that safety is the responsibility of all individuals; this message is reinforced by the licensees' management, supervisors and workers. The licensees' management members stress the importance of conventional health and safety through regular communication, management oversight and the continual improvement of safety systems. Through remote inspections, CNSC staff have identified a high level of communication and awareness in the area of conventional health and safety. CNSC staff concluded that in 2020, licensees of uranium mines and mills were committed to accident prevention and safety awareness, and focused on safety culture.

Figure 2.11: Warning signage in underground work area

Source: CNSC

Performance

Key performance measurement criteria for conventional health and safety are the number of lost-time injuries (LTIs) and the total recordable incident rate (TRIR) that occur at each facility. An LTI is a workplace injury that results in the worker being unable to return to work for a period of time. In reviewing each LTI, CNSC staff consider injury severity and frequency rates. The TRIR is the incident frequency rate, measuring the number of fatalities, LTIs and other injuries requiring medical treatment. Table 2.7 shows the number of LTIs at the uranium mines and mills, along with severity, frequency and TRIRs.

Table 2.7: Uranium mines and mills, lost-time injury statistics, 2020 (including contractors)

	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
Lost-time injuries[1]	0	0	0	0	2
Severity rate[2]	0	0	40.86	0	42.8
Frequency rate[3]	0	0	0	0	0.7
Total Recordable Incident Rate[4]	2.08	1.98	1.13	2.04	2.7

[1] An injury that takes place at work and results in the worker being unable to return to work for a period of time.

[2] A measure of the total number of days lost to injury for every 200,000 person-hours worked at the facility. Accident severity rate = [(# of days lost in last 12 months) / (# of hours worked in last 12 months)] x 200,000.

[3] A measure of the number of LTIs for every 200,000 person-hours worked at the facility. Accident frequency rate = [(# of injuries in last 12 months) / (# of hours worked in last 12 months)] x 200,000.

[4] A measure of the number of fatalities, lost-time injuries, and other injuries requiring medical treatment for every 200,000 person-hours worked at the facility. Recordable incident rate = [(#incidents in last 12 months) / # hours worked in last 12 months)] x 200,000.

Appendix K provides additional details on LTIs that occurred at the McClean Lake Operation in 2020 and the corrective actions taken. Information about these events can be found in section 7.4. Rabbit Lake has a positive severity rate despite there having been no LTIs in 2020, this is due to the time of occurrence and severity of an LTI in 2019. CNSC staff and the Saskatchewan Ministry of Labour Relations and Workplace Safety monitor and review each reportable injury to verify the cause is identified and the corrective actions taken are satisfactory. When applicable, injury information is shared among the facilities for lessons learned to improve safety and prevent reoccurrences.

CNSC staff concluded through their compliance verification activities that the health and safety programs at all uranium mines and mills met regulatory requirements in 2020.

Lost-time injuries: Comparison of the uranium mining sector to other mining sectors in Saskatchewan

Table 2.8 displays the various safety statistics concerning mining sectors within Saskatchewan. When contractors are excluded, the uranium mining and milling sector exhibits performance similar to other mining sectors for LTIs and frequency rate. The uranium sector comparison excludes contractors because statistics for the other sectors do not include contractors.

Table 2.8: Safety statistics for mining sectors in Saskatchewan, 2020

Mining sector	Number of LTIs[1]	Accident frequency rate (200,000 person-hours)[1]	Accident severity rate (200,000 person-hours)[1]	Total Recordable Incident Rate (200,000 person-hours)[3]
Potash (underground)	4	0.1	6.8	1.3
Solution (potash)	3	0.4	5.8	0.77
Minerals (sodium sulphate, sodium chloride)	2	0.7	2.5	– –
Hard rock (gold, diamond)	10	0.8	31.1	3.62
Coal (strip mining)	6	1.1	38.4	2.10
Uranium	2	0.08	8.5	1.74
Uranium (including contractors)[2]	2	0.06	14.0	2.74[4]

1 Saskatchewan Ministry of Labour Relations and Workplace Safety.
2 Statistics for all the other mining sectors do not include contractors.
3 Saskatchewan Mining Association, data provided voluntarily by member companies.
4 See tables 3.3, 4.3, 5.4, 6.3 and 7.3 for the data for each individual licensed uranium operation.

CNSC staff benchmarked the injury frequency rate at Saskatchewan uranium mines and mills with national and international mining statistics. The variation in definitions of a workplace injury is a limitation to consider when comparing safety-related statistics. However, where possible, efforts are made to compare and assess licensee performance against relevant national and international benchmarks. Table 2.9 shows various international benchmarks related to workplace incident frequency rates. The performance of the uranium mining and milling sector in Canada is similar.

Table 2.9: National/International benchmarking related to workplace safety

Publication/Standard	Lost Time Frequency rate	Total Recordable Incident Rate	Notes
Government of Western Australia Department of Mines, Industry Regulation and Safety[1]	2.3, 3.1	N/A	Lost time frequency rate of 2.3 across all mining sectors, and 3.1 in non-metal mining environments; rates are per million hours worked for 2016/2017
International Council on Mining and Metals[2]	4.3	N/A	Average rate are per million hours worked for 2016 based on statistics from 27 of the largest international mining companies
2017 Workplace Fatality and Injury Rate Report – Canada[3]	1.9	N/A	Average rate across all Canadian provinces and territories per million hours worked
The National Institute for Occupational Safety and Health[4] (US)	1.7	N/A	Average rate per 200,000 hours worked in 2015
International Council on Mining and Metals (ICMM)[5]	N/A	3.94	Total Recordable Injury Frequency Rate for ICMM Members. Rate per 200,000 hours worked in 2017
International Council on Mining and Metals (ICMM)[5]	N/A	4.26	Total Recordable Injury Frequency Rate for ICMM Members. Rate per 200,000 hours worked in 2016
International Council on Mining and Metals (ICMM)[5]	N/A	4.70	Total Recordable Injury Frequency Rate for ICMM Members. Rate per 200,000 hours worked in 2015

[1] Safety performance in the Western Australian mineral industry 2016-17, Government of Western Australia, Department of Mines, Industry Regulations and Safety, 2018.

[2.] Benchmarking 2016 Safety Data: Progress of ICMM Members, International Council on Mining and Metals.

[3] 2017 Workplace Fatality and Injury Rate, Tucker. S, University of Regina, 2017.

[4] Number and rate of mining nonfatal lost-time injuries by year, 2006-15, The National Institute for Occupational Safety and Health.

[5] Benchmarking 2017 safety data; progress of ICMM members, International Council on Mining & Minerals.

N/A = not available.

3 CIGAR LAKE OPERATION

Cameco Corporation is the operator of the Cigar Lake Operation, which is located approximately 660 kilometres north of Saskatoon, Saskatchewan.

The Cigar Lake Operation consists of an underground uranium mine with surface facilities for loading ore slurry into trucks, waste management facilities, a water treatment plant, surface freeze plants, administration offices and warehouses. Figure 3.1 shows an aerial view of the Cigar Lake Operation.

Figure 3.1: Cigar Lake Operation – aerial view looking north

Source: Shaw Global

Table 3.1 presents the mining production data from 2016 through 2020.

Table 3.1: Cigar Lake Operation - mining production data, 2016–20

Mining	2016	2017	2018	2019	2020
Ore tonnage (Mkg/year)	37.27	36.49	43.06	46.09	24.6
Average ore grade mined (%U)	18.27	18.85	16.1	15.1	14.6
Uranium mined (Mkg U/year)	6.81	6.88	6.94	6.98	3.61
Authorized annual production (Mkg U/year)*	9.25	9.25	9.25	9.25	9.25

* Mining up to 7.0 Mkg of uranium per year, with a production flexibility up to 9.25 Mkg of uranium.

CNSC staff confirmed the Cigar Lake Operation production remained within the authorized CNSC licence limit for the 2020 calendar year and is carrying forward a cumulative production shortfall of 16.1 million kilograms of uranium. This shortfall can be recouped in future years by increasing production.

3.1 Performance

For 2020, CNSC staff rated all 14 SCAs for the Cigar Lake Operation as satisfactory. The SCA ratings for the 5-year period from 2016 to 2020 are provided in appendix E.

In 2020, CNSC staff conducted 4 compliance inspections that covered the following SCAs: management system, fitness for service, operating performance, safety analysis, physical design, environmental protection, radiation protection, conventional health and safety, human performance management, waste management, security, and packaging and transport. There was 1 non-compliance identified through CNSC inspections at the Cigar Lake Operation for the 2020 calendar year. This non-compliance item was of low risk and related to the management system, and radiation protection SCAs. Corrective actions were implemented by the licensee, then reviewed and accepted by CNSC staff. A complete list of these inspections, including the dates the reports were sent to licensees and SCAs assessed, can be found in appendix B.

This report encompasses all SCAs but focuses on the 3 that cover the key performance indicators for these mines and mills: radiation protection, environmental protection, and conventional health and safety.

3.2 Radiation Protection

For 2020, CNSC staff continued to rate the radiation protection SCA at Cigar Lake as “satisfactory” based on regulatory oversight activities.

Cigar Lake Operation - radiation protection ratings

2016	2017	2018	2019	2020
SA	SA	SA	SA	SA

SA = satisfactory

Radiological hazard control

The main source of radiological exposure at the Cigar Lake Operation is from mining high-grade uranium ore. The effective dose contributors to nuclear energy workers (NEWs) at Cigar Lake remained similar to previous years, with gamma radiation (42%), radon progeny (32%) and long-lived radioactive dust (LLRD) (26%). Gamma radiation hazards are controlled through the effective use of time, distance and shielding. Exposures to radon progeny and LLRD are controlled through source control, ventilation, contamination control and personal protective equipment.

Radiation protection program performance

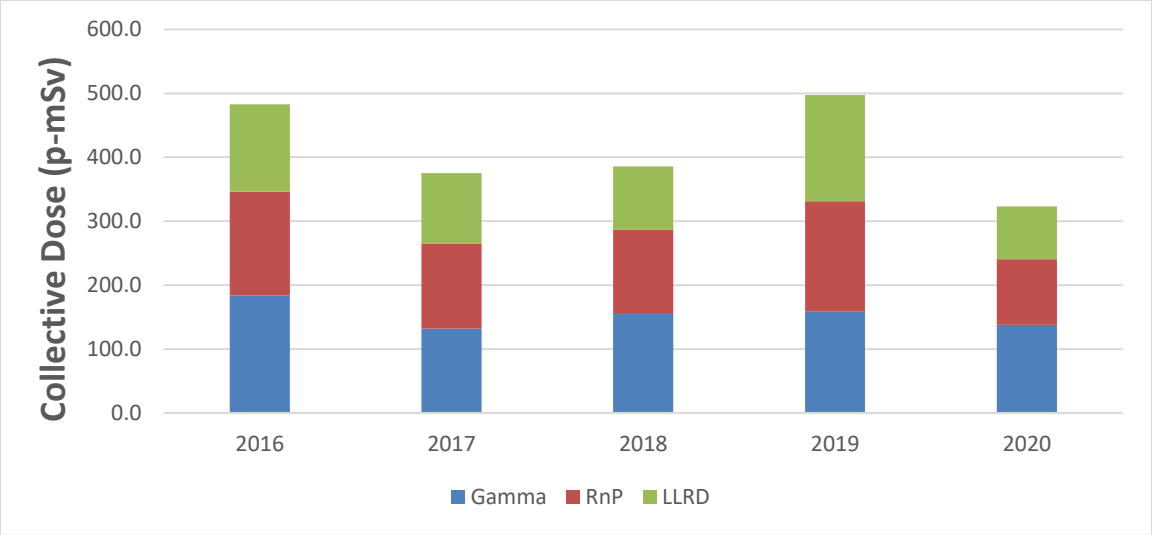
CNSC staff confirmed that the radiation protection program and practices at the Cigar Lake Operation remained effective in controlling radiological exposure to workers. In September 2020, 1 event resulted in an employee exceeding the weekly action level. Cameco's response to the action level exceedance complied with subsection 6(2) of the *Radiation Protection Regulations* [5] and that corrective actions were taken to verify ongoing effectiveness of the Radiation Protection Program.

Application of ALARA

In 2020, the collective radiation exposure to NEWs at the Cigar Lake Operation was 323.3 person-millisieverts (p-mSv).

Figure 3.2 illustrates the annual collective radiation exposures at the Cigar Lake Operation from 2016 to 2020.

Figure 3.2: Cigar Lake Operation – annual collective dose, 2016–20



	2016	2017	2018	2019	2020
Gamma (p-mSv)	184	131	154	158	137
RnP (p-mSv)	162	132	131	173	102
LLRD (p-mSv)	137	110	98	166	82
RnG (p-mSv)	0	0	0	0	0
Total*	483	376	387	498	323

RnP = radon progeny; LLRD = long-lived radioactive dust; RnG = radon gas
* The total collective dose may not match the individual components due to rounding errors.

In 2020, Cameco continued the practice of identifying workers with the top 25 highest effective doses from the previous year and then working with both the supervisors and workers to reduce their effective dose. Based on a pro-rated exposure value due to the 5-month shutdown in 2020, 20 of the 25 workers were successful in reducing their total effective dose, while the remaining 5 were slightly above the prorated individual target.

Worker dose control

During 2020, the average individual effective dose to NEWs was 0.38 millisieverts (mSv), compared to the average effective dose of 0.57 mSv in 2019. The maximum individual dose decreased from 3.7 mSv in 2019 to 2.82 mSv in 2020. The decreases in both the average and maximum individual doses is attributed to the 5-month shutdown due to COVID-19 protocols. The maximum 5 year dose for the 5-year dosimetry period of 2016 to 2020 was 19.43 mSv (~ 19.4% of the 100 mSv dose limit).

As indicated in figures 2.3 and 2.4, no worker exceeded the regulatory individual effective dose limit of 50 mSv in 1 year. CNSC staff verified that Cigar Lake Operation provided assurance that radiological hazards are anticipated and verified through suitable radiological monitoring by Cameco.

In September 2020, Cameco reported that a worker had exceeded the weekly action level of 1 mSv (appendix H). Cameco identified 9 corrective actions as a result of this event. CNSC staff reviewed the corrective actions and are satisfied with the actions taken. This event was reported as part of CNSC staff's presentation to the Commission in CMD 21-H2 [11].

Based on compliance verification activities that included inspections, reviews of licensees' reports, work practices, monitoring results and individual effective dose results for 2020, CNSC staff were satisfied that the Cigar Lake Operation continued to be effective at controlling radiation doses to workers.

3.3 Environmental Protection

For 2020, CNSC staff continued to rate the environmental protection SCA as "satisfactory". CNSC staff concluded that the licensee's environmental protection program was effectively implemented and met all regulatory requirements.

Cigar Lake Operation - environmental protection ratings

2016	2017	2018	2019	2020
SA	SA	SA	SA	SA

SA = satisfactory

Environmental management system

The environmental management system at the Cigar Lake Operation includes activities such as establishing annual environmental objectives, goals and targets. Cameco conducts internal audits of its environmental management program at the Cigar Lake Operation, as identified in the CNSC-approved management system program. CNSC staff reviewed and assessed the objectives, goals and targets through regular compliance verification activities. CNSC staff confirmed that Cameco continued to conduct routine inspections, internal audits, environmental training and periodic reviews of environmental monitoring data. These activities were conducted to assess continual improvement and to confirm that the controls put in place to protect the environment are effective.

Effluent and emissions control

Treated effluent released to the environment

CNSC staff confirmed that parameter concentrations in treated effluent were low and remained below treated-effluent discharge limits at the Cigar Lake Operation. CNSC staff verified that treated effluent released to the environment was well below regulatory requirements. At the Cigar Lake Operation throughout 2020, concentrations for molybdenum, selenium and uranium (shown in figures 2.5 to 2.7) remained below their respective action levels and well below provincial licence effluent discharge limits.

The Cigar Lake Operation is required to monitor concentrations of other regulatory contaminants and contaminants of potential concern (COPCs), such as radium-226, arsenic, copper, lead, nickel, zinc, total suspended solids (TSS) and pH. CNSC staff reviewed the Cigar Lake Operation effluent treatment concentrations and confirmed that it continued to meet MDMER [8] discharge limits (shown in section 2.4). There were no exceedances of the action levels in the environmental code of practice.

In 2016, the Cigar Lake Operation Environmental Performance Report (EPR) identified an increasing arsenic trend in effluent. While below regulatory limits, arsenic concentrations in the treated effluent were above environmental assessment predictions and above concentrations previously measured in the effluent prior to achieving full ore production. In response, Cameco created a working group to identify the causes of the elevated concentration and develop mitigation strategies. Cameco continues to implement several mitigation techniques to reduce arsenic loadings to the environment, such as improving the recycling of process water captured onsite for use in underground processes. As a result, arsenic loadings and mean concentrations changed to 0.063 mg/L in 2020 compared to 0.095 mg/L in 2019 at Cigar Lake. CNSC staff are satisfied that Cameco is taking appropriate actions to lower arsenic concentrations in the effluent.

CNSC staff will continue to review effluent quality results to verify that effluent treatment performance remains effective.

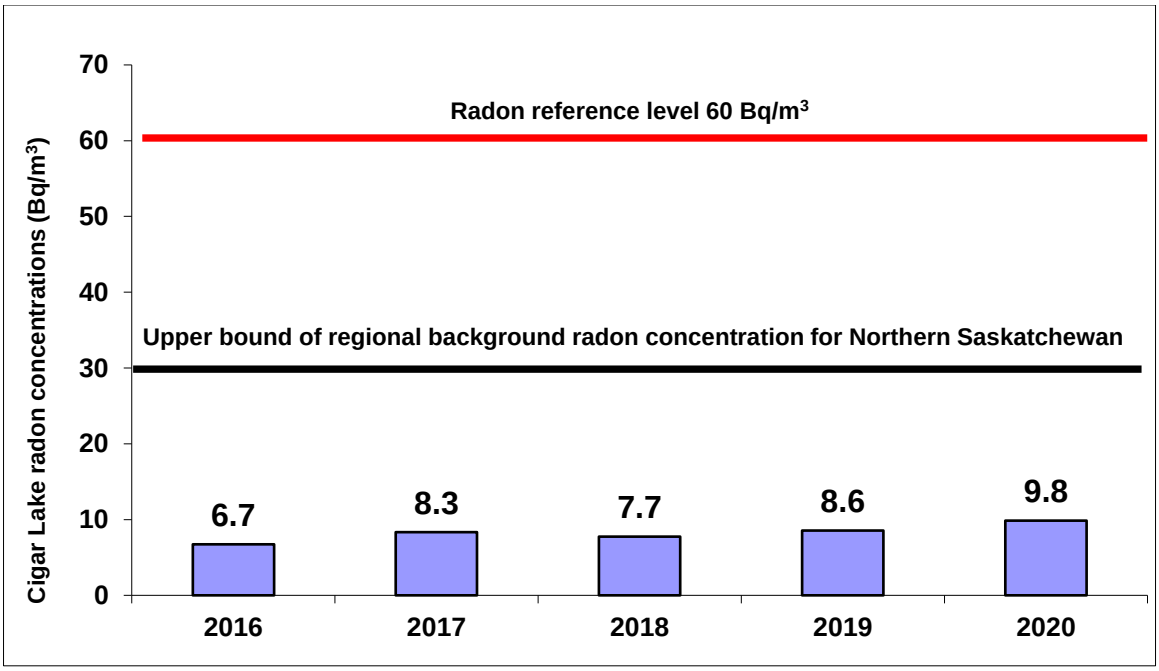
Air emissions released to the environment

As required by the CNSC, the Cigar Lake Operation maintains an air and terrestrial monitoring program. Air monitoring at the Cigar Lake facility includes ambient radon, total suspended particulate (TSP), soil sampling and lichen sampling to assess the impact of air emissions. Lichen samples are analyzed to determine the level of airborne particulate contaminants deposited on the surface of the lichen as a means of estimating the level of contamination, if any, entering lichen consumers, such as caribou.

Radon in ambient air is measured using passive track etch cups at 8 monitoring stations around the operation. The background concentration of radon in northern Saskatchewan ranges from less than 7.4 Bq/m^3 to 25 Bq/m^3.

Figure 3.3 illustrates the average concentrations of radon in the air at the Cigar Lake Operation from 2016 to 2020, and shows that measured values are similar to values measured as northern Saskatchewan regional background. The average radon concentrations are less than the reference level of 60 Bq/m^3, which represents an incremental dose of 1 mSv per year over background. CNSC staff noted that concentrations remained well below the reference level.

Figure 3.3: Cigar Lake Operation - average concentrations of radon in ambient air, 2016–20



* Upper-bound of the incremental dose of 1 mSv per year above background (i.e., an incremental radon concentration of 30 Bq/m^3 above natural background) based on ICRP 115. Values are calculated as geometric means.

A high-volume air sampler was used to collect and measure TSP in air. Results showed that the TSP levels were lower than provincial standards (see table 3.2). The mean concentrations of metal and radionuclides adsorbed to TSP were low and below the reference annual air quality levels identified in table 3.2.

Table 3.2: Cigar Lake Operation - concentrations of metal and radionuclides in air, 2016–20*

Parameter	Reference annual air quality levels	2016	2017	2018	2019	2020
TSP ($\mu g/m^3$)	**60** [3]	10.0	30.3	18.9	19.9	8.9
As ($\mu g/m^3$)	**0.06** [1]	0.0003	0.00039	0.00023	0.00026	0.00019
Mo ($\mu g/m^3$)	**23** [1]	0.0002	0.0002	0.0003	0.0002	0.0001
Ni ($\mu g/m^3$)	**0.04** [1]	0.00105	0.00103	0.00083	0.00060	0.00030
Pb ($\mu g/m^3$)	**0.10** [1]	0.0009	0.0008	0.0008	0.0007	0.0004
Se ($\mu g/m^3$)	**1.9** [1]	0.00003	0.00005	0.00003	0.00003	0.00002
Pb-210 (Bq/m^3)	**0.021** [2]	0.000305	0.00036	0.00037	0.000250	0.000313
Po-210 (Bq/m^3)	**0.028** [2]	0.000099	0.00012	0.00013	0.000089	0.000095
Ra-226 (Bq/m^3)	**0.013** [2]	0.000020	0.000030	0.000026	0.000013	0.000015
Th-230 (Bq/m^3)	**0.0085** [2]	0.000012	0.000023	0.000018	0.000009	0.000012
U ($\mu g/m^3$)	**0.06** [1]	0.00113	0.00151	0.00103	0.00096	0.00078

1 Reference annual air quality levels are derived from Ontario's 24-hour ambient air quality criteria (2012).

2 Reference level is derived from International Commission on Radiological Protection (ICRP) Publication 96, *Protecting People Against Radiation Exposure in the Event of a Radiological Attack.*

3 *Saskatchewan Environmental Quality Guidelines*, Table 20: Saskatchewan Ambient Air Quality Standards. Values are calculated as geometric means.

* Reference levels based on Province of Ontario Ambient Air Quality Criteria and are shown for reference only. No federal or Saskatchewan provincial limits were established at the time of this report.

Soil and terrestrial vegetation may be affected by the atmospheric deposition of particulate, adsorbed metals and radionuclides associated with onsite activities. Lichen and soil samples were collected in 2019 as required under the triennial sampling program. COPC concentrations measured in the soil samples collected from the study area were comparable to historical results. Concentrations of metals remained below existing *Canadian Environmental Quality Guidelines* [12] set by the Canadian Council of Ministers of the Environment, and radionuclide concentrations were low and near or at background levels and analytical detection limits. CNSC staff concluded that the level of airborne particulate contaminants produced by the Cigar Lake Operation is acceptable and does not pose a risk to the environment.

The lichen chemistry results from exposure stations in 2016 were similar to those of the reference stations and historic data. CNSC staff concluded that the level of airborne particulate contaminants was acceptable and did not pose a risk to lichen consumers.

Uncontrolled releases

In 2020, no hazardous substances were released at the Cigar Lake Operation, therefore, there was no residual impact to the environment. CNSC staff were satisfied with the licensee's reporting of releases and the corrective actions taken. CNSC staff rate spills in accordance with the definitions provided in appendix I, table I-2. Figure 2.10 in section 2 displays the number of environmental reportable spills at the Cigar Lake Operation from 2016 to 2020.

Appendix I contains a brief description of reported spills, the corrective actions taken by the licensee, CNSC staff's assessment of those actions, and the significance ratings for 2020.

Assessment and monitoring

CNSC staff confirmed that the licensee, in accordance with the Cigar Lake Environmental Protection Program, successfully carried out the required environmental monitoring.

Through the compliance verification activities conducted and the review of annual reports and EPRs, CNSC staff concluded that the environmental monitoring conducted at the Cigar Lake Operation met regulatory requirements. Consequently, CNSC staff concluded that the environment remained protected.

Environmental risk assessment

The CNSC uses environmental risk assessments (ERAs) to determine that people and the environment are protected. With the exception of arsenic, the Cigar Lake ERA 2017 submission indicated that contaminant levels in the receiving water and sediment were within the predictions made in the 2011 environmental assessment. Although arsenic levels in Seru Bay of Waterbury Lake were above ERA predictions, they remained below the *Saskatchewan Surface Water Quality Objectives* of 5 µg/L. Cameco implemented measures to address arsenic in the effluent as noted above, and CNSC staff verified that arsenic loading to the environment has decreased steadily since 2016.

The Cigar Lake EPR and updated ERA for the period from 2011 to 2015 were submitted to the CNSC in 2016 and to the Saskatchewan Ministry of the Environment in 2017. CNSC staff reviewed the environmental monitoring results for air, soil, vegetation, surface water, groundwater, sediment and aquatic health indicators and confirmed that the results were within those predicted in the ERA.

After reviewing the EPR and ERA, CNSC staff concluded that adequate measures have been taken at the Cigar Lake Operation to protect the environment.

Protection of people

Cameco is required to demonstrate that the health and safety of the public are protected from exposures to hazardous substances released from the Cigar Lake Operation. The effluent and environmental monitoring programs currently conducted by the licensee are used to verify that releases of hazardous substances do not result in environmental concentrations that may affect public health.

The CNSC receives reports of discharges to the environment through the reporting requirements outlined in the licence and licence conditions handbook (LCH). The review of Cigar Lake Operation's hazardous (non-radiological) discharges to the environment indicates that the public and the environment are protected. CNSC staff confirmed that environmental concentrations in the vicinity of the Cigar Lake Operation remained within those predicted in the 2017 ERA, and that human health remained protected.

Based on compliance verification activities that included inspections, reviews of licensees' reports, work practices and monitoring results for 2020, CNSC staff concluded that the Cigar Lake Operation's environmental protection program continued to be effective at protecting the public and the environment.

3.4 Conventional Health and Safety

CNSC staff continued to rate the conventional health and safety SCA as "satisfactory" based on regulatory oversight activities conducted during 2020.

Cigar Lake Operation - conventional health and safety ratings

2016	2017	2018	2019	2020
SA	SA	SA	SA	SA

SA = satisfactory

Practices

CNSC staff monitored the implementation of the Cigar Lake Operation's safety and health management program to verify the protection of workers. The program includes planned internal inspections, a safety permit system, occupational health committees, training and incident investigations. Cameco's incident reporting system includes reporting, trending and investigation of near misses, which helps reduce future incidents that could cause injury.

Cigar Lake implemented a "Safety Through Empowering Employee Leadership Committee". This safety steering committee is unique to the Cigar Lake Operation along with the "Good Catch" reporting environment where facility staff are recognized for distinguishing near misses related to safety. These were found to be safety culture strengths at the Cigar Lake Operation.

CNSC staff verified that the conventional health and safety work practices and conditions at the Cigar Lake Operation continued to be effective in 2020.

Performance

Table 3.3 summarizes lost-time injuries (LTIs) at the Cigar Lake Operation from 2016 to 2020. There were no LTIs at the Cigar Lake Operation in 2020.

Included in this report is the total recordable incident rate (TRIR). The TRIR is the incident frequency rate that measures the number of fatalities, LTIs and other injuries requiring medical treatment, per 200,000 person-hours worked.

Table 3.3: Cigar Lake Operation – lost-time injury statistics, 2016–20

	2016*	2017	2018	2019	2020
Lost-time injuries[1]	2	0	0	0	0
Severity rate[2]	8.85	8.72	0	0	0
Frequency rate[3]	0.29	0	0	0	0
Total recordable incident rate[4]	2.14	1.58	1.00	1.67	2.08

1 An injury that takes place at work and results in the worker being unable to return to work for a period of time.

2 A measure of the total number of days lost to injury for every 200,000 person-hours worked at the facility. Accident severity rate = [(# of days lost in last 12 months) / (# of hours worked in last 12 months)] x 200,000.

3 A measure of the number of LTIs for every 200,000 person-hours worked at the facility. Accident frequency rate = [(# of injuries in last 12 months) / (# of hours worked in last 12 months)] x 200,000.

4 A measure of the number of fatalities, lost-time injuries and other injuries requiring medical treatment for every 200,000 person-hours worked at the facility. Recordable incident rate = [(# of incidents in last 12 months) / # of hours worked in last 12 months)] x 200,000.

* The statistics for 2016 have been changed from previous regulatory oversight reports due to a reclassification of a 2016 injury to an LTI.

Awareness

CNSC staff observed that the conventional health and safety program at the Cigar Lake Operation continued to provide education, training, tools and support to workers. In 2020, Cameco suspended operations as part of the response to the COVID-19 pandemic. Cameco implemented several operational changes and reviewed practices that were impacted by adjustments due to COVID-19. CNSC staff verified, through remote compliance activities, that Cameco implemented effective controls to ensure that ongoing activities continued to be conducted safely as a result of any changes. CNSC staff confirmed that conventional health and safety events at the operation were investigated and that effective corrective actions were implemented.

CNSC staff compliance verification activities concluded that the Cigar Lake Operation's health and safety program met regulatory requirements in 2020.

3.5 Additional SCAs

In this 2020 regulatory oversight report, CNSC staff have provided a brief discussion of the additional SCAs; these are presented in the following sections.

3.5.1 Management System

The licensee includes program documentation for the management system SCA as part of the overall management system documents; these constitute part of the licensing basis for this facility in the LCH.

Although there were no inspections in 2020 at the Cigar Lake Operation focused on evaluating the management system SCA, there was 1 notice of non-compliance related to this SCA. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

3.5.2 Human Performance Management

The licensee includes program documentation for the human performance management SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no focused inspections and no notices of non-compliance in 2020 at the Cigar Lake Operation related to the human performance management SCA. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

3.5.3 Operating Performance

The licensee includes program documentation for the operating performance SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections in 2020 at the Cigar Lake Operation focused on evaluating the operating performance SCA. There were no notices of non-compliance related to the operating performance SCA and no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

3.5.4 Safety Analysis

The licensee includes program documentation for the safety analysis SCA as part of the overall management system documents and these are part of the licensing basis for this facility in the LCH.

There were no inspections in 2020 at the Cigar Lake Operation focused on evaluating the safety analysis SCA. There were no notices of non-compliance related to the safety analysis SCA and no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

3.5.5 Physical Design

The licensee includes program documentation for the physical performance SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections in 2020 at the Cigar Lake Operation focused on evaluating the physical design SCA and no notices of non-compliance related to this SCA. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

3.5.6 Fitness for Service

The licensee includes program documentation for the fitness for service SCA as part of the overall management system documents and these are part of the licensing basis for this facility in the LCH.

There were no inspections in 2020 at the Cigar Lake Operation focused on evaluating the fitness for service SCA and no notices of non-compliance related to this SCA. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

3.5.7 Emergency Management and Fire Protection

The licensee includes program documentation for the emergency management and fire protection SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections in 2020 at the Cigar Lake Operation focused on evaluating the emergency management and fire protection SCA. There were no notices of non-compliance related to the emergency management and fire protection SCA and no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

3.5.8 Waste Management

The licensee includes program documentation for the waste management SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections in 2020 at the Cigar Lake Operation focused on evaluating the waste management SCA. There were no notices of non-compliance related to the waste management SCA and no event reports for which this SCA was the main contributory factor.

In November 2020 the Commission accepted a revised financial guarantee and issued an amendment to the CNSC-issued licence for the facility. The update to the financial guarantee corresponded with the submission of an updated preliminary decommissioning plan and cost estimate submitted to the CNSC and the Saskatchewan Ministry of Environment. An update to the decommissioning plan and cost estimate are required a minimum of every 5 years.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

3.5.9 Security

The licensee includes program documentation for the security SCA as part of the overall management system documents and these constitute part of the licensing basis for this facility in the LCH.

There were no inspections in 2020 at the Cigar Lake Operation focused on evaluating the security SCA. There were no notices of non-compliance related to the security SCA and no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

3.5.10 Safeguards and Non-proliferation

The licensee includes program documentation for the safeguards and non-proliferation SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

In addition to CNSC compliance activities with respect to the specific areas under the safeguards and non-proliferation SCA, the International Atomic Energy Agency (IAEA) conducts its own inspections with coordination and support through the CNSC regulatory framework. No IAEA inspections were conducted at the Cigar Lake Operation during 2020 and no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

3.5.11 Packaging and Transport

The licensee includes program documentation for the packaging and transport SCA as part of the overall management system documents and these form part of the licensing basis for this facility in the LCH.

There were no inspections in 2020 at the Cigar Lake Operation focused on evaluating the packaging and transport SCA. There were no notices of non-compliance related to this SCA and no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

4 MCARTHUR RIVER OPERATION

Cameco Corporation is the operator of the McArthur River mine which is located approximately 620 kilometres north of Saskatoon, Saskatchewan.

The McArthur River Operation consists of an underground uranium mine, primary ore processing, ore slurry loading, waste management facilities, a water treatment plant, effluent storage ponds, surface freeze plants, administration offices and warehouses (see figure 4.1).

In October 2013, following a public hearing in La Ronge, Saskatchewan, the Commission issued a 10-year licence to Cameco for the McArthur River Operation. Cameco's licence expires on October 31, 2023.

Figure 4.1: McArthur River Operation – aerial view

Source: Cameco

In 2018, the McArthur River Operation halted active mining of high-grade uranium ore and the mining facility was placed, and remains, in safe care and maintenance. Mining production data from 2016 to 2020 for the McArthur River Operation is provided in table 4.1.

Table 4.1: McArthur River Operation – mining production data, 2016–20

Mining	2016	2017	2018	2019	2020
Ore tonnage (Mkg/year)	89.28	91.44	2.79	0	0
Average ore grade mined (%U)	7.89	7.09	6.42	N/A	N/A
Uranium mined (Mkg U/year)	7.04	6.48	0.18	N/A	N/A
Authorized annual production (Mkg U/year)	9.6	9.6	9.6	9.6	9.6

N/A = not applicable.

4.1 Performance

The SCA ratings at McArthur River Operation for the 5-year period from 2016 to 2020 are shown in appendix E. For 2020, CNSC staff rated all SCAs as "satisfactory".

In 2020, CNSC staff carried out 3 virtual compliance inspections which evaluated the following SCAs: fitness for service, environmental protection, conventional health and safety, physical design, packaging and transport, safeguards and non-proliferation, safety analysis, radiation protection, and emergency management and fire protection.

There were 4 instances of non-compliance identified during CNSC inspections at the McArthur River Operation in 2020. These instances of non-compliance were of low risk and related to the radiation protection and conventional health and safety SCAs. The licensee implemented corrective actions which were reviewed and accepted by CNSC staff. A complete list of inspections can be found in appendix B.

This report covers all SCAs but focuses on the 3 SCAs that cover many of the key performance indicators for these mines and mills: radiation protection, environmental protection, and conventional health and safety.

4.2 Radiation Protection

For 2020, CNSC staff continued to rate the radiation protection SCA as "satisfactory", based on regulatory oversight activities.

McArthur River Operation - radiation protection ratings

2016	2017	2018	2019	2020
SA	SA	SA	SA	SA

SA = satisfactory

Cameco includes the program documentation for the radiation protection SCA as part of the overall management system documents and form part of the licensing basis in the licence conditions handbook (LCH).

There were no exceedances of the regulatory dose limit and no exceedances of the weekly and quarterly action levels. There were 2 inspections conducted at the McArthur River Operation that focused on evaluating compliance with the radiation protection SCA. There were no event reports for which this SCA was the contributory factor.

Radiological hazard control

In 2020, the radiation dose to nuclear workers at the McArthur River facility was contributed by radon progeny (72%), gamma radiation (11%), and long-lived radioactive dust (LLRD) (17%). This distribution is similar to that in the previous year during which the mine was also in care and maintenance. Exposures to radon progeny, radon gas and LLRD are managed through source control, ventilation, contamination control and personal protective equipment. Gamma radiation hazards are controlled through practices that involve the effective use of time, distance and shielding.

Radiation protection program performance

In 2020, CNSC staff were satisfied that the radiation protection program and practices at the McArthur River Operation remained effective at controlling radiological exposure to workers. The doses to workers remained below regulatory limits and as low as reasonably achievable (ALARA). There were no exceedances of regulatory limits or action levels at the McArthur River Operation in 2020.

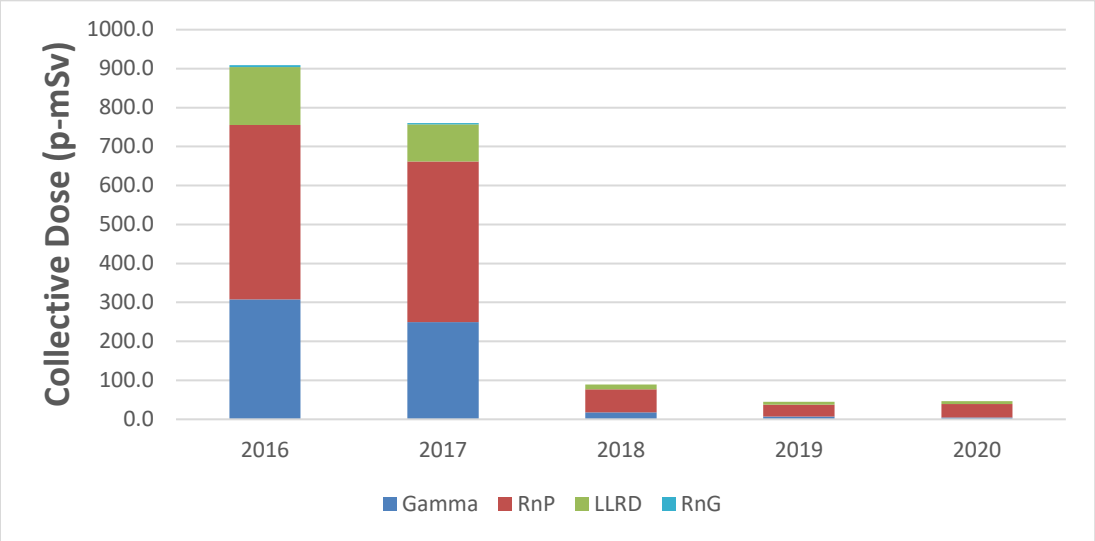
Application of ALARA

In 2020, the collective dose to nuclear energy workers (NEWs) at the McArthur River Operation was 47 person-millisieverts (p-mSv). The reduction in the collective dose reflects the state of care and maintenance of the facility over the last 2 years.

The ALARA focus at the McArthur River Operation was on radiation training during this period of reduced staff and care and maintenance activities.

Figure 4.2 displays the annual collective radiation exposures at the McArthur River Operation from 2016 to 2020.

Figure 4.2: McArthur River Operation – annual collective dose, 2016–20



	2016	2017	2018	2019	2020
Gamma (p-mSv)	308	249	17	7	5
RnP (p-mSv)	447	411	59	30	34
LLRD (p-mSv)	149	95	11	6	8
RnG (p-mSv)	5	3	0	0	0
Total*	914	756	88	44	46.9

RnP = radon progeny; LLRD = long-lived radioactive dust; RnG = radon gas
* The total collective dose may not match the individual components due to rounding errors.

Worker dose control

The average individual effective dose to NEWs was 0.27 mSv. The maximum individual effective dose of 2.94 mSv was assigned to an underground support worker. The 2020 values are comparable with those from the previous year. All individual effective doses were well below the annual regulatory limit of 50 mSv (as indicated in figures 2.3 and 2.4). The maximum 5 year dose for the 5-year dosimetry period of 2016 to 2020 was 13.65 mSv (~13.7% of the 100 mSv dose limit).

Based on compliance verification activities, such as inspections, reviews of licensees' reports, work practices, monitoring results and individual effective dose results, CNSC staff were satisfied that the radiation doses to workers continued to be effectively controlled at the McArthur River Operation during 2020.

4.3 Environmental Protection

For 2020, CNSC staff continued to rate the environmental protection SCA as "satisfactory" based on regulatory oversight activities. This marks continued satisfactory performance for the McArthur River Operation. CNSC staff verified that the environmental protection program was effectively implemented and met all regulatory requirements.

McArthur River Operation - environmental protection ratings

2016	2017	2018	2019	2020
SA	SA	SA	SA	SA

SA = satisfactory

Cameco includes program documentation for the environmental protection SCA as part of the overall management system documents and these constitute part of the licensing basis in the LCH.

There was 1 inspection in 2020 at the McArthur River Operation focusing on evaluating the environmental protection SCA. No issues were found during the inspection and there were no event reports for which this SCA was the main contributory factor.

Environmental management system

The environmental management system at the McArthur River Operation includes activities such as establishing annual environmental objectives, goals and targets. Cameco conducts internal audits of its environmental management program at the McArthur River Operation, as identified in their CNSC-approved management system program. CNSC staff reviewed and assessed the objectives, goals and targets through regular compliance verification activities. CNSC staff noted that Cameco had continued with routine inspections, internal audits, environmental training and periodic reviews of environmental monitoring data. These activities were conducted to verify continual improvement and to confirm that the controls put in place to protect the environment are effective.

Effluent and emissions control

Treated effluent released to the environment

CNSC staff verified that treated effluent released to the environment was below regulatory requirements and has remained stable or improved over the past 5 years. As discussed in section 2.4, constituents of potential concern (COPC) with potential to adversely affect the environment in treated effluent at multiple uranium mine and mill operations are molybdenum, selenium and uranium (figures 2.5 to 2.7). Of the 3 COPCs, molybdenum posed an elevated risk at the McArthur River Operation. In response, Cameco implemented process changes prior to 2018 during active mining which reduced molybdenum concentrations in treated effluent. Since 2018, concentrations of molybdenum were further reduced by approximately 90% as a result of placing the facility into a state of care and maintenance.

Cameco analyzed treated effluent from the McArthur River Operation for other constituents such as radium-226, arsenic, copper, lead, nickel, zinc, total suspended solids (TSS) and pH, for which limits are defined in the McArthur River CNSC-issued licence and mirror those limits defined in the MDMER [8] (section 2.4). CNSC staff reviewed the effluent treatment concentrations and confirmed that the McArthur River Operation continued to meet the discharge limits.

The CNSC will continue to review effluent quality results to verify that effluent treatment performance remains effective.

Figure 4.3: McArthur River Operation – monitoring pond

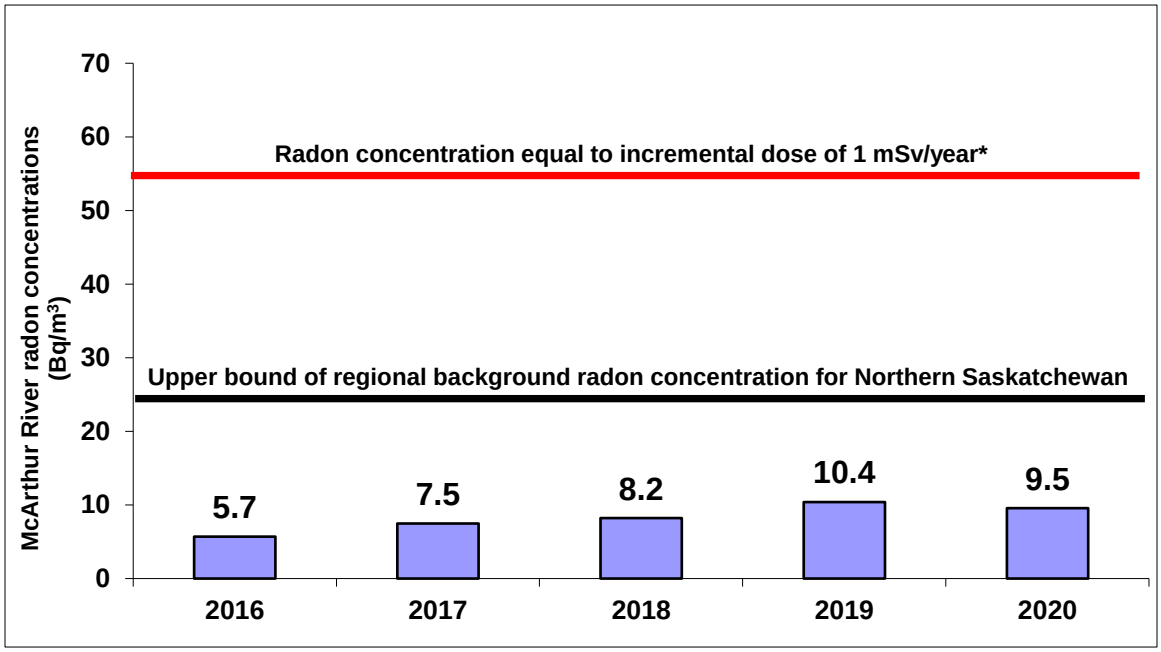
Source: Cameco

Air emissions released to the environment

The CNSC requires that Cameco maintain an air and terrestrial monitoring program at its McArthur River Operation. Air and terrestrial monitoring at the McArthur River facility includes ambient radon, total suspended particulate (TSP), soil sampling and lichen sampling to assess the impact of air emissions. An analysis of blueberry chemistry was also included to align with country food studies. Blueberry twigs are monitored to determine whether soil-borne contaminants (when present) are being absorbed through the roots into the growing plant parts. The monitoring of soil and blueberry stems/twigs was completed in the summer of 2018. The results are within the historical range for the stations sampled.

Radon in ambient air is monitored using passive track etch cups at 10 monitoring stations surrounding the operation. Figure 4.4 shows that the average concentrations of radon in ambient air from 2016 to 2020 were similar to past performance, with radon concentrations typical of the northern Saskatchewan regional background of less than 7.4 Bq/m^3 to 25 Bq/m^3. The average radon concentrations are less than the reference level of 55 Bq/m^3, which represents an incremental dose of 1 mSv/year above background.

Figure 4.4: McArthur River Operation - concentrations of radon in ambient air, 2016–20



* Upper-bound of the incremental dose of 1 mSv per year above background (i.e., an incremental radon concentration of 30 Bq/m^3 above natural background) based on ICRP Publication 115. Values are calculated as geometric means.

Two high-volume air samplers were used to collect and measure TSP in air. Taking the average of the 2 stations, the TSP levels were lower than provincial standards (see table 4.2). The mean concentrations of metal and radionuclides adsorbed to TSP were low and below the reference annual air quality levels identified in table 4.2.

Table 4.2: McArthur River Operation - concentrations of metal and radionuclides in air, 2016-20*

Parameter	Reference annual air quality levels	2016	2017	2018	2019	2020
TSP (µg/m^3)	**60** [3]	2.24	3.24	1.69	2.5	1.31
As (µg/m^3)	**0.06** [1]	0.0001	0.0001	0.00006	0.00004	0.00005
Cu (µg/m^3)	**9.6** [1]	0.0065	0.0064	0.0072	0.0063	0.0042
Ni (µg/m^3)	**0.04** [1]	0.0007	0.0007	0.0006	0.00054	0.00049
Pb (µg/m^3)	**0.10** [1]	0.0011	0.0006	0.0008	0.00063	0.00046
Se (µg/m^3)	**1.9** [1]	0.00004	0.00004	0.00003	0.000025	0.0000025
Zn (µg/m^3)	**23** [1]	0.0106	0.0084	0.0295	0.023	0.010
Pb-210 (Bq/m^3)	**0.021** [2]	0.0002	0.0004	0.0003	0.0003	0.0003
Po-210 (Bq/m^3)	**0.028** [2]	0.0001	0.0001	0.0001	0.0001	0.0001
Ra-226 (Bq/m^3)	**0.013** [2]	0.000007	0.00001	0.00001	0.0000	0.0000044
Th-230 (Bq/m^3)	**0.0085** [2]	0.000007	0.000007	0.00001	0.000008	0.000008
U (µg/m^3)	**0.06** [1]	0.0004	0.0003	0.0001	0.0001	0.0001

1 Reference annual air quality levels are derived from Ontario's 24-hour ambient air quality criteria (2012).

2 Reference level is derived from International Commission on Radiological Protection (ICRP) Publication 96, *Protecting People Against Radiation Exposure in the Event of a Radiological Attack.*

3 *Saskatchewan Environmental Quality Guidelines*, Table 20: Saskatchewan Ambient Air Quality Standards. Values are calculated as geometric means.

* Reference levels based on Province of Ontario ambient air quality criteria and are shown for reference only. No federal or Saskatchewan provincial limits were established at the time of this report.

Soil and terrestrial vegetation may be affected by the atmospheric deposition of particulate and adsorbed metals and radionuclides associated with onsite activities. A terrestrial monitoring program is in place and includes triennial measurements of metals and radionuclides in soil and blueberry samples.

Soil, blueberry twig and lichen samples were last collected in 2018 as required by the triennial sampling program. The results indicated that the parameters measured were within historical ranges.

CNSC staff concluded that the level of airborne particulate contaminants produced by the McArthur River Operation is acceptable and does not pose a risk to the environment.

Uncontrolled releases

In 2020, no events reported to the CNSC were classified as a release (spill) of a hazardous substance to the environment. CNSC spill rating definitions can be found in appendix I, table I-2.

Figure 2.10 in section 2 shows the number of spills at the McArthur River Operation from 2016 to 2020.

Assessment and monitoring

CNSC staff confirmed that the licensee, in accordance with the McArthur River environmental protection program, successfully carried out the required environmental monitoring.

Through the compliance verification activities conducted and the review of annual reports and environmental protection reports (EPRs), CNSC staff concluded that the environmental monitoring conducted at the McArthur River Operation met regulatory requirements. Consequently, CNSC staff concluded that the environment remains protected.

Environmental risk assessment

In 2020, the McArthur River EPR and updated Environmental Risk Assessment (ERA) for 2015 to 2019 were submitted to the CNSC and the Saskatchewan Ministry of Environment. CNSC staff have reviewed the environmental monitoring results for air, soil, vegetation, surface water, groundwater and sediment, as well as the health indicators for fish and their prey inhabiting sediment and confirmed the results to date were within those predicted in the ERA. The ERA review process is still ongoing at this time.

After reviewing the EPR and ERA data that has been collected, CNSC staff concluded that adequate measures have been taken at the McArthur River Operation to protect the environment.

Protection of people

Cameco is required to demonstrate that the health and safety of the public are protected from exposures to hazardous substances released from the McArthur River Operation. The effluent and environmental monitoring programs currently conducted by the licensee are used to verify that releases of hazardous substances do not result in environmental concentrations that may affect public health.

The CNSC receives reports of discharges to the environment through the reporting requirements outlined in the licence and LCH. The review of McArthur River Operation's hazardous (non-radiological) discharges to the environment indicates that the public and the environment are protected. CNSC staff confirmed that environmental concentrations in the vicinity of the McArthur River Operation remained within those predicted in the 2015 ERA, and that human health remained protected.

Based on compliance verification activities that included inspections, reviews of licensees' reports, work practices and monitoring results for 2020, CNSC staff concluded that the McArthur River Operation's environmental protection program continued to be effective at protecting the public and the environment.

4.4 Conventional Health and Safety

CNSC staff rated the conventional health and safety SCA as "satisfactory" based on regulatory oversight activities conducted during 2020.

McArthur River Operation - conventional health and safety ratings

2016	2017	2018	2019	2020
SA	SA	SA	SA	SA

SA = satisfactory

Cameco includes program documentation for the conventional health and safety SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were 2 inspections conducted at the McArthur River Operation that focused on the conventional health and safety SCA. As a result of these inspections, only 1 non-compliance was identified. This non-compliance was related to housekeeping and of low risk significance. There were no event reports for which this SCA was the main contributory factor.

Practices

To promote continued effective safety performance, the McArthur River Operation has implemented a health and safety management program to identify and mitigate risks at the facility. The program includes a safety permit system, continued training, planned internal inspections, occupational health committees and incident investigations. The incident reporting system includes investigating and reporting on near misses and reduces chances of future incidents that could cause injury. CNSC staff verified that Cameco's conventional health and safety work practices and conditions at the McArthur River Operation met regulatory requirements in 2020.

Performance

Table 4.3 summarizes lost-time injuries (LTIs) at the McArthur River Operation from 2016 to 2020. There were no LTIs at the McArthur River Operation in 2020.

Included in this report is the total recordable incident rate (TRIR). The TRIR is the incident frequency rate that measures the number of fatalities, LTIs and other injuries requiring medical treatment, per 200,000 person-hours worked.

Table 4.3: McArthur River Operation – lost-time injury statistics, 2016 –20

	2016	2017	2018	2019	2020
Lost-time injuries[1]	2*	1	0	0	0
Severity rate[2]	0	12.11	23.2**	0	0
Frequency rate[3]	0.24*	0.15	0	0	0
Total recordable incident rate[4]	3.74	5.24	5.02	2.12	1.98

1 An injury that takes place at work and results in the worker being unable to return to work for a period of time.

2 A measure of the total number of days lost to injury for every 200,000 person-hours worked at the facility. Accident severity rate = [(# of days lost in last 12 months) / (# of hours worked in last 12 months)] x 200,000.

3 A measure of the number of LTIs for every 200,000 person-hours worked at the facility. Accident frequency rate = [(# of injuries in last 12 months) / (# of hours worked in last 12 months)] x 200,000.

4 A measure of the number of fatalities, lost-time injuries and other injuries requiring medical treatment for every 200,000 person-hours worked at the facility. Recordable incident rate = [(# of incidents in last 12 months) / # of hours worked in last 12 months)] x 200,000.

* A hip injury in 2016 resulted in the worker being unable to return to work in 2017, resulting in lost time. Consequently, the number of 2016 LTIs increased from 1 to 2, and the frequency rate rose from 0.12 to 0.24.

** Severity rating of 23.2 is related to time lost in 2018 due to injuries that occurred in 2016 and 2017.

Awareness

CNSC staff observed that the conventional health and safety programs at the McArthur River Operation continued to provide education, training, tools and support to workers. Managers, supervisors and workers share and promote the idea that safety is the responsibility of all individuals. The facility's management stresses the importance of conventional health and safety through regular communication, management oversight and the continual improvement of safety systems.

CNSC staff verified that the health and safety program at the McArthur River Operation met regulatory requirements.

4.5 Additional SCAs

In this 2020 report, CNSC staff have provided a brief discussion of the additional SCAs; these are presented in the following sections.

4.5.1 Management System

Cameco maintains a Quality Management Program which is part of the licensing basis for McArthur River Operation in the LCH.

There were no inspections at the McArthur River Operation focusing on evaluating the management system SCA in 2020 and no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

4.5.2 Human Performance Management

Cameco includes program documentation for the human performance management SCA as part of the overall management system documents; these form part of the licensing basis in the LCH.

There were no inspections at the McArthur River Operation focusing on evaluating the human performance management SCA in 2020 and no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

4.5.3 Operating Performance

Cameco includes program documentation for the operating performance SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections at the McArthur River Operation focusing on evaluating the operating performance SCA in 2020 and no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

4.5.4 Safety Analysis

Cameco includes program documentation for the safety analysis SCA as part of the overall management system documents; these constitute part of the licensing basis for McArthur River Operation in the LCH.

No non-compliances were found in the 2 inspections conducted in 2020 with a focus on evaluating the safety analysis SCA. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

4.5.5 Physical Design

Cameco includes program documentation for the physical design SCA as part of the overall management system documents; these form part of the licensing basis for McArthur River Operation in the LCH.

There was 1 inspection conducted in 2020 at the McArthur River Operation focusing on evaluating the physical design SCA and there were no issues that arose from this inspection relating to this SCA. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program with respect of this SCA remains satisfactory.

4.5.6 Fitness for Service

Cameco includes program documentation for the fitness for service SCA as part of the overall management system documents; these constitute part of the licensing basis for the McArthur River Operation in the LCH.

There was 1 inspection conducted in 2020 at the McArthur River Operation that focused on evaluating the fitness for service SCA. No non-compliances were found during this inspection and there were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

4.5.7 Emergency Management and Fire Protection

Cameco includes program documentation for the emergency management and fire protection SCA as part of the overall management system documents; these form part of the licensing basis for McArthur River Operation in the LCH.

One inspection included focus on evaluating the emergency management and fire protection SCA at the McArthur River Operation in 2020. There was no issue found related to this SCA and there were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

4.5.8 Waste Management

Cameco includes program documentation for the waste management SCA as part of the overall management system documents; these form part of the licensing basis for McArthur River Operation in the LCH.

No inspections were conducted at the McArthur River Operation in 2020 that focused on evaluating the waste management SCA. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

4.5.9 Security

Cameco includes program documentation for the security SCA as part of the overall management system documents; these constitute part of the licensing basis for McArthur River Operations in the LCH.

There were no inspections conducted at the McArthur River Operation that focused on evaluating the security SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program with respect of this SCA remains satisfactory.

4.5.10 Safeguards and Non-proliferation

Cameco includes program documentation for the safeguards and non-proliferation SCA as part of the overall management system documents; these form part of the licensing basis for McArthur River Operation in the LCH.

In addition to CNSC compliance activities with respect to the specific areas under the safeguards and non-proliferation SCA, the International Atomic Energy Agency (IAEA) conducts independent inspections with coordination and support through the CNSC regulatory framework. No IAEA inspections were conducted at the McArthur River Operation during 2020. A CNSC inspection performed in 2020 verified Cameco's compliance regarding reporting requirements under the safeguard and non-proliferation SCA. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect to this SCA remains satisfactory.

4.5.11 Packaging and Transport

Cameco includes program documentation for the packaging and transport SCA as part of the overall management system documents; these form part of the licensing basis for McArthur River Operation in the LCH.

CNSC staff conducted 1 inspection at the McArthur River Operation during this reporting period that focused on evaluating the packaging and transport SCA. No non-compliances were noted during the inspection. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

5 RABBIT LAKE OPERATION

The Rabbit Lake Operation is located 750 kilometres north of Saskatoon, Saskatchewan. Owned and operated by Cameco Corporation, the facility stretches across approximately 20 kilometres. The Eagle Point underground mine is located at the northern margin of the property. Moving southward, 3 mined-out pits, 2 reclaimed, A-Zone and D-Zone, and 1 flooded, B-Zone pit all border Collins Bay of Wollaston Lake. The B-Zone pit remains isolated from Collins Bay by an intact dyke. In the central part of the property, the mined-out Rabbit Lake pit was converted to a tailings management facility (TMF). Adjacent to the in-pit TMF is the mill. South of the mill is the above ground TMF, which has not received tailings since 1985. At the southern margin, after passage through settling ponds, all treated effluent which must meet discharge limits is continuously discharged and eventually reaches Hidden Bay of Wollaston Lake. Figure 5.1 provides an aerial view of the mill area of the Rabbit Lake Operation.

Figure 5.1: Rabbit Lake Operation - aerial view

Source: CNSC

In October 2013, the Commission issued a 10-year licence following a public hearing in La Ronge, Saskatchewan. Cameco's licence for the Rabbit Lake Operation expires on October 31, 2023.

Mining production data for the Rabbit Lake Operation are provided in table 5.1.

Table 5.1: Rabbit Lake Operation - mining production data, 2016–20

Mining	2016	2017	2018	2019	2020
Ore tonnage (Mkg/year)	79.87	0	0	0	0
Average ore grade mined (%U)	0.59	0	0	0	0
Uranium mined (Mkg U/year)	0.47	0	0	0	0

On April 21, 2016, Cameco formally announced that due to market conditions, production at the Rabbit Lake Operation was to be suspended and the facility was placed in a safe state of care and maintenance. This decision allows Cameco the flexibility to resume production when market conditions improve.

No uranium concentrate was produced nor was any ore production conducted at the Rabbit Lake Operation during the 2020 reporting period. Table 5.2 provides milling production data from 2016 to 2020.

Table 5.2: Rabbit Lake Operation - milling production data, 2016–20

Milling	2016	2017	2018	2019	2020
Mill ore feed (Mkg/year)	61.67	0	0	0	0
Average annual mill feed grade (%U)	0.69	0	0	0	0
Percent uranium recovery (%)	97.0	0	0	0	0
Uranium concentrate produced (Mkg U/year)	0.43	0	0	0	0
Authorized annual production (Mkg U/year)	4.25	4.25	4.25	4.25	4.25

Cameco has implemented the safe transition of the operations to care and maintenance. The focus was on 3 key areas:

- preservation of facilities and equipment to ensure future availability
- ongoing collection and treatment of contaminated water from various areas of the operation
- maintenance of operational compliance with applicable regulations, approvals and licensed programs.

The transition to care and maintenance occurred through the suspension of production and the safe shutdown of related infrastructure and systems. The main functional areas to be managed include mill operations, mine operations and tailings management. A submission updating the plan and process to be followed and the status of the facility was provided to the CNSC and the Saskatchewan Ministry of Environment in October 2016. The submission has been reviewed by both agencies and the measures and activities outlined have been accepted. The following summarizes the transition initiatives.

Mill operations

The mill's transition to care and maintenance was similar to a routine maintenance shutdown event. The primary focus of the mill while in care and maintenance is the ongoing treatment of contaminated water from the mine, in-pit TMF, and lesser facilities across the site.

The required fire protection systems will continue to be maintained throughout the main mill complex.

Mine operations

No exploration, development or production activities took place in 2020. During the care and maintenance transition, activities at the Eagle Point mine were minimized and the focus was on the continued dewatering of the mine.

The licensee conducts and reports on routine inspections of the mine to verify proper functioning of dewatering and ventilation systems and to monitor for unusual or changing conditions. Emergency response is maintained by the licensee in accordance with the requirements of the Saskatchewan Ministry of Labour Relations and Workplace Safety.

Tailings management

The Rabbit Lake in-pit TMF continued to operate during the care and maintenance period. The primary operating functions involved:

- storing solids produced by the mill water treatment system
- providing ongoing dewatering of tailings solids and hydraulic containment of pore water, supernatant, surface runoff and groundwater from the existing catchment area
- providing short-term water storage capacity as part of the facility's water management system.

Reclamation

No changes to the existing preliminary decommissioning plan and cost estimate have occurred due to the suspension of production. Progressive reclamation activities will continue throughout the care and maintenance period. Cameco must notify CNSC staff if the scope of activities or timeline for decommissioning changes relative to the current operating status.

CNSC staff have verified the care and maintenance status of the mine and mill and the continuation of reclamation activities through desktop reviews of applications, reports and inspections. CNSC staff will continue to monitor and review the Rabbit Lake Operation's water management practices and reclamation activities to verify that the environment is protected during this period of care and maintenance.

5.1 Performance

For 2020, CNSC staff rated all 14 SCAs as "satisfactory" based on regulatory oversight activities. Ratings at the Rabbit Lake Operation for these 14 SCAs during the 5-year period from 2016 to 2020 are shown in appendix E. This report covers all SCAs but focuses on the 3 SCAs that cover many of the key performance indicators for these mines and mills: radiation protection, environmental protection, and conventional health and safety.

In 2020, CNSC staff conducted 1 baseline compliance inspection which focused on the following SCAs: operating performance, emergency management and fire protection, fitness for service, conventional health and safety, radiation protection and human performance (Training). There were no non-compliances identified as a result of the CNSC inspection of the Rabbit Lake Operation. The second planned CNSC inspection at Rabbit Lake for 2020 had been postponed until March 2021 and changed from an onsite inspection to a virtual inspection due to the travel restrictions resulting from the COVID-19 pandemic. A list of inspections is provided in appendix B.

5.2 Radiation Protection

For 2020, CNSC staff continued to rate the radiation protection SCA at Rabbit Lake as "satisfactory" based on regulatory oversight activities.

Rabbit Lake Operation - radiation protection ratings

2016	2017	2018	2019	2020
SA	SA	SA	SA	SA

SA = satisfactory

Radiological hazard control

The sources of radiological exposure at the Rabbit Lake Operation during production were from mining at the Eagle Point underground mine and from milling uranium ore into yellowcake at the Rabbit Lake mill. The effective dose contributors to nuclear energy workers (NEWs) at Rabbit Lake were radon progeny (78%), gamma radiation (16%), long-lived radioactive dust (LLRD) (4%) and radon gas (2%). Effective doses to NEWs from exposures to radon progeny, radon gas and LLRD are controlled through the effective use of source control, ventilation, contamination control and personal protective equipment. Gamma radiation exposure is controlled through practices related to the effective use of time, distance and shielding.

Radiation protection program performance

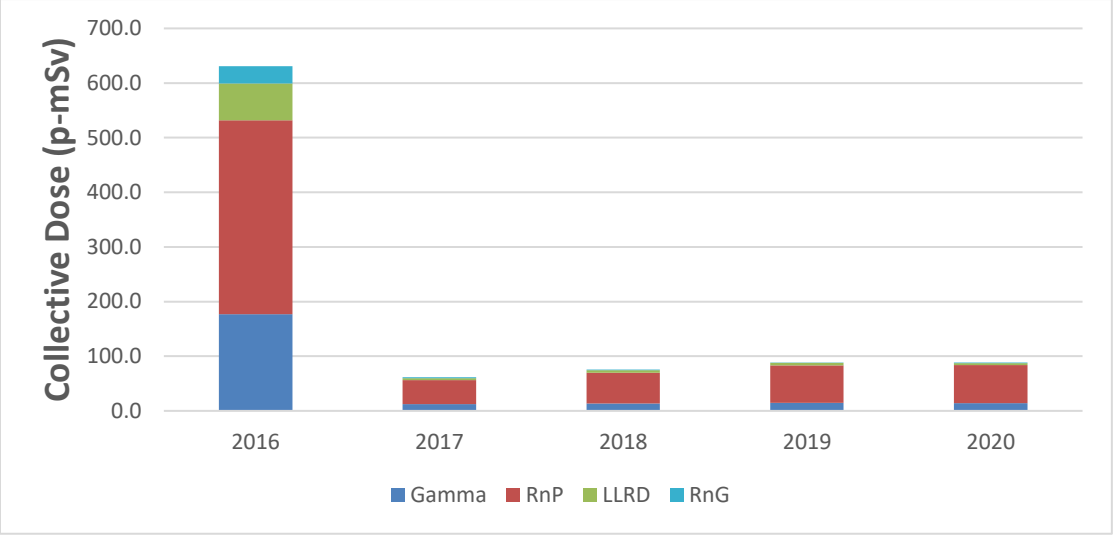
In 2020, CNSC staff were satisfied that the radiation protection program and practices at the Rabbit Lake Operation remained effective at controlling radiological exposure to workers. The doses to workers remained below regulatory limits and as low as reasonably achievable (ALARA). No exceedances of action levels were reported at the Rabbit Lake Operation in 2020.

Application of ALARA

In 2020, the collective dose to NEWs at the Rabbit Lake Operation was 89 person-millisieverts (p-mSv), a minor increase over the 2019 value of 88.8 p-mSv (see figure 5.2). The increase is a result of changes to staffing and maintenance activities.

Figure 5.2 displays the annual collective radiation exposures at the Rabbit Lake Operation from 2016 to 2020.

Figure 5.2: Rabbit Lake Operation – annual collective dose, 2016–20



	2016	2017	2018	2019	2020
Gamma (p-mSv)	177	12	13	15	14
RnP (p-mSv)	355	44	56	68	70
LLRD (p-mSv)	67	3	5	5	4
RnG (p-mSv)	32	2	1	1	1
Total*	631	61	76	89	89

RnP = radon progeny; LLRD = long-lived radioactive dust; RnG = radon gas
* The total collective dose may not match the individual components due to rounding errors.

In 2020, the Rabbit Lake Operation identified 2 targets for the ALARA program. The first was to meet 100% compliance to routine requirements such as schedule samples, target number of Job Task Observations etc. The second was the corporate industrial hygiene initiative –Disintegrations Per Minute (DPM) sampling underground at Eagle Point where DPM information was compiled and submitted in support of reduced reporting requirements based on risk levels in care and maintenance for Saskatchewan Ministry of Labour Relations and Workplace Safety.

CNSC staff have verified through regulatory oversight activities that Cameco continued to keep worker exposures ALARA.

Worker dose control

During 2020, the average individual effective dose for NEWs was 0.70 mSv and the maximum individual effective dose was 2.93 mSv. This is consistent with the average effective dose of 0.75 mSv and the maximum individual dose of 2.73 mSv in 2019. As shown in figures 2.3 and 2.4 (section 2), all individual effective doses for NEWs were below the annual regulatory limit of 50 mSv. The maximum 5-year dose for the 5-year dosimetry period of 2016 to 2020 was 8.52 mSv (~ 8.5% of the 100 mSv dose limit).

Based on CNSC staff's compliance verification activities, such as inspections, reviews of licensees' reports and work practices, and monitoring of results and individual effective dose results for 2020, CNSC staff were satisfied that the Rabbit Lake Operation continued to be effective at controlling radiation doses to workers.

5.3 Environmental Protection

For 2020, CNSC staff continued to rate the environmental protection SCA at Rabbit Lake as "satisfactory" based on regulatory oversight activities. CNSC staff concluded that the licensee's environmental protection program was effectively implemented and met all regulatory requirements.

Rabbit Lake Operation - environmental protection ratings

2016	2017	2018	2019	2020
SA	SA	SA	SA	SA

SA = satisfactory

Environmental management system

The environmental management system at the Rabbit Lake Operation includes activities such as establishing annual environmental objectives, goals and targets. Cameco conducts internal audits of its environmental protection program at the Rabbit Lake Operation as identified in its CNSC-approved management system program. CNSC staff review and assess the objectives, goals and targets through regular compliance verification activities. CNSC staff noted that Cameco continued to conduct routine inspections, internal audits, environmental training and periodic reviews of environmental monitoring data. These activities were conducted to verify continual improvement and to confirm that the controls put in place to protect the environment are effective.

Effluent and emissions control

Treated effluent released to the environment

For previously identified constituents of potential concern (COPC) with the potential to adversely affect the environment (i.e., uranium, molybdenum and selenium), the effluent treatment system at the Rabbit Lake Operation continued to meet performance expectations in terms of reducing the concentrations of these parameters (see figures 2.5 to 2.7 of section 2). At times in 2020, molybdenum concentrations were above the historical mean; however, the mean annual concentration (0.184 mg/L) remained relatively consistent with the 3-year historical mean (0.174 mg/l) and was stable most of the year.

As shown in section 2.4, CNSC staff verified that the Rabbit Lake Operation continued to meet the discharge limits set out in the *Metal and Diamond Mining Effluent Regulations* [8].

Cameco's environmental management system and effluent monitoring programs at the Rabbit Lake Operation met regulatory requirements, and all treated effluent discharged to the environment complied with licence requirements. In 2020, the concentrations of regulated parameters in treated effluent released to the environment were well below the regulatory limits and there were no exceedances of environmental action levels at the Rabbit Lake Operation. Figure 5.3 shows the B-Zone settling pond at the Rabbit Lake Operation. CNSC staff will continue to review effluent quality results to verify that effluent treatment performance remains effective.

Figure 5.3: Rabbit Lake Operation - B-Zone settling pond

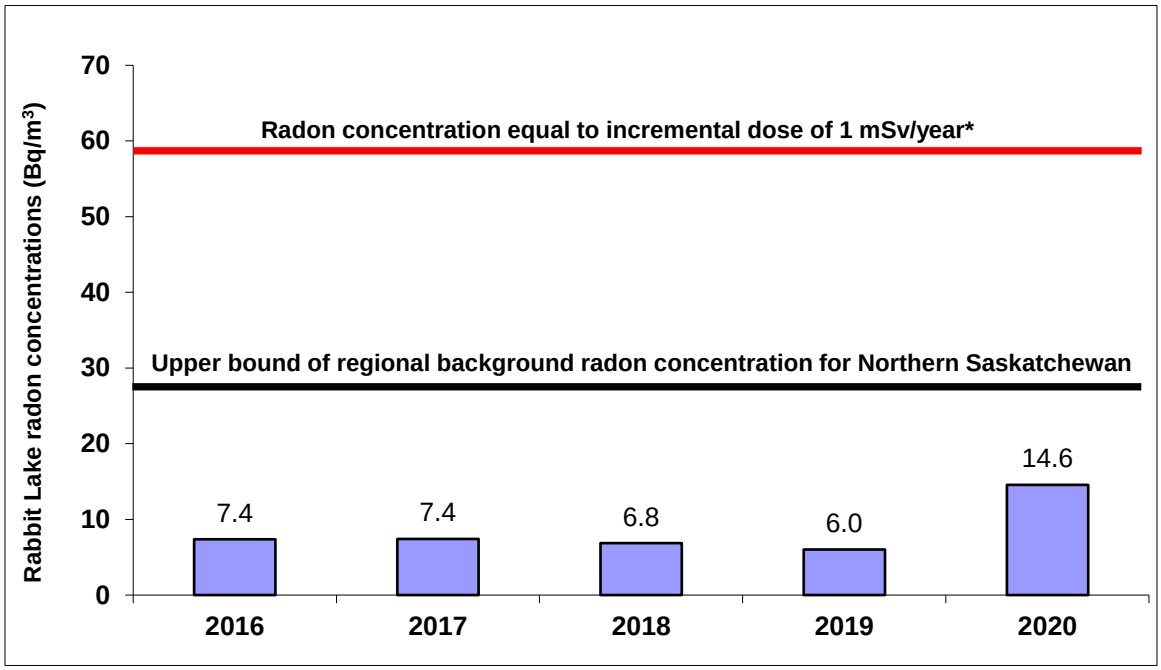
Source: Cameco

Air emissions released to the environment

Cameco also maintains an air and terrestrial monitoring program at the Rabbit Lake Operation. Air and terrestrial monitoring at the Rabbit Lake facility includes ambient radon, total suspended particulate (TSP), sulphur dioxide, soil sampling and lichen sampling to assess the impact of air emissions.

Radon in ambient air around the Rabbit Lake Operation is monitored at 13 stations using passive track etch cups. Figure 5.4 shows that the average concentrations of radon in ambient air from 2016 to 2020 is similar to background concentrations for northern Saskatchewan's regional baseline of less than 7.4 Bq/m^3 to 25 Bq/m^3. The average radon concentrations are less than the reference level of 55 Bq/m^3, which represents an incremental dose of 1 mSv/year above background.

Figure 5.4: Rabbit Lake Operation - concentrations of radon in ambient air, 2016–20



* Upper-bound of the incremental dose of 1 mSv per year above background (i.e., an incremental radon concentration of 30 Bq/m^3 above natural background) based on ICRP 115. Values are calculated as geometric means.

Three high-volume air samplers were used to collect and measure TSP in air. The TSP levels from the average of the 3 stations were lower than provincial standards (see table 5.3). TSP samples were also analyzed for concentrations of metals and radionuclides. The mean concentrations of metals and radionuclides adsorbed to TSP are low and remained below the reference annual air quality levels identified in table 5.3.

Table 5.3: Rabbit Lake Operation – concentrations of metal and radionuclides in air, 2016–20

Parameter	Reference annual air quality levels*	2016	2017	2018	2019	2020
TSP (µg/m^3)	**60** [3]	4.97	4.79	3.91	4.31	3.00
As (µg/m^3)	**0.06** [1]	0.000290	0.000285	0.000365	0.000128	0.000247
Ni (µg/m^3)	**0.04** [1]	0.000540	0.000404	0.000183	0.000140	0.000580
Pb-210 (Bq/m^3)	**0.021** [2]	0.000011	0.000013	0.000015	0.000006	0.000007
Ra-226 (Bq/m^3)	**0.013** [2]	0.0000014	0.0000004	0.0000002	0.000000	0.0000002
Th-230 (Bq/m^3)	**0.0085** [2]	0.0000007	0.0000004	0.0000003	0.0000000	0.0000000
U (µg/m^3)	**0.06** [1]	0.0011	0.000190	0.000277	0.000117	0.00012

1 Reference annual air quality levels are derived from Ontario's 24-hour ambient air quality criteria (2012).

2 Reference level is derived from International Commission on Radiological Protection (ICRP) Publication 96, *Protecting People Against Radiation Exposure in the Event of a Radiological Attack*.

3 *Saskatchewan Environmental Quality Guidelines*, Table 20: Saskatchewan Ambient Air Quality Standards. Values are calculated as geometric means.

* Reference levels based on Province of Ontario ambient air quality criteria and are shown for reference only. No federal or Saskatchewan provincial limits were established at the time of this report.

Daily in-stack monitoring of sulphur dioxide emissions from the mill acid plant was discontinued in 2017 for the duration of the care and maintenance period, as the acid plant and mill processing circuits were not operating.

Soil and terrestrial vegetation may be affected by the atmospheric deposition of particulate and adsorbed metals and radionuclides associated with onsite activities. A terrestrial monitoring program is in place and includes measurements of metals and radionuclides in lichen.

Lichen sampling has been conducted for 3 decades at the Rabbit Lake Operation, most recently in 2019. CNSC staff concluded that the level of airborne particulate contaminants produced by the Rabbit Lake Operation does not pose a risk to lichen consumers, such as caribou.

Assessment and monitoring

CNSC staff confirmed that the licensee successfully carried out required environmental monitoring, in accordance with the Rabbit Lake environmental protection program.

Through the compliance activities conducted and the review of annual reports and EPRs, CNSC staff concluded that the environmental monitoring conducted at the Rabbit Lake Operation met regulatory requirements. Consequently, CNSC staff concluded that the environment remains protected.

Environmental risk assessment

The Rabbit Lake Operation updated ERA for 2015 to 2019 was submitted to the CNSC and the Saskatchewan Ministry of Environment in December 2020. CNSC staff are currently finalizing their review of the environmental monitoring results for air, soil, vegetation, surface water, groundwater and sediment, as well as health indicators for fish and their prey inhabiting sediment, to confirm that the results were within those predicted in the ERA. The ERA review process is still ongoing at this time.

Protection of people

Cameco is required to demonstrate that the health and safety of the public are protected from exposures to hazardous substances released from the Rabbit Lake Operation. The effluent and environmental monitoring programs currently conducted by the licensee are used to verify that releases of hazardous substances do not result in environmental concentrations that may affect public health.

The CNSC receives reports of discharges to the environment through the reporting requirements outlined in the licence and the LCH. The review of Rabbit Lake Operation's hazardous (non-radiological) discharges to the environment indicates that the public and environment are protected. CNSC staff confirmed that environmental concentrations in the vicinity of the Rabbit Lake Operation remained within those predicted in the current 2015 ERA and that human health remained protected in 2020.

Based on compliance verification activities that included inspections, reviews of licensees' reports and work practices and monitoring results for 2020, CNSC staff concluded that the Rabbit Lake Operation's environmental protection program continued to be effective at protecting the public and the environment.

5.4 Conventional Health and Safety

For 2020, CNSC staff continued to rate the conventional health and safety SCA as "satisfactory" based on regulatory oversight activities.

Rabbit Lake Operation - conventional health and safety ratings

2016	2017	2018	2019	2020
SA	SA	SA	SA	SA

SA = satisfactory

Practices

Cameco's Rabbit Lake Operation has implemented a health and safety program to identify and mitigate risks. The program includes internal inspections, a safety permit system, occupational health committees, training and incident investigations. CNSC staff monitor this program through compliance activities to verify the protection of workers.

The incident reporting system at the Rabbit Lake Operation includes reporting on and investigating near misses with the aim of reducing future incidents that could cause injury. CNSC compliance verification activities confirmed that the Rabbit Lake Operation continued to focus on preventing accidents and injuries through the implementation of its health and safety management program.

Performance

No lost-time injuries were reported for the Rabbit Lake Operation in 2020. The lost-time injury (LTI) performance at the Rabbit Lake Operation from 2016 to 2020 is shown in table 5.4.

The total recordable incident rate (TRIR) is included for the last 5 years. The TRIR is the incident frequency rate that measures the number of fatalities, LTIs and other injuries requiring medical treatment, per 200,000 person-hours worked.

Table 5.4: Rabbit Lake Operation – lost-time injury statistics, 2016–20

	2016	2017	2018	2019	2020
Lost-time injuries[1]	1	0	0	1	0
Severity rate[2]	2.65	0	0	104.79	40.860
Frequency rate[3]	0.26	0	0	1.05	0
Total recordable incident rate[4]	1.85	1.03	5.03	2.10	1.13

[1] An injury that takes place at work and results in the worker being unable to return to work for a period of time.

[2] A measure of the total number of days lost to injury for every 200,000 person-hours worked at the facility. Accident severity rate = [(# of days lost in last 12 months) / (# of hours worked in last 12 months)] x 200,000.

[3] A measure of the number of LTIs for every 200,000 person-hours worked at the facility. Accident frequency rate = [(# of injuries in last 12 months) / (# of hours worked in last 12 months)] x 200,000.

[4] A measure of the number of fatalities, lost-time injuries, and other injuries requiring medical treatment for every 200,000 person-hours worked at the facility. Recordable incident rate = [(#incidents in last 12 months) / # hours worked in last 12 months)] x 200,000.

Awareness

CNSC staff observed that Cameco's conventional health and safety program at the Rabbit Lake Operation continued to provide education, training, tools and support to workers. Managers, supervisors and workers share and promote the idea that safety is the responsibility of all individuals. Facility management emphasizes the importance of conventional health and safety through regular communication, management oversight and the continual improvement of safety systems.

CNSC staff verified that the conventional health and safety program at the Rabbit Lake Operation remained effective at managing health and safety risks.

5.5 Additional SCAs

In this 2020 regulatory oversight report, CNSC staff have provided a brief discussion of the additional SCAs; these are presented in the following sections.

5.5.1 Management System

The licensee maintains a quality management program; this program forms part of the licensing basis for this facility in the LCH.

There were no inspections focusing on evaluating the management system SCA at the Rabbit Lake Operation in 2020 and no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

5.5.2 Human Performance Management

The licensee includes program documentation for the human performance management SCA as part of the overall management system documents; these constitute part of the licensing basis for this facility in the LCH.

There were no inspections focusing on evaluating the human performance management SCA at the Rabbit Lake Operation in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

5.5.3 Operating Performance

The licensee includes program documentation for the operating performance SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections focusing on evaluating the operating performance SCA at the Rabbit Lake Operation in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

5.5.4 Safety Analysis

The licensee includes program documentation for the safety analysis SCA as part of the overall management system documents; these constitute part of the licensing basis for this facility in the LCH.

There were no inspections conducted at the Rabbit Lake Operation focusing on evaluating the safety analysis SCA in 2020 and no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

5.5.5 Physical Design

The licensee includes program documentation for the physical design SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections at the Rabbit Lake Operation focusing on evaluating the physical design SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

5.5.6 Fitness for Service

The licensee includes program documentation for the fitness for service SCA as part of the overall management system documents; these constitute part of the licensing basis for this facility in the LCH.

There were no inspections at the Rabbit Lake Operation that focused on evaluating the fitness for service SCA in 2020 and there were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

5.5.7 Emergency Management and Fire Protection

The licensee includes program documentation for the emergency management and fire protection SCA as part of the overall management system documents; these constitute part of the licensing basis for this facility in the LCH.

There were no inspections conducted at the Rabbit Lake Operation focusing on evaluating the emergency management and fire protection SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

5.5.8 Waste Management

The licensee includes program documentation for the waste management SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections at the Rabbit Lake Operation focusing on evaluating the waste management SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

5.5.9 Security

The licensee includes program documentation for the security SCA as part of the overall management system documents; these documents constitute part of the licensing basis for this facility in the LCH.

There were no inspections focusing on evaluating the security SCA at the Rabbit Lake Operation in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

5.5.10 Safeguards and Non-Proliferation

The licensee includes program documentation for the safeguards and non-proliferation SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

In addition to CNSC compliance activities with respect to the specific areas under the safeguards and non-proliferation SCA, the International Atomic Energy Agency (IAEA) conducts independent inspections with coordination and support through the CNSC regulatory framework. No IAEA inspections were conducted at the Rabbit Lake Operation during 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

5.5.11 Packaging and Transport

The licensee includes program documentation for the packaging and transport SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections at the Rabbit Lake Operation focusing on evaluating the packaging and transport SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

6 KEY LAKE OPERATION

Cameco Corporation (Cameco) is the owner and operator of the Key Lake Operation which is located approximately 570 kilometres north of Saskatoon. Figure 6.1 provides an aerial view of the Key Lake facility. The operation began with 2 open-pit mines and a mill complex. The Gaertner open pit was mined from 1983 to 1987, followed by the Deilmann open pit until 1997.

Figure 6.1: Key Lake Operation - aerial view

Source: Cameco

Milling of the stockpiled Deilmann ore continued until 1999, when the McArthur River Operation began supplying ore slurry to the Key Lake mill. The Key Lake Operation continues today as a mill operation that processes McArthur River ore and residual special waste from previous mining at Key Lake.

After open pit mining in the eastern pit of the Deilmann ore body was completed in 1995, the pit was converted to the engineered Deilmann tailings management facility (TMF), while mining continued in other parts of the pit area (see figure 6.2). Mill tailings continue to be deposited in this facility today.

Figure 6.2: Key Lake Operation - Deilmann tailings management facility

Source: CNSC

In October 2013, the Commission issued a 10-year licence following a public hearing in La Ronge, Saskatchewan. The Key Lake Operation licence expires on October 31, 2023.

On November 8, 2017, Cameco notified the CNSC that effective January 2018, they would be temporarily suspending production at the Key Lake Operation. This included all activities directly related to the processing of uranium ore. On July 25, 2018, Cameco notified the CNSC of its decision to suspend production at the Key Lake Operation for an indefinite period, until economic conditions improve.

Milling data for the Key Lake Operation during the 5-year reporting period are presented in table 6.1. The Key Lake Operation operated in a state of care and maintenance for 2020.

Table 6.1: Key Lake Operation - milling production data, 2016–20

Milling	2016	2017	2018	2019	2020
Mill ore feed (Mkg/year)	155.30	143.26	0	0	0
Average annual mill feed grade (% U)	4.51	4.37	N/A	N/A	N/A
Percentage of uranium recovery (%)	99.04	99.05	N/A	N/A	N/A
Uranium concentrate produced (Mkg U/year)	6.95	6.20	0.06*	0.006**	0
Authorized annual production (Mkg U/year)	9.60	9.60	9.60	9.60	9.60

* Processing of remaining ore slurry from 2017.
**From calciner clean-out and disposal of laboratory samples.

6.1 Performance

The SCA ratings at the Key Lake Operation for the 5-year period from 2016 to 2020 are shown in appendix E. CNSC staff continued to rate all SCAs for 2020 as "satisfactory" based on regulatory oversight activities.

In 2020, CNSC staff carried out compliance inspections that covered multiple SCAs, as detailed in appendix B. Four instances of non-compliance were noted as a result of CNSC inspections at the Key Lake Operation for the 2020 calendar year. These instances of non-compliance were of low risk and related to the environmental protection, radiation protection and fitness for service SCAs as well as public information and disclosure. The licensee has implemented corrective actions which have been reviewed and accepted by CNSC staff. A list of inspections can be found in appendix B of this report.

This report covers all SCAs but focuses on the 3 SCAs that cover many of the key performance indicators for these mines and mills: radiation protection, environmental protection, and conventional health and safety.

Cameco is required to maintain a financial guarantee acceptable to the Commission. The financial guarantee must be reviewed and updated every 5 years, or if there are material changes to the licensees' operational activities. To fulfill the 5-year update requirement, on October 11, 2019, Cameco submitted a request to the CNSC to update their financial guarantee for the Key Lake Operation. This request included a proposed revision to the value of Cameco's financial guarantee from C$218.3 million to C$222.5 million, primarily to account for inflation. CMD 20-H101, *Key Lake Operation, Financial Guarantee Review and Licence Modernization Amendments,* [13] was prepared by CNSC staff and a hearing in writing based solely on written submissions was conducted by the Commission. A Record of Decision, DEC 20-H101 [14], was issued by the Commission on July 29, 2020.

The licence was amended to account for the new financial guarantee and was updated to the standard licence conditions at that time. Updated financial guarantee instruments were submitted by Cameco following the Commission decision.

6.2 Radiation Protection

Based on regulatory oversight activities during the reporting period, CNSC staff rated the radiation protection SCA at the Key Lake Operation as "satisfactory".

Key Lake Operation - radiation protection ratings

2016	2017	2018	2019	2020
SA	SA	SA	SA	SA

SA = satisfactory

Radiological hazard control

The effective dose contributors to nuclear energy workers (NEWs) at the Key Lake mill were gamma radiation (44%), radon progeny (35%) and long-lived radioactive dust (LLRD) (21%). Gamma radiation hazards are controlled through practices related to the effective use of time, distance and shielding. Radon progeny and LLRD are controlled through source control, ventilation contamination control and personal protective equipment.

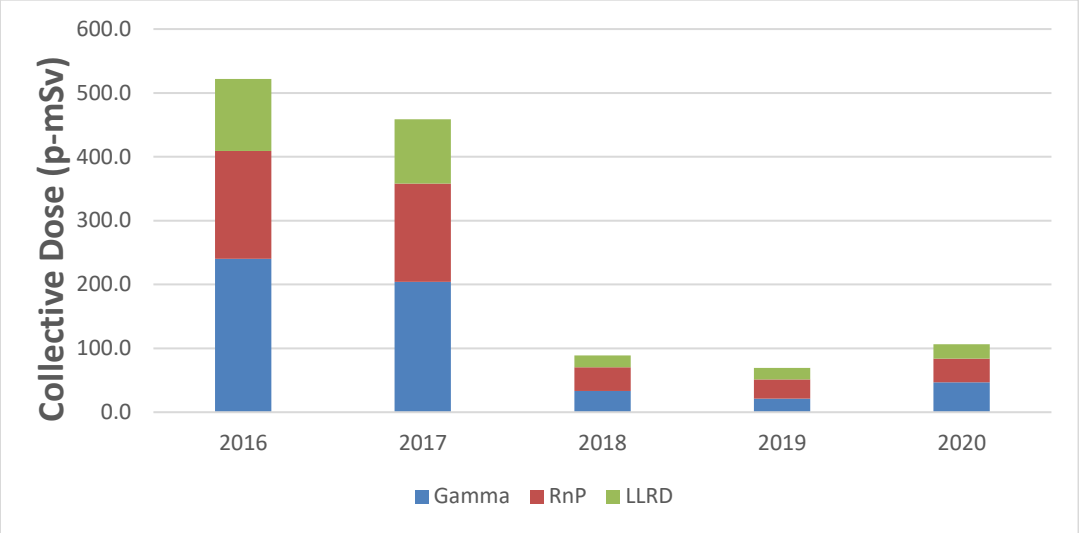
Radiation protection program performance

In 2020, CNSC staff were satisfied that the radiation protection program and practices at the Key Lake Operation remained effective at controlling radiological exposure to workers. The doses to workers remained below regulatory limits and as low as reasonably achievable (ALARA). No exceedances of action levels were reported at the Key Lake Operation in 2020.

Application of ALARA

In 2020, the collective dose to NEWs at the Key Lake Operation was 106 person-millisieverts (p-mSv), a 54% increase from the 2019 value of 69.2 p-mSv (see figure 6.3). This increase in collective dose reflects both an increase in the total number of staff and an increase to individual exposures to staff at Key Lake performing maintenance and improvements, including cleaning and inspection of its largest sump located at the crushing and grinding facility, expansion of the in-mill internet, and repairs in the crystallization and yellowcake areas. The collective dose in 2020 was similar to the value estimated in 2018, and well below the values estimated during active processing of uranium ore.

Figure 6.3: Key Lake Operation - annual collective dose, 2016–20



	2016	2017	2018	2019	2020
Gamma (p-mSv)	240	199	33	21	47
RnP (p-mSv)	169	153	37	30	38
LLRD (p-mSv)	113	99	19	18	33
RnG (p-mSv)	0	0.0	0	0	0.0
Total*	522	451	88	69	106

RnP = radon progeny; LLRD = long-lived radioactive dust; RnG = radon gas
* The total collective dose may not match the individual components due to rounding errors.

Cameco continued to meet its objectives in 2020 for keeping doses consistent with the ALARA principle at the Key Lake Operation. To support this objective, the radiation area monitoring program was revised for the transition to care and maintenance.

Worker dose control

In 2020, the average individual effective dose to NEWs was 0.35 mSv, while the maximum individual effective dose received was 2.11 mSv. This compares to an average effective dose of 0.27 mSv and a maximum individual dose of 1.64 mSv in 2019. The effective doses received by workers from 2018 to 2020 are lower than historic values because the facility is in a state of care and maintenance.

The maximum individual effective dose at the Key Lake Operation was identified as a mill maintenance worker. The maximum 5 year dose for the 5-year dosimetry period of 2016 to 2020 was 14.09 mSv (~ 14.1% of the 100 mSv dose limit).

No worker exceeded the regulatory individual effective dose limit of 50 mSv in 1 year and 100 mSv in a 5-year dosimetry period. There were also no administrative or action level exceedances in 2020.

Based on compliance verification activities, such as onsite inspections, reviews of licensee reports and work practices, monitoring of results and individual effective dose results, CNSC staff were satisfied that the Key Lake Operation continued to be effective at controlling radiation doses to workers in 2020.

6.3 Environmental Protection

For 2020, CNSC staff continued to rate the environmental protection SCA as "satisfactory" based on regulatory oversight activities. CNSC staff concluded that the licensees' environmental protection program was effectively implemented and met all regulatory requirements.

Key Lake Operation - environmental protection ratings

2016	2017	2018	2019	2020
SA	SA	SA	SA	SA

SA = satisfactory

Environmental management system

The environmental management system at the Key Lake Operation includes activities such as establishing annual environmental objectives, goals and targets. Cameco conducts internal audits of its environmental protection program at the Key Lake Operation, as identified in its CNSC-approved management system program. CNSC staff review and assess the objectives, goals and targets through regular compliance verification activities. CNSC staff noted that Cameco had continued to conduct routine inspections, internal audits, environmental training and periodic reviews of environmental monitoring data. These activities were conducted to verify continual improvement and to confirm that the controls put in place to protect the environment are effective.

Effluent and emissions control

Treated effluent released to the environment

At the Key Lake Operation, 2 effluent streams are processed in separate treatment facilities before being released to the environment:

- The mill effluent is processed with a treatment system of chemical precipitation and liquid/solid separation, then released to Wolf Lake in the David Creek system.
- Effluent from dewatering wells of the Gaertner pit and Deilmann pit hydraulic containment systems is treated with a reverse osmosis system before being released to Horsefly Lake in the McDonald Lake system.

Monitoring confirmed that this effluent is within design specifications and the predictions outlined in the ERA. Effluent from the reverse osmosis system was in compliance with licence/regulatory limits and there were no environmental action level exceedances.

The treated effluent quality presented in table 6.2 refers only to the mill effluent as released to the David Creek system. CNSC staff verified that the concentration of all regulated contaminants in the treated mill effluent released in 2020 met licence limits. There were no exceedances of environmental action levels.

As discussed in section 2.4, constituents of potential concern (COPC) with potential to adversely affect the environment in treated effluent at uranium mine and mill operations are molybdenum, selenium and uranium (see figures 2.5 to 2.7). Of these, molybdenum and selenium concentrations were the primary concerns at the Key Lake Operation. The licensee previously completed process changes to reduce concentrations in treated effluent.

Reductions of molybdenum and selenium occurred from 2007 to 2009 when additional treatment components were installed and optimized. Figures 2.5 and 2.6 display stable or declining concentrations of molybdenum and selenium in treated effluent from 2016 to 2020, indicating these parameters are being effectively controlled. Cameco submitted a molybdenum and selenium follow-up program closure report in 2018. Based on the results of the follow-up program, Cameco proposed that current regulatory monitoring requirements were sufficient to monitor future changes in sediment and other environmental receptors, and proposed that the formal follow-up program cease. CNSC staff confirmed in 2019 that the follow-up program could conclude, and, as a result, the monitoring requirements were added to the environmental monitoring program for the facility.

Figure 2.7 indicates that uranium concentrations in treated effluent released from the Key Lake mill remain low and are effectively controlled. In addition to analyzing treated effluent for uranium, molybdenum and selenium, Cameco analyzed treated effluent for concentrations of other COPCs, such as radium-226, arsenic, copper, lead, nickel, zinc and total suspended solids (TSS), as well as pH levels at Key Lake. As discussed in section 2.4, the Key Lake Operation continued to meet MDMER [8] discharge limits.

CNSC staff will continue to review effluent quality results to verify that the treatment of effluent remains effective.

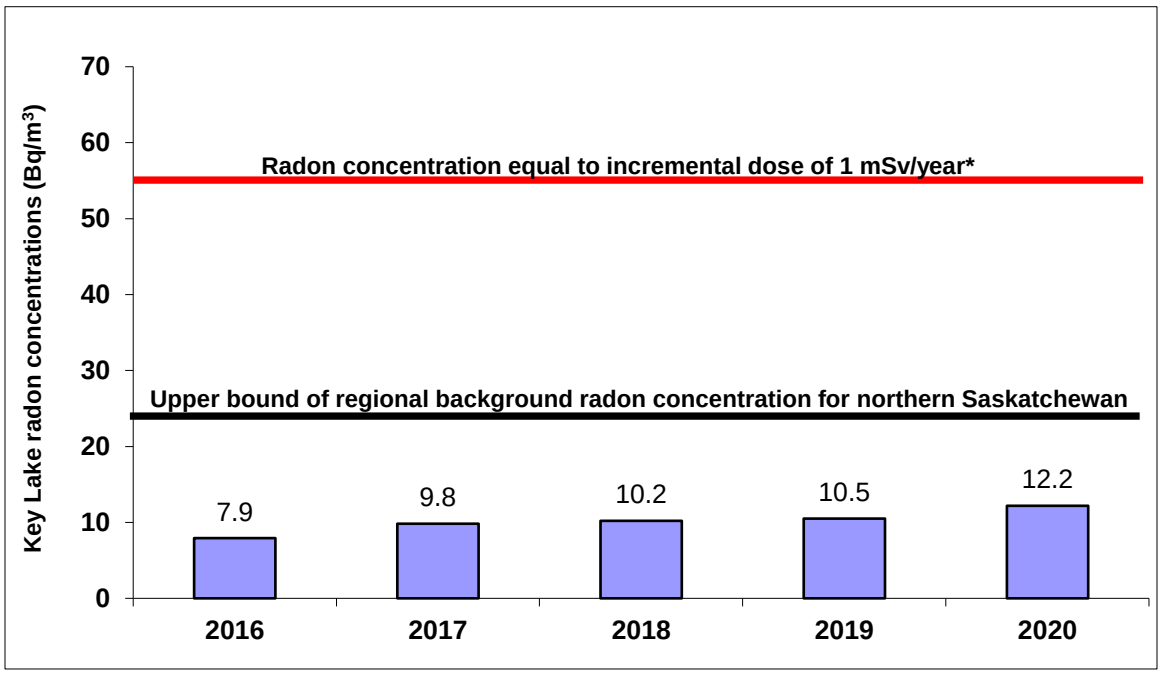
Air emissions released to the environment

The air and terrestrial monitoring program at the Key Lake Operation includes ambient monitoring for sulphur dioxide, radon and total suspended particulate (TSP), as well as soil and lichen sampling to assess air quality. Air emissions monitoring from the mill stacks is also included in the air-quality monitoring program.

The Key Lake calciner stack was not sampled in 2020 due to the facility not being in operation. Sulphur dioxide concentrations from the acid plant stack are monitored daily when in operation, however, the plant did not operate in 2020.

Radon in air around the Key Lake Operation is monitored at 5 stations using passive track etch cups. Figure 6.4 shows the average concentrations of radon in ambient air from 2016 to 2020. Ambient radon concentrations were typical of the northern Saskatchewan regional background of less than 7.4 Bq/m^3 to 25 Bq/ m^3. The measured radon concentrations are also below a reference radon concentration of 55 Bq/m^3, which is equal to an incremental dose of 1 mSv per year above background.

Figure 6.4: Key Lake Operation - concentrations of radon in ambient air, 2016–20



* Upper-bound of the incremental dose of 1 mSv per year above background (i.e., an incremental radon concentration of 30 Bq/m^3 above natural background) based on ICRP 115. Values are calculated as geometric means.

Five high-volume air samplers were used to collect and measure TSP. The TSP levels are below the province of Saskatchewan's authorized concentration of contaminants monitored for ambient air quality, as listed in the facility's approval to operate pollutant control facilities. TSP samples are also analyzed for concentrations of metals and radionuclides. The mean concentrations of metal and radionuclides adsorbed to TSP are low and below the reference annual air quality levels, as identified in table 6.2.

Table 6.2: Key Lake Operation - concentrations of metal and radionuclides in air, 2016–20

Parameter	Reference annual air quality levels*	2016	2017	2018	2019	2020
TSP ($\mu g/m^3$)	**60** [3]	10.77	11.90	8.80	6.91	6.04
As ($\mu g/m^3$)	**0.06** [1]	0.00084	0.0045	0.0021	0.0021	0.0008
Ni ($\mu g/m^3$)	**0.04** [1]	0.0007	0.0029	0.0011	0.0017	0.0006
Pb-210 (Bq/m^3)	**0.021** [2]	0.0003	0.0004	0.0002	0.003	0.0002
Ra-226 (Bq/m^3)	**0.013** [2]	0.0001	0.0003	0.0001	0.0001	0.0001
Th-230 (Bq/m^3)	**0.0085** [2]	0.0001	0.0002	0.0001	0.0001	0.0001
U ($\mu g/m^3$)	**0.06** [1]	0.0076	0.0085	0.0012	0.0008	0.0002

1 Reference annual air quality levels derived from Ontario's 24-hour ambient air quality criteria (2012).

2 Reference level from International Commission on Radiological Protection (ICRP) Publication 96, *Protecting People Against Radiation Exposure in the Event of a Radiological Attack*.

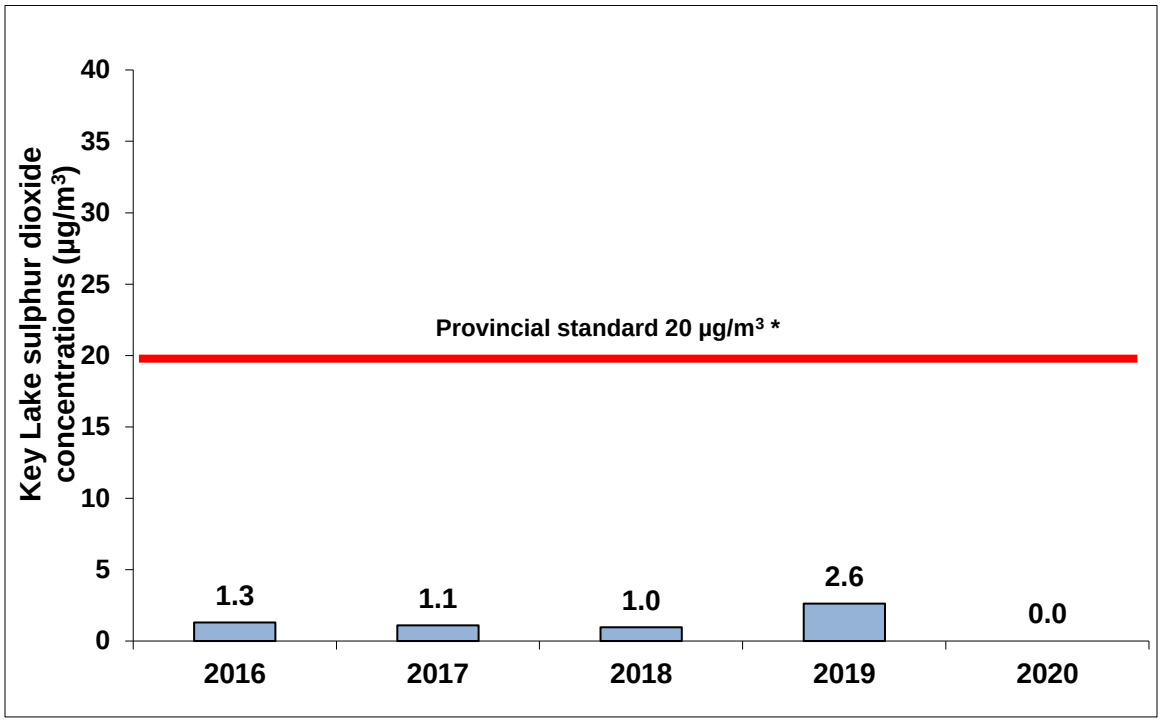
3 *Saskatchewan Environmental Quality Guidelines*, Table 20: Saskatchewan Ambient Air Quality Standards. Values are calculated as geometric means.

* Reference levels based on Province of Ontario ambient air quality criteria and are shown for reference only. No federal or Saskatchewan provincial limits were established at the time of this report.

A sulphur dioxide monitor is located approximately 300 metres downwind of the mill facility and is used to continuously measure the ambient sulphur dioxide associated with mill emissions. Because the site has been in a state of care and maintenance, CNSC staff and the Saskatchewan Ministry of Environment granted approval to cease ambient sulphur dioxide monitoring. Monitoring will be required when the acid plant resumes operation.

Figure 6.5 shows the measured sulphur dioxide monitoring data from 2019 did not exceed the annual standard of 20 $\mu g/m^3$.

Figure 6.5: Key Lake Operation - concentrations of ambient sulphur dioxide, 2016–20



* Monitoring suspended in 2020.

In addition to ambient air monitoring for sulphur dioxide, sulphate levels have been monitored in 4 lakes to measure the effects of sulphur dioxide emissions from the operation. The results of the 2020 lake sampling program continued to show that sulphate concentrations remain relatively unchanged from historical concentrations. CNSC staff concluded that the operations at Key Lake and the resulting sulphur dioxide emissions do not have an adverse effect on the sulphate levels in nearby lakes.

Soil and terrestrial vegetation may be affected by atmospheric deposition of particulate, adsorbed metals and radionuclides associated with onsite activities. The terrestrial monitoring program in place includes measurements of metals and radionuclides in soil and in lichen. Lichen and soil samples were collected in 2016 and will be collected again in 2021.

Based on the 2016 soil and lichen sampling results, CNSC staff concluded that the level of airborne particulate contaminants produced by the Key Lake Operation is acceptable and does not pose a risk to the environment.

Uncontrolled releases

In 2020, there were 2 events reported to CNSC staff that were considered to be releases of hazardous substances to the environment:

- On March 17, 2020, approximately 3,000 litres of untreated water overflowed from the reverse osmosis water treatment plant building and was released to the ground outside of the building. When performing a preventative maintenance test of the Uninterruptible Power Supply (UPS) at the plant, the UPS failed, resulting in a loss of power to the system communications. This loss of power also affected the high-level alarm in the raw water tank preventing the automatic shutdown of the raw water pumps, thus causing the raw water tank to overflow from the tank vent. The spilled material was collected and placed on the Gaertner special waste pad.
- On October 27, 2020, approximately 12,000 litres of untreated water was released from the mine shop building to the ground. When filling a hydrovac truck from the potable supply line, the line was left open which overflowed the truck, wash bay sumps and ultimately flowed outside of the building. The water froze on surface and was collected and transferred to the above ground tailings management facility.

These releases were minor and reporting met the requirements of CNSC's REGDOC-3.2.1, *Public Information and Disclosure* [4].

Appendix I provides a brief description of each release and the actions taken by the licensee. All corrective actions related to these spills have been completed and accepted by CNSC staff.

Figure 2.10 in section 2 displays the number of environmental reportable spills, as well as the number of releases of hazardous material to the environment from the licensed activities at the Key Lake Operation from 2016 to 2020.

Assessment and monitoring

CNSC staff confirmed that the licensee, in accordance with the Key Lake environmental protection program, successfully carried out the required environmental monitoring.

Through the compliance activities carried out and the review of annual reports and environmental protection reports (EPRs), CNSC staff concluded that the environmental monitoring conducted at the Key Lake Operation met regulatory requirements. Consequently, CNSC staff concluded that the environment remains protected.

Environmental risk assessment

The Key Lake Operation EPR and updated environmental risk assessment (ERA) for 2015 to 2019 were submitted to the CNSC and the Saskatchewan Ministry of Environment in December 2020. CNSC staff reviewed the environmental monitoring results for air, soil, vegetation, surface water, groundwater and sediment, as well as health indicators for fish and their prey inhabiting sediment, and confirmed that the results were within those predicted in the ERA.

After reviewing the EPR and ERA, CNSC staff concluded that adequate measures have been taken at the Key Lake Operation to protect human health and the environment.

Protection of people

Cameco is required to demonstrate that the health and safety of the public are protected from exposures to hazardous substances released from the Key Lake Operation. The effluent and environmental monitoring programs currently conducted by the licensee verify that releases of hazardous substances do not result in environmental concentrations that may affect public health.

The CNSC receives reports of discharges to the environment through the reporting requirements outlined in the Key Lake licence and licence conditions handbook (LCH). A review of the hazardous (non-radiological) discharges to the environment indicates that the public and the environment are protected. CNSC staff confirmed that environmental concentrations in the vicinity of the Key Lake Operation remained within those predicted in the 2013 ERA and that human health and the environment remained protected in 2020.

Based on compliance verification activities that included inspections, reviews of licensees' reports and work practices, and monitoring results for 2020, CNSC staff concluded that the Key Lake Operation's environmental protection program continued to be effective at protecting the public and the environment.

6.4 Conventional Health and Safety

For 2020, CNSC staff continued to rate the conventional health and safety SCA as "satisfactory", based on regulatory oversight activities.

Key Lake Operation - conventional health and safety ratings

2016	2017	2018	2019	2020
SA	SA	SA	SA	SA

SA = satisfactory

Practices

The Key Lake Operation's incident reporting system records health and safety related events and uses several layers of review in investigations. Corrective measures are tracked and assessed for effectiveness before the incident record is closed. The Key Lake Operation continued its planned health and safety inspection program in 2020. Any items of concern found during these inspections are included in the licensee's incident reporting system.

Performance

There were 2 lost-time injuries (LTIs) at the Key Lake Operation between 2016 and 2020. There were no LTIs in 2020.

Included in this report is the total recordable incident rate (TRIR). The TRIR is the incident frequency rate that measures the number of fatalities, LTIs and other injuries requiring medical treatment.

Table 6.3: Key Lake Operation – lost-time injury statistics, 2016-20

	2016	2017	2018	2019	2020
Lost-time injuries[1]	2	0	0	0	0
Severity rate[2]	71.0	0	0	0	0
Frequency rate[3]	0.41	0	0	0	0
Total recordable incident rate[4]	6.17	3.48	2.59	2.22	2.04

[1] An injury that takes place at work and results in the worker being unable to return to work for a period of time.

[2] A measure of the total number of days lost to injury for every 200,000 person-hours worked at the facility. Accident severity rate = [(# of days lost in last 12 months) / (# of hours worked in last 12 months)] x 200,000.

[3] A measure of the number of LTIs for every 200,000 person-hours worked at the facility. Accident frequency rate = [(# of injuries in last 12 months) / (# of hours worked in last 12 months)] x 200,000.

[4] A measure of the number of fatalities, lost-time injuries and other injuries requiring medical treatment for every 200,000 person-hours worked at the facility. Recordable incident rate = [(# of incidents in last 12 months) /(# of hours worked in last 12 months)] x 200,000.

Awareness

CNSC staff evaluated Cameco's conventional health and safety program at Key Lake and determined that it continued to provide education, training, tools and support to workers. The idea that safety is the responsibility of all individuals is promoted by the licensee's managers, supervisors and workers. The licensee's management stresses the importance of conventional health and safety through regular communication, management oversight and continual improvement of safety systems.

CNSC staff's compliance verification activities concluded that Cameco's health and safety program at the Key Lake Operation met regulatory requirements in 2020.

6.5 Additional SCAs

In this 2020 regulatory oversight report, CNSC staff have provided a brief discussion of the additional SCAs; these are presented in the following sections.

6.5.1 Management System

The licensee maintains a quality management program and this program is part of the licensing basis for this facility in the LCH.

There were no inspections at the Key Lake Operation that focused on evaluating the management system SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

6.5.2 Human Performance Management

The licensee includes program documentation for the human performance management SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections at the Key Lake Operation focusing on evaluating the human performance SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

6.5.3 Operating Performance

The licensee includes program documentation for the operating performance SCA as part of the overall management system documents; these constitute part of the licensing basis for this facility in the LCH.

There were no inspections at the Key Lake Operation focusing on evaluating the operating performance SCA in 2020 and there were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

6.5.4 Safety Analysis

The licensee includes program documentation for the safety analysis SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections at the Key Lake Operation focusing on evaluating the safety analysis SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

6.5.5 Physical Design

The licensee includes program documentation for the physical design SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections at the Key Lake Operation focusing on evaluating the physical design SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

6.5.6 Fitness for Service

The licensee includes program documentation for the fitness for service SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There was 1 inspection in September 2020 at the Key Lake Operation that focused on evaluating the fitness for service SCA. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

6.5.7 Emergency Management and Fire Protection

The licensee includes program documentation for the emergency management and fire protection SCA as part of the overall management system documents; these constitute part of the licensing basis for this facility in the LCH.

There were no inspections at the Key Lake Operation focusing on evaluating the emergency management and fire protection SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

6.5.8 Waste Management

The licensee includes program documentation for the waste management SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections at the Key Lake Operation focusing on evaluating the waste management SCA in 2020 and there were no event reports for which this SCA was the main contributory factor.

In July 2020, the Commission accepted a revised financial guarantee and issued an amendment to the CNSC-issued licence for the facility. The update to the financial guarantee corresponded with the submission of an updated preliminary decommissioning plan and cost estimate submitted to the CNSC and the Saskatchewan Ministry of Environment. An update to the decommissioning plan and cost estimate are required a minimum of every 5 years.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

6.5.9 Security

The licensee includes program documentation for the security SCA as part of the overall management system documents; these constitute part of the licensing basis for this facility in the LCH.

There were no inspections at the Key Lake Operation focusing on evaluating the security SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

6.5.10 Safeguards and Non-Proliferation

The licensee includes program documentation for the safeguards and non-proliferation SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

In addition to CNSC compliance activities with respect to the specific areas under the safeguards and non-proliferation SCA, the International Atomic Energy Agency (IAEA) conducts independent inspections with coordination and support through the CNSC regulatory framework. No IAEA inspections were conducted at the Key Lake Operation during 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

6.5.11 Packaging and Transport

The licensee includes program documentation for the packaging and transport SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections at the Key Lake Operation focusing on evaluating the packaging and transport SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

7 MCCLEAN LAKE OPERATION

Orano Canada Inc. (Orano) is the operator of the McClean Lake Operation. The McClean Lake Operation is a uranium mine and mill facility located approximately 750 kilometres north of Saskatoon in the Athabasca Basin of northern Saskatchewan. Ownership of the McClean Lake Operation is held by Orano (77.5%) and Denison Mines Inc. (22.5%). The McClean Lake Operation includes the John Everett Bates (JEB) milling area, Sue mining area, JEB tailings management facility (TMF) and the undeveloped McClean, Midwest and Caribou ore deposits.

An aerial view of the facility is presented in figure 7.1.

Figure 7.1: McClean Lake Operation - aerial view

Source: Orano

Following a public hearing held on June 7 and 8, 2017 in La Ronge, Saskatchewan, the current operating licence was renewed on July 1, 2017 and expires on June 30, 2027. This licence authorizes the operation of a nuclear facility for mining uranium ore, processing high-grade ore slurry from Cameco Corporation's Cigar Lake Operation, producing uranium concentrate and disposing of tailings at the JEB TMF. The Commission amended the McClean Lake operating licence on July 1, 2018, to reflect the licensee's corporate name change from AREVA Resources Canada Inc. to Orano Canada Inc.

Construction of the McClean Lake Operation began in 1994 and the milling of ore and processing of yellowcake product began in 1999. The McClean Lake Operation was designed and constructed with radiation protection features (e.g., lead shielding, concrete enclosures for storage and leach tanks) for processing undiluted high-grade ore averaging from 20% uranium to as high as 30% uranium. The mining and milling of uranium ore from 5 open-pit mines has been completed and conventional mining has not been carried out at the McClean Lake Operation since 2008. Mill tailings have been deposited in the JEB TMF, which was engineered from the mined-out JEB open pit.

Since March of 2014, the McClean Operation has been milling high grade ore slurry from Cameco's Cigar Lake mine. CNSC staff confirmed that the McClean Lake Operation's production did not exceed the authorized annual production limit. Table 7.1 presents milling production data for the McClean Lake Operation for the 5-year reporting period.

Table 7.1: McClean Lake Operation - milling production data, 2016–20

Milling	2016	2017	2018	2019	2020
Mill ore feed (Mkg/year)	37.20	36.35	42.9	46.2	26.3
Average annual mill feed grade (%U)	18.08	19.30	16.26	15.15	14.56
Percentage of uranium recovery (%)	99.10	99.03	98.94	98.91	98.81
Uranium concentrate produced (Mkg U)	6.67	6.93	6.94	6.94	3.88
Authorized annual production (Mkg U/year)	9.23	9.23	9.23	9.23	9.23

Orano has stated that milling of Cigar Lake ore produced more tailings per tonne of ore processed than initially expected. Current mining and milling plans indicate that the JEB TMF will reach its full storage capacity during the year of 2027. In order for Orano to secure future mining and milling plans, sufficient tailings capacity must be available to prevent production disruptions. Therefore, on June 16, 2020, Orano submitted an application to amend the CNSC issued Uranium Mine Operating Licence UMOL-MINEMILL-McCLEAN.01/2027 for the expansion of the JEB TMF at the McClean Lake Operation [15]. This was an update of an earlier submission made by Orano on November 1, 2019 [16]. CNSC staff evaluated Orano's application and supporting documentation and will be making recommendations to the Commission at a public proceeding in 2021 (CMD 21-H6) [17].

7.1 Performance

The SCA ratings at the McClean Lake Operation for the 5-year period from 2016 to 2020 are shown in appendix E. For 2020, CNSC staff rated all SCAs as "satisfactory" based on regulatory oversight activities.

In 2020, CNSC staff carried out 3 compliance inspections that covered multiple SCAs and 1 focused management system inspection, as detailed in appendix B.

For the 2020 calendar year, 5 instances of non-compliance were noted during CNSC inspections at the McClean Lake Operation. These instances of non-compliance were of low risk and related to the management system SCA. The licensee has implemented corrective actions, which have been reviewed and accepted by CNSC staff. A list of inspections can be found in appendix B.

This report covers all SCAs but focuses on the 3 SCAs that cover many of the key performance indicators for these mines and mills: radiation protection, environmental protection, and conventional health and safety.

7.2 Radiation Protection

Based on regulatory oversight activities during the reporting period, CNSC staff rated the radiation protection SCA at McClean Lake as "satisfactory" as shown in the table below:

McClean Lake Operation - radiation protection ratings

2016	2017	2018	2019	2020
SA	SA	SA	SA	SA

SA = satisfactory

Radiological hazard control

The source of radiological exposure at the McClean Lake Operation is the milling of high-grade uranium ore received from Cameco's Cigar Lake mine. The 3 primary dose contributors are gamma radiation (50%), radon progeny (RnP) (32%) and long-lived radioactive dust (LLRD) (18%). Gamma radiation hazards are controlled through practices related to the effective use of time, distance and shielding. Effective doses to nuclear energy workers (NEWs) from exposures to radon progeny and LLRD are controlled through the effective use of source control, ventilation, contamination control and personal protective equipment.

Orano has incorporated specific radiation protection features into its design to process undiluted, high-grade uranium ore at McClean Lake. These design features were established to limit radiological hazards (for all types) to specific design hazard objectives. Orano continues to implement a comprehensive monitoring program for all hazards to confirm that the engineered control of hazards remains effective, verify that design hazard objectives continue to be met and identify opportunities for improvement at the McClean Lake Operation.

CNSC staff concluded that Orano continues to implement a comprehensive monitoring program and remains highly effective at controlling all radiological hazards at the McClean Lake Operation during 2020.

Radiation protection program performance

The *Uranium Mines and Mills Regulations* [10] and the *Radiation Protection Regulations* [5] require that a licensee report any radiation action level exceedances as defined in Orano's McClean Lake Radiation Code of Practice (RCOP). The action levels for effective dose are 1 mSv per week and 5 mSv per quarter of a year. In 2020, there was 1 action level exceedance, which was attributed to the exposure that occurred during dust-generating cleaning activities within a vessel in the water treatment plant (WTP). The employee's personal alpha dosimeter (PAD) recorded a radon progeny exposure of 0.495 mSv and a long-lived radioactive dust exposure of 1.92 mSv for a combined PAD dose of 2.42 mSv, thus exceeding action levels for effective dose of 1 mSv per week. The corrective actions identified by Orano for interior cleaning of vessels within the WTP included using:

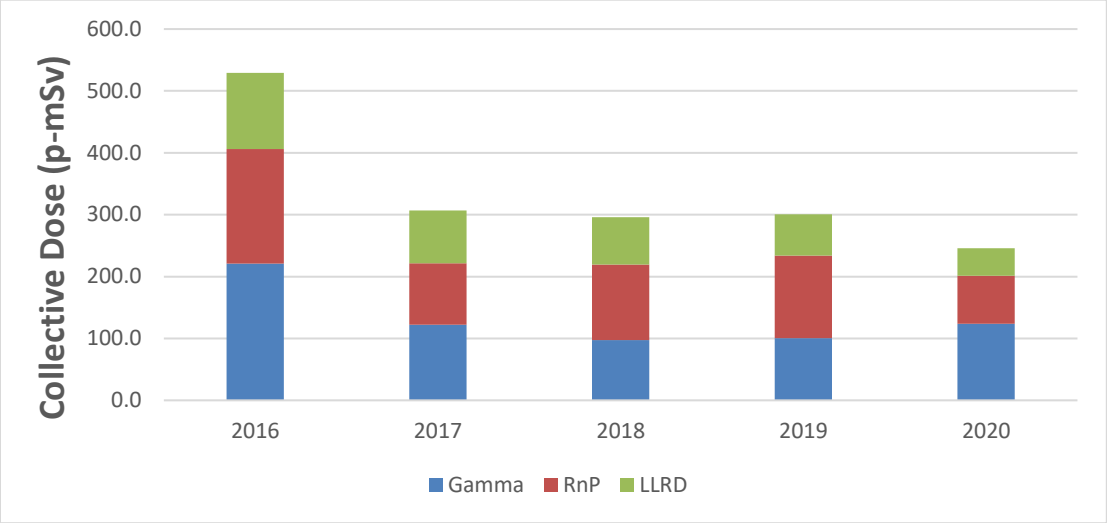
- dust sampling pumps
- radiation work permits.

CNSC staff are satisfied with the actions taken by the McClean Lake Operation to address the action level exceedance and to prevent similar future occurrences.

Application of ALARA

In 2020, collective radiation exposure to NEWs at the McClean Lake Operation was 246 person-millisieverts (p-mSv), an 18.3% decrease from the 2019 value of 301 p-mSv (figure 7.2).

Figure 7.2: McClean Lake Operation - annual collective dose, 2016–20



	2016	2017	2018	2019	2020
Gamma (p-mSv)	221	122	98	100	124
RnP (p-mSv)	185	100	122	133	78
LLRD (p-mSv)	123	85	76	67	45
RnG	0	0	0	0	0
Total	529	307	307	301	246

RnP = radon progeny; LLRD = long-lived radioactive dust; RnG = radon gas
* The total collective dose may not match the individual components due to rounding errors.

Through reviews of radiation monitoring, exposure reports and inspections, CNSC staff confirmed that the radiation protection program was highly effective and verified that worker exposures remained consistent with the ALARA principle in 2020.

Worker dose control

In 2020, the average individual effective dose to NEWs was 0.67 mSv, while the maximum individual effective dose received by a NEW was 4.28 mSv. These values compare to an average individual effective dose of 0.93 mSv and a maximum individual dose of 4.70 mSv in 2019. All individual effective doses were well below the 50 mSv annual regulatory limit (as indicated in figures 2.3 and 2.4). The maximum 5 year dose for the 5-year dosimetry period of 2016 to 2020 was 20.49 mSv (~ 20.5% of the 100 mSv dose limit).

Based on Orano's compliance verification activities, such as inspections, reviews of licensee reports and work practices, and the monitoring of results and individual effective dose results in 2020, CNSC staff were satisfied that the McClean Lake Operation continued to be effective at controlling radiation doses to workers in 2020.

7.3 Environmental Protection

For 2020, CNSC staff continued to rate the environmental protection SCA as "satisfactory" based on regulatory oversight activities. CNSC staff concluded that the licensee's environmental protection program was effectively implemented and met all regulatory requirements.

McClean Lake Operation - environmental protection ratings

2016	2017	2018	2019	2020
SA	SA	SA	SA	SA

SA = satisfactory

Environmental management system

The environmental management system at the McClean Lake Operation includes activities such as establishing annual environmental objectives, goals and targets. Orano conducts internal audits of its environmental management program at the McClean Lake Operation, as identified in their CNSC-approved management system program. CNSC staff review and assess the objectives, goals and targets through regular compliance verification activities. CNSC staff noted that Orano continued with routine inspections, internal audits, environmental training and periodic reviews of environmental monitoring data. These activities were conducted to verify continual improvement and to confirm that the controls put into place to protect the environment are effective.

Effluent and emissions control

Effluent and emissions monitoring programs serve to demonstrate that the facility's emissions, wastes, tailings and effluent discharges of nuclear and hazardous substances are properly controlled at the McClean Lake Operation.

Treated effluent released to the environment

At the McClean Lake Operation, 2 effluent streams are processed in separate treatment facilities before being released to the environment:

- The mill effluent is processed at the JEB water treatment plant with a treatment system of chemical precipitation and liquid/solid separation. Treated water is released to the Sink/Vulture treated effluent management system.
- The Sue water treatment plant treats effluent which is pumped to control the water level from the mined-out open pits using a chemical precipitation and settling pond clarification process. This effluent is then released to the Sink/Vulture treated effluent management system.

The blended treated effluent is released in a controlled manner.

The 2016 Environmental Risk Assessment identified future potential risks to aquatic organisms in McClean Lake east due to exposure to selenium from the milling of Cigar Lake ore. In the *Regulatory Oversight Report for Uranium Mines, Mills, Historic and Decommissioned Sites in Canada: 2017* [2], CNSC staff reported on the selenium adaptive management plan developed and implemented by Orano. CNSC staff continue to review reported selenium concentrations in effluent through quarterly reports to verify that the receiving environment remains protected.

Orano submitted a selenium review and assessment report in July 2018. This report provided a technical evaluation of operating performance with implemented process improvements, the feasibility of potentially augmenting selenium removal technologies and selenium risks in the environment. CNSC staff reviewed and accepted the report with a recommendation to modify the environmental monitoring program.

Orano reported 1 action level exceedance of selenium concentrations in the JEB water treatment plant effluent in March 2020. In response, CNSC staff requested Orano to propose a long-term solution for the reduction in selenium loading to the environment. Orano submitted an updated Selenium Adaptive Management Plan (SAMP) in September 2020. Although this update provided details regarding continuous improvement techniques currently being implemented to reduce selenium releases in the interim, CNSC staff asked Orano to verify that a long-term treatment solution is implemented by the fourth quarter of 2021.

Orano analyzed treated effluent for concentrations of various substances such as radium-226, arsenic, copper, lead, nickel, zinc and TSS, and verified pH levels at McClean Lake. As discussed in section 2.4, the McClean Lake Operation continued to meet the discharge limits set out in the MDMER [8].

CNSC staff will continue to review results on the quality of effluent in order to verify that the treatment of effluent remains effective.

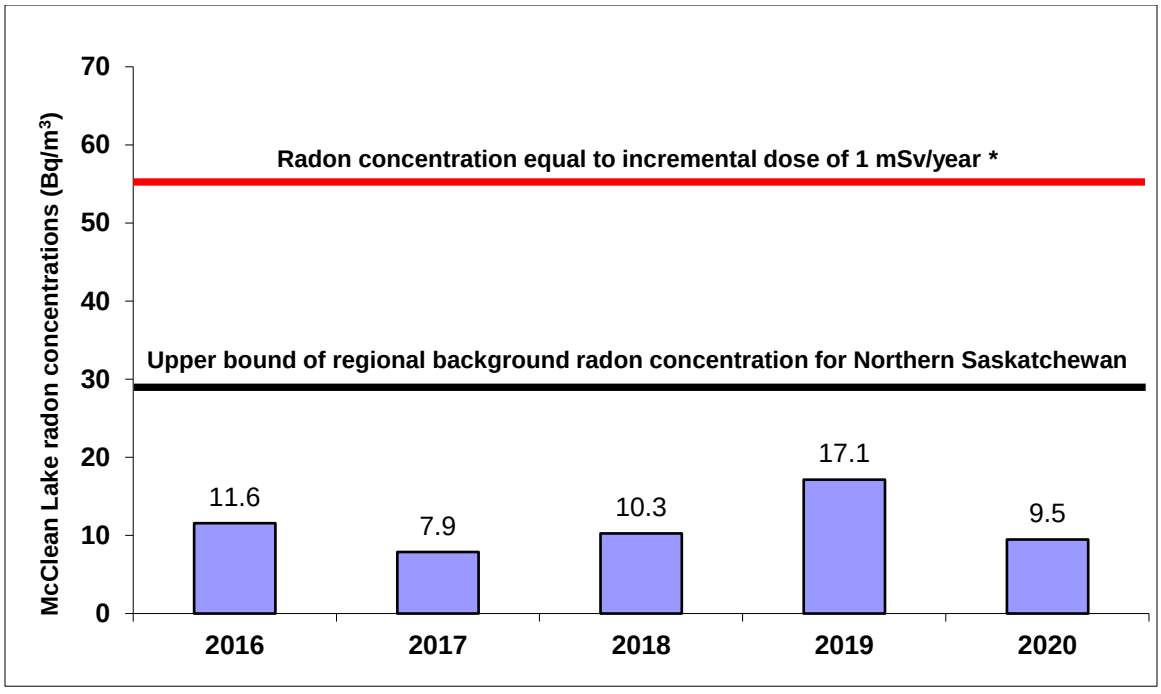
Air emissions released to the environment

Air quality at the McClean Lake Operation is monitored directly by measuring emissions from the mill and the ambient air quality near the operation, and indirectly by measuring metal accumulations in the terrestrial environment.

Air quality monitoring at the McClean Lake Operation includes ambient radon, total suspended particulate (TSP), sulphur dioxide and exhaust stack monitoring. Ambient sulphur dioxide and exhaust stack monitoring were commensurate with the mill commissioning activities and restarted in September 2014. Terrestrial monitoring components include soil and vegetation sampling.

Environmental monitoring for radon concentrations is conducted using the passive method of track etch cups. There are 23 monitoring stations in various locations around the site-lease boundary. Figure 7.3 shows the average concentrations of radon in ambient air from 2016 to 2020. Ambient radon concentrations were typical of the northern Saskatchewan regional background concentration of less than 7.4 Bq/m^3 to 25 Bq/m^3. The measured radon concentrations were also below the reference radon concentration of 55 Bq/m^3, which is equal to an incremental dose of 1 mSv per year above background.

Figure 7.3: McClean Lake Operation - concentrations of radon in ambient air, 2016–20



* Upper bound of the incremental dose of 1 mSv per year above background (i.e., an incremental radon concentration of 30 Bq/m^3 above natural background) based on ICRP Publication 115. Values are calculated as geometric means.

Five high-volume air samplers monitor TSP and are located at the McClean Lake Operation. As shown in table 7.2, TSP values remained low in 2020 and well below the provincial standard of 60 µg/m^3.

TSP samples were also analyzed for concentrations of metals and radionuclides. The mean concentrations of metal and radionuclides adsorbed to TSP were low and below the reference annual air quality levels identified in table 7.2.

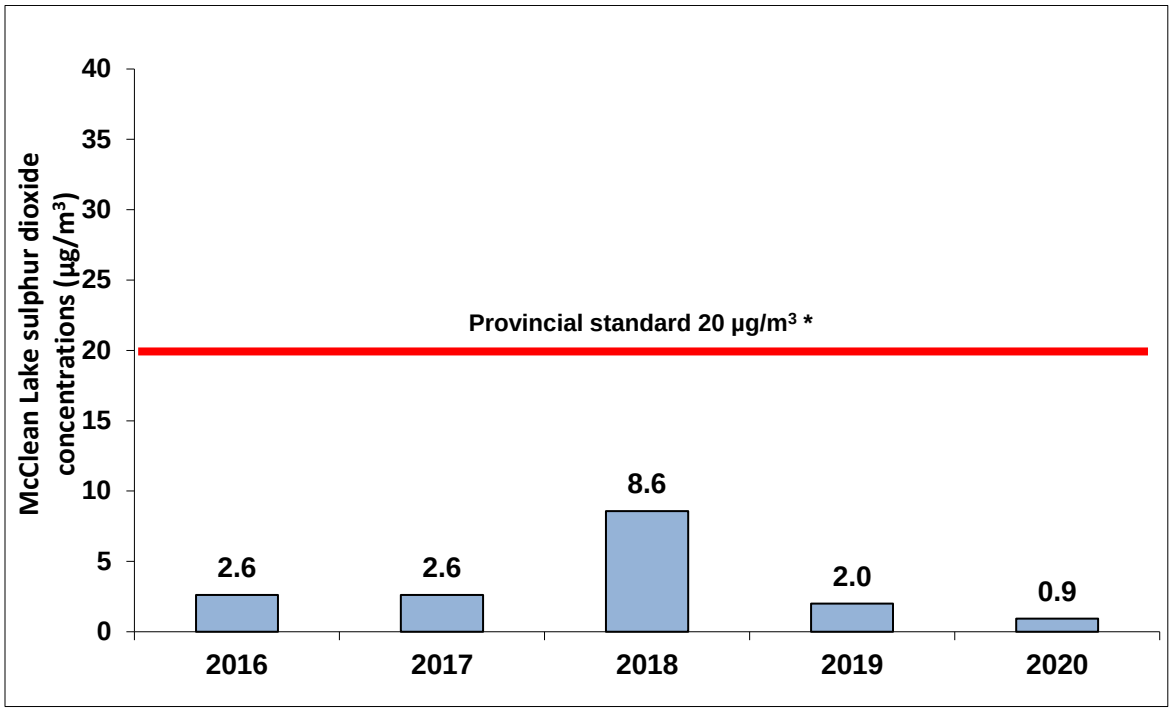
Table 7.2: McClean Lake Operation - concentrations of metal and radionuclides in air, 2016–20

Parameter	Reference annual air quality levels*	2016	2017	2018	2019	2020
TSP (µg/m^3)	**60** (3)	5.12	4.96	8.00	5.00	3.24
As (µg/m^3)	**0.06** (1)	0.000032	0.000432	0.000354	0.000239	0.000122
Cu (µg/m^3)	**9.6** (1)	0.021613	0.017159	0.018107	0.021454	0.0367798
Mo (µg/m^3)	**23** (1)	0.000145	0.001028	0.001154	0.001005	0.00132060
Ni (µg/m^3)	**0.04** (1)	0.000259	0.000321	0.000262	0.000144	0.0001016
Pb (µg/m^3)	**0.10** (1)	0.000762	0.000406	0.000417	0.00025	0.0001648
Zn (µg/m^3)	**23** (1)	0.004703	0.003165	0.004684	0.00839	0.0025862
Pb-210 (Bq/m^3)	**0.021** (2)	0.000285	0.000309	0.000253	0.000261	0.0002894
Po-210(Bq/m^3)	**0.028** (2)	0.000087	0.000100	0.000087	0.000083	0.000087
Ra-226 (Bq/m^3)	**0.013** (2)	0.000009	0.000014	0.000022	0.000022	0.000001
Th-230 (Bq/m^3)	**0.0085** (2)	0.000005	0.000006	0.000004	0.000005	0.0000052
U (µg/m^3)	**0.06** (1)	0.003138	0.002029	0.001654	0.002497	0.000889

1 Reference annual air quality levels are derived from Ontario 24-hour Ambient Air Quality Criteria (2012).
2 Reference level is derived from International Commission of Radiological Protection (ICRP) Publication 96, *Protecting People Against Radiation Exposure in the Event of a Radiological Attack*.
3 *Saskatchewan Environmental Quality Guidelines*, Table 20: Saskatchewan Ambient Air Quality Standards. Values are calculated as geometric means.
* Reference levels based on Province of Ontario ambient air quality criteria and are shown for reference only. No federal or Saskatchewan provincial limits were established at the time of this report.

A sulphur dioxide monitor is used during operations to continuously measure ambient sulphur dioxide concentrations associated with mill emissions. The monitor is located approximately 200 metres downwind of the sulphuric acid plant stack. The measured sulphur dioxide monitoring data (see figure 7.4) showed no exceedances of the annual standard of 20 µg/m^3 in 2020.

Figure 7.4: McClean Lake Operation - concentrations of ambient sulphur dioxide, 2016–20



*Province of Saskatchewan's ambient air quality standard is shown.

Orano's terrestrial monitoring program at McClean Lake determines whether any impact on the environment arises from aerial deposition. Soil and terrestrial vegetation may be affected by the atmospheric deposition of particulate and adsorbed metals and radionuclides associated with onsite activities. This program includes measurements of metals and radionuclides in soil and vegetation. Terrestrial monitoring is scheduled for 2021 and the results will be included in the 2021 environmental performance reporting, submitted in 2022.

Soil monitoring results from soil samples collected in 2015 are presented in the 2016 Technical Information Document – Environmental Performance (TID-EP). The results show that the soil metal parameter concentrations were below the *Canadian Environmental Quality Guidelines* [12] set by the Canadian Council of Ministers of the Environment. Radionuclide concentrations in soils were near or at background levels and analytical detection limits. CNSC staff concluded that the level of airborne particulate contaminants produced by the McClean Lake Operation is acceptable and does not pose a risk to the environment.

Vegetation sampling was also presented in the 2016 TID-EP and shows that most parameters are within the range of concentrations previously measured in lichen, Labrador tea and blueberry twig samples. The concentrations of metals and radionuclides in lichen, Labrador tea and blueberry twigs were higher than background concentrations for some samples located in the immediate vicinity of mining activities, although the concentrations decreased within a short distance. Overall, the results indicated that the McClean Lake Operation has had a localized effect on the vegetation in areas of activity.

These higher concentrations were below levels that are toxic to plants, and they decreased to within background concentrations at a short distance from the facility. Therefore, no changes are predicted to terrestrial habitat, both within and outside the facility boundary. The elevated concentrations of contaminants within the facility boundary were modelled in an ERA, and no adverse effects were predicted for terrestrial non-human biota.

CNSC staff concluded that the level of airborne particulate contaminants produced by the McClean Lake Operation was acceptable and did not pose a risk to browse (twigs and Labrador tea) and lichen consumers, such as caribou.

Uncontrolled releases

In 2020, 4 events reported to CNSC staff were identified as releases of hazardous substances to the environment:

- On February 18, 2020, approximately 360 kilograms of molten sulphur were released through an improperly sealed discharge valve during offloading.
- On February 21, 2020, approximately 0.3 m^3 of ethylene glycol leaked from the pipe through the uncapped vent. The probable cause was a falling ice chunk that hit the valve handle.
- On June 11, 2020, approximately 34.4 m^3 of anhydrous ammonia was released through the fitting when the sensor (Vaporizer A) was removed.
- On July 11, 2020, approximately 3 m^3 of sulphuric acid was released into secondary containment through a hole in a pipe coming out from the sulphuric acid tank.

All releases were of low safety significance and reporting met the requirements of CNSC's REGDOC-3.2.1, *Public Information and Disclosure* [4]. Appendix I describes the spills and corrective actions taken. As a result of the actions taken by Orano, no residual impacts to the environment were caused by the releases. CNSC staff were satisfied with the reporting of releases of hazardous materials to the environment and the corrective actions taken. CNSC staff rated all the 2020 spills as being of low significance.

Figure 2.10 in section 2 shows the number of reportable environmental spills that occurred at the McClean Lake Operation from 2016 to 2020.

Assessment and monitoring

CNSC staff confirmed that the licensee successfully carried out required environmental monitoring, in accordance with the McClean Lake environmental protection program.

Based on compliance activities and the review of annual reports and the environmental 2016 TID-EP, CNSC staff concluded that the environmental monitoring conducted at the McClean Lake Operation met regulatory requirements. Consequently, CNSC staff concluded that the environment and the public remains protected.

Environmental risk assessment

The McClean Lake Operation's TID-EP, submitted to the CNSC in 2016, contained environmental monitoring data from 2011 to 2015 as well as an updated ERA. CNSC staff reviewed the environmental monitoring results for air, soil, vegetation, surface water, groundwater and sediment, as well as the health indicators for fish and their prey inhabiting sediment, and confirmed that the results were within those predicted in the ERA.

After reviewing the TID-EP and Orano's ongoing activities to ensure the protection of the environment, CNSC staff concluded that adequate measures have been taken at the McClean Lake Operation to protect the environment.

Protection of people

Orano is required to demonstrate that the health and safety of the public are protected from exposures to hazardous substances released from the McClean Lake Operation. The effluent and environmental monitoring programs currently conducted by the licensee are used to verify that releases of hazardous substances do not result in environmental concentrations that may affect public health.

The CNSC receives reports of discharges to the environment through the reporting requirements outlined in the McClean Lake Operation CNSC-issued licence and LCH. The review of Orano's hazardous (non-radiological) discharges to the environment at the McClean Lake Operation in 2020 indicated that the public and environment were protected. CNSC staff confirmed the environmental concentrations in the vicinity of the McClean Lake Operation remained within those predicted in the 2016 ERA, and that human health remained protected.

Based on compliance verification activities that included inspections, reviews of licensee reports and work practices, and monitoring results for 2020, CNSC staff concluded that the McClean Lake Operation's environmental protection program continued to be effective at protecting the public and the environment.

7.4 Conventional Health and Safety

For 2020, CNSC staff continued to rate the conventional health and safety SCA as "satisfactory" based on regulatory oversight activities.

McClean Lake Operation - conventional health and safety ratings

2016	2017	2018	2019	2020
SA	SA	SA	SA	SA

SA = satisfactory

Practices

As required under the *Nuclear Safety and Control Act* [1], Orano continued to improve performance and maintain health and safety programs at the McClean Lake Operation to minimize occupational health and safety risks. CNSC staff confirmed that Orano had an effective occupational health and safety committee and that it was completing regular reviews of its safety program at the McClean Lake facility.

Orano's McClean Lake Operation investigates safety concerns and incidents, including near-miss events. In 2020, several investigations were completed to determine the cause of incidents, near misses, injuries or property damage. Their incident investigation process employs a collaborative effort to identify a problem, analyze its causes and determine the best solutions. CNSC staff reviewed the investigation results and corrective actions and confirmed Orano's commitment to accident prevention and safety awareness with a focus on safety culture.

Performance

Table 7.3 shows that from 2016 to 2020, Orano's McClean Lake Operation reported 9 lost-time injuries (LTIs). There were 2 LTIs reported in 2020. Details on the 2020 LTIs and corrective actions can be found in appendix K.

Included in this report is the total recordable incident rate (TRIR) from 2016 to 2020. The TRIR is the incident frequency rate that measures the number of fatalities, LTIs and other injuries requiring medical treatment.

Table 7.3: McClean Lake Operation - lost-time injury statistics, 2016–20

	2016	2017	2018	2019	2020
Lost-time injuries[1]	3	0	1	3	2
Severity rate[2]	10.9	67.8	4.8	48	42.8
Frequency rate[3]	0.6	0.0	0.3	0.9	0.7
Total recordable incident rate[4]	2.9	1.4	0.75	3.15	2.7

[1] An injury that takes place at work and results in the worker being unable to return to work for a period of time.

[2] A measure of the total number of days lost to injury for every 200,000 person-hours worked at the facility. Accident severity rate = [(# of days lost in last 12 months) / (# of hours worked in last 12 months)] x 200,000.

[3] A measure of the number of LTIs for every 200,000 person-hours worked at the facility. Accident frequency rate = [(# of injuries in last 12 months) / (# of hours worked in last 12 months)] x 200,000.

[4] A measure of the number of fatalities, lost-time injuries, and other injuries requiring medical treatment for every 200,000 person-hours worked at the facility. Recordable incident rate = [(#incidents in last 12 months) / # hours worked in last 12 months)] x 200,000.

Corrective actions, where necessary, were implemented and the effectiveness was verified and documented by management. CNSC staff verified that Orano strives to involve all levels of its organization in the health and safety program at the McClean Lake Operation. Employees are encouraged and trained to continuously identify and assess risks, and propose solutions.

Awareness

CNSC staff observed that conventional health and safety programs provided education, training, tools and support to verify worker protection at the McClean Lake Operation. An active onsite occupational health and safety committee completes regular reviews of the McClean Lake safety program. Through inspections, reviews of incidents and discussions with McClean Lake staff, CNSC staff verified that the McClean Lake Operation is committed to accident prevention and safety awareness. CNSC staff's compliance verification activities concluded that the McClean Lake Operation's health and safety program met regulatory requirements in 2020.

7.5 Additional SCAs

In this 2020 regulatory oversight report, CNSC staff have provided a brief discussion of the additional SCAs; these are presented in the following sections.

7.5.1 Management System

The licensee maintains an Integrated Management System; this forms part of the licensing basis for this facility in the LCH.

In June 2020, a focused inspection was conducted remotely to verify the implementation and effectiveness of Orano's management system at the McClean Lake Operation. The inspection report outlined some low risk deficiencies that resulted in 5 non-compliances related to the documentation in the areas of commissioning, operating experience, change control and design control, self and independent assessment (e.g., missing signatures, incorrect form number). Orano provided an action plan to address these non-compliances. CNSC staff reviewed and confirmed that Orano addressed the non-compliances in a timely and satisfactory manner and have taken appropriate corrective actions; therefore, all 5 non-compliances were closed.

There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

7.5.2 Human Performance Management

The licensee includes program documentation for the human performance management SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections at the McClean Lake Operation with a focus on evaluating the human performance SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

7.5.3 Operating Performance

The licensee includes program documentation for the operating performance SCA as part of the overall management system documents; these constitute part of the licensing basis for this facility in the LCH.

There were no inspections at the McClean Lake Operation with a focus on evaluating the operating performance SCA in 2020 and there were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

7.5.4 Safety Analysis

The licensee includes program documentation for the safety analysis SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections at the McClean Lake Operation focusing on evaluating the safety analysis SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

7.5.5 Physical Design

The licensee includes program documentation for the physical design SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections at the McClean Lake Operation with a focus on evaluating the physical design SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

7.5.6 Fitness for Service

The licensee includes program documentation for the fitness for service SCA as part of the overall management system documents; these constitute part of the licensing basis for this facility in the LCH.

There were no inspections at the McClean Lake Operation focusing on evaluating the fitness for service SCA. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

7.5.7 Emergency Management and Fire Protection

The licensee includes program documentation for the emergency management and fire protection SCA as part of the overall management system documents; these constitute part of the licensing basis for this facility in the LCH.

There were no inspections at the McClean Lake Operation focusing on evaluating the emergency management and fire protection SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

7.5.8 Waste Management

The licensee includes program documentation for the waste management SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections at the McClean Lake Operation focusing on evaluating the waste management SCA in 2020 and there were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

7.5.9 Security

The licensee includes program documentation for the security SCA as part of the overall management system documents; these constitute part of the licensing basis for this facility in the LCH.

There were no inspections at the McClean Lake Operation focusing on evaluating the security SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

7.5.10 Safeguards and Non-Proliferation

The licensee includes program documentation for the safeguards and non-proliferation SCA as part of the overall management system documents; these constitute part of the licensing basis for this facility in the LCH.

In addition to CNSC compliance activities with respect to the specific areas under the safeguards and non-proliferation SCA, the International Atomic Energy Agency (IAEA) conducts independent inspections with coordination and support through the CNSC regulatory framework. No IAEA inspections were conducted at the McClean Lake Operation during 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

7.5.11 Packaging and Transport

The licensee includes program documentation for the packaging and transport SCA as part of the overall management system documents; these form part of the licensing basis for this facility in the LCH.

There were no inspections at the McClean Lake Operation with a focus on evaluating the packaging and transport SCA in 2020. There were no event reports for which this SCA was the main contributory factor.

CNSC staff concluded that the licensee's program in respect of this SCA remains satisfactory.

SECTION II – HISTORIC (REMEDIATING) AND DECOMMISSIONED URANIUM MINE AND MILL SITES

8 OVERVIEW

Section II of this report provides information on 2 historic sites that are being actively remediated, 10 decommissioned uranium mine and mill sites in long-term monitoring and maintenance, and 1 site that has been fully released from licensing (see figure 8.1 for site locations).

The objective of active remediation projects is to establish long-term, stable conditions that ensure the safe use of each site by current and future generations. Wherever possible, the remediation plans aim to return historic uranium mine and mill sites to previously existing environmental conditions or to land uses that will be sustainable in the long term. Active remediation projects consist of ongoing cleanup activities involving full-time staff and contractors, as well as frequent monitoring and reporting.

The decommissioned sites discussed in this report are in the long-term maintenance and monitoring phase. These sites have a very low potential of radiation exposures because of limited onsite work, the outdoor setting, and low radiation levels following completed remediation activities.

Figure 8.1: Locations of historic and decommissioned sites in Canada

The following 2 historic mine sites are undergoing active remediation:

- Gunnar legacy uranium mine
- Madawaska closed uranium mine

The following 10 sites have been decommissioned for several years and are currently in the long-term monitoring and maintenance phase:

- Former Lorado mill
- Beaverlodge mine and mill
- Cluff Lake uranium mine and mill
- Rayrock closed mine
- Port Radium closed mine
- Agnew Lake tailings management facility
- Bicroft tailings storage facility
- Dyno closed mine
- Elliot Lake historic sites
- Denison and Stanrock closed mines

The following site has been completely released from CNSC licensing:

- Deloro mine

8.1 Regulatory Efforts

CNSC staff provide risk-informed regulatory oversight of licensed activities at the active remediation projects and decommissioned sites. Based on CNSC staff's risk-informed baseline inspection plan, the 2 remediation projects and 7 of the 10 decommissioned sites are required to have at least 1 inspection per year. The Rayrock and Port Radium decommissioned mine sites are inspected once every 3 years. An inspection of the Rayrock closed mine was completed in 2019, however the Port Radium closed mine inspection has been deferred to February of 2022 due to COVID-19 pandemic measures and restrictions.

The CNSC requires licensees to develop decommissioning plans for each of their sites. Each plan, reviewed and approved by CNSC staff, is accompanied by a financial guarantee that provides the funding necessary to complete all decommissioning work. For sites that have been decommissioned, financial guarantees are still required to support the monitoring and the care and maintenance of the site.

The values of the financial guarantees for the historic and decommissioned sites are listed in appendix F.

8.1.1 Effects of COVID-19 on regulatory efforts

On March 15, 2020, the CNSC activated the Business Continuity Plan (BCP) in response to the COVID-19 pandemic and effective March 16, all CNSC staff were directed to work from home. CNSC management immediately suspended all CNSC staff in-person activities at nuclear fuel cycle facilities and identified activities that were considered critical in order to support continued safe operation of licensed facilities and delivery of the CNSC mission and mandate.

In April of 2020, CNSC staff reviewed all planned onsite compliance activities on a risk-informed basis to determine an appropriate path forward. CNSC staff identified planned compliance activities well suited to be delivered by other means (remote verification methods, desktop review of documents and licensee submissions, etc.) and adjusted planned activities accordingly.

Compliance activities of uranium mine and mill facilities continued remotely and onsite verification activities will resume on a risk-informed basis in observance of relevant COVID-19 health protocols. CNSC staff continue to conduct oversight activities during the COVID-19 pandemic to verify the protection of the environment, and the health and safety of the public. In-person inspections were conducted provided a safety case could be made. There was 1 in-person inspection conducted of the Beaverlodge properties in September of 2020. Some low risk criteria that cannot be assessed remotely have been deferred until such time as in-person inspections can be conducted. Six inspections at historic and decommissioned sites were deferred from 2020 due to these measures, interprovincial travel restrictions, and the low risk of those sites. Specific compliance activities are detailed in appendix B.

8.2 Performance

The CNSC requires all licensees, as per their CNSC licences, to submit annual compliance reports with information pertaining to their performance in the applicable SCAs. CNSC staff review these reports to verify if licensees are complying with regulatory requirements and are operating safely. These reports are available on licensees' websites, as applicable (see appendix M of this report for the links).

CNSC staff reviewed licensee compliance reports, revisions to licensee programs, licensee responses to events and incidents, and results of their inspections to compile the performance ratings for the active remediation projects and decommissioned sites.

As per their licences, not every SCA will be applicable to each of the sites in this section. The following safety and control areas (SCAs) were not rated for all of the historic and decommissioned sites:

- *Human performance management*: This SCA is not applicable, as the routine monitoring and maintenance activities carried out at decommissioned mine and mill sites require a very low level of onsite worker presence.
- *Operating performance*: This SCA was not rated since historic and decommissioned sites do not operate.
- *Safety analysis*: A safety analysis is completed at the licensing stage and used throughout the lifecycle of each site. Due to the static nature of historic and decommissioned sites, new safety analyses are not required.
- *Waste management*: This SCA does not apply, as the authorized licence activities are all related to the management of wastes for the historic and decommissioned sites.
- *Safeguards and non-proliferation*: This SCA is not applicable because each site has been decommissioned and there is no requirement for the licensee to provide routine access and information for safeguards purposes. Licensees are required to provide reasonable services and assistance to the International Atomic Energy Agency (IAEA) inspectors to carry out their duties and functions. During the 2018 to 2020 period, there were no requests by IAEA inspectors to inspect any of these sites.
- *Packaging and transport*: Licensees of historic and decommissioned sites do not ship radioactive materials, therefore the packaging and transport SCA does not apply.

Tables 8.1 and 8.2 present the ratings for applicable SCAs for each historic and decommissioned site for 2018 to 2020. For the review period of 2018 to 2020, CNSC staff rated all applicable SCAs as “satisfactory” for all historic and decommissioned sites.

Table 8.1: Applicable SCA performance ratings for historic sites, 2018–20

Safety and control area	Gunnar	Madawaska
Radiation protection	SA	SA
Environmental protection	SA	SA
Conventional health and safety	SA	SA

SA = satisfactory

As shown in table 8.2, all decommissioned sites received ratings of "satisfactory" for all applicable SCAs from 2018 to 2020. Appendix E contains the applicable SCA performance ratings from 2016 to 2020 for historic and decommissioned mine and mill sites.

Table 8.2: Applicable SCA performance ratings for decommissioned sites, 2018–20

Safety and control area	Lorado	Beaverlodge	Cluff Lake	Rayrock	Port Radium	Agnew Lake	Bicroft	Dyno	Elliot Lake	Denison and Stanrock	Deloro
Radiation protection	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA

SA = satisfactory

This report focuses on the 3 SCAs that cover many of the key performance indicators for historic and decommissioned sites: radiation protection, environmental protection and conventional health and safety.

8.3 Radiation Protection

The radiation protection SCA covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations* [5]. This program must verify that contamination levels and radiation doses received by individuals are monitored, controlled and maintained as low as reasonably achievable (ALARA).

Radiological hazard control

Sources of radiation exposure at historic and decommissioned sites include:

- gamma radiation
- long-lived radioactive dust
- radon progeny
- radon gas

Through their verification activities, CNSC staff found that the licensees controlled these hazards through practices related to the effective use of time, distance and shielding, contamination control and personal protective equipment.

Radiation protection performance

From 2018 to 2020, CNSC staff conducted regulatory oversight activities in the radiation protection SCA at all historic and decommissioned sites, in order to evaluate if licensees were complying with regulatory requirements.

CNSC staff concluded that licensees had adequate radiation protection practices identified for the work activities being conducted from 2018 to 2020, and for ensuring the protection of health and safety of persons working at their sites.

Worker dose control

The only sites with workers designated as nuclear energy workers (NEWs) during these reporting periods were the Gunnar and Madawaska legacy uranium mine sites. The maximum individual effective dose to a NEW at these sites ranged from 0.75 mSv to 1.37 mSv over the reporting period. These values were all well below the regulatory dose limit of 50 mSv per year and 100 mSv in a 5-year dosimetry period.

Annual effective doses to NEWs are based on work conditions and environments that vary among work sites. Therefore, direct comparisons of effective doses to workers at different sites do not necessarily provide appropriate measures of the effectiveness of radiation protection programs.

There were no workers designated as NEWs at the Beaverlodge, Cluff Lake, Rayrock, Port Radium, Agnew Lake, Bicroft, Dyno, Deloro, Elliot Lake, Denison and Stanrock sites from 2018 to 2020.

Application of ALARA

The CNSC requirement to apply the ALARA principle has consistently resulted in doses well below regulatory dose limits at historic and decommissioned sites. Based on the review of the work activities conducted at these sites and the dose data provided in appendix G, CNSC staff are satisfied that all licensees controlled radiation doses so as to keep them below regulatory dose limits for NEWs and in accordance with the ALARA principle.

Estimated dose to the public

The maximum allowable dose to the public from licensed activities at each of the remediation projects and decommissioned sites is based on a human health risk assessment and supported with monitoring data. From 2018 to 2020, doses to the public from historic and decommissioned sites continued to be well below the regulatory annual public dose limit of 1 mSv due to the limited site accessibility; this is confirmed through dose readings obtained during CNSC compliance inspections.

8.4 Environmental Protection

The environmental protection SCA covers programs that identify, control and monitor all releases of radioactive and hazardous substances and the effects on the environment from facilities or as the result of licensed activities.

The historic and decommissioned sites received a rating of "satisfactory" for the environmental protection SCA from 2018 to 2020.

From 2018 to 2020, environmental protection programs were effectively implemented and met regulatory requirements for all historic and decommissioned sites. There were no exceedances of effluent discharge limits at Elliot Lake, the only site in section II of this regulatory oversight report where water treatment occurs.

Water quality objectives

Water quality is typically compared to the *Canadian Water Quality Guidelines for the Protection of Aquatic Life* [18], *Health Canada's Guidelines for Canadian Drinking Water Quality* [19] and/or to provincial levels where applicable. For example, for sites in Saskatchewan, water quality is compared to the province's *Surface Water Quality Objectives* [20]. In some cases, there are site-specific objectives that are based on risk assessments at the time of licensing. Water quality objectives for each site are provided in their respective sections where applicable.

8.5 Conventional Health and Safety

The conventional health and safety SCA covers the implementation of programs to manage workplace safety hazards and to protect workers and equipment.

For 2018 and 2020, CNSC staff rated the conventional health and safety SCA at historic and decommissioned sites as "satisfactory".

Practices

Licensees are responsible for developing and implementing conventional health and safety programs for the protection of workers. These programs must comply with Part II of the *Canada Labour Code* [21]. CNSC staff reviewed licensee annual reports and conducted site inspections where safety practices were observed. CNSC staff concluded that licensees implemented their conventional health and safety programs satisfactorily from 2018 to 2020, and that licensee programs were effective in protecting the health and safety of persons working in their facilities.

Performance

A key performance measure for conventional health and safety is the number of lost-time injuries (LTIs) per facility. An LTI is a workplace injury that results in the worker being unable to return to work for a period of time. There were no LTIs at any of the historic and decommissioned sites during this reporting period.

SECTION II-A – HISTORIC (REMEDIATING) URANIUM MINES AND MILLS

9 GUNNAR

The Gunnar legacy uranium mine site is located approximately 600 kilometres north of Saskatoon, on the north shore of Lake Athabasca in northwest Saskatchewan.

Gunnar was a commercial uranium mine that operated from 1955 to 1963. The site closed in 1964, with little decommissioning performed at the time. The former uranium mine and mill is being remediated by the Saskatchewan Research Council (SRC). Following a November 2014 public hearing, the Commission issued the SRC a waste nuclear substance licence for the Gunnar Remediation Project. SRC's licence is valid until November 30, 2024.

The remediation project consists of the cleanup of mine tailings, waste rock piles, an open pit, a mine shaft, and demolition debris. The remediation work is being carried out in 3 phases. Phase 1, which has been completed, involved characterizing and monitoring the onsite waste and developing remediation plans. Phase 2, currently ongoing, consists of implementing the remediation plans. Phase 3 will involve long-term monitoring and maintenance to verify that the site remains stable and safe.

During the 2018 to 2020 review period, work conducted at the Gunnar site consisted of:

- grading, excavating and placement of waste rock and clean borrow cover material at both the Gunnar main and central tailings surfaces
- submission, review and approval of detailed remediation design for other clean-up aspects
- preparation of Langley Bay tailings remediation (delayed until 2022 due to exceptionally high water levels in Lake Athabasca and contingent on water levels returning to normal)
- Landfills A and B construction which contained both radioactive and hazardous waste.

Additional remediation work is scheduled to continue until the end of 2025; this will include:

- legacy waste sweeps and consolidation of all waste on site
- grading, excavation and construction of the tailings cover area at Langley Bay
- grading and placement of cover material on waste rock piles
- remediation of all mine openings on site (i.e. vent raises).

9.1 Performance

For the review period of 2018 to 2020, CNSC staff were satisfied with SRC's performance at the Gunnar site in the SCAs of radiation protection, environmental protection, and conventional health and safety.

The CNSC's baseline inspection plan for 2018 to 2020 required CNSC staff to conduct 1 site inspection per year at the Gunnar site. In June 2018 CNSC staff conducted a combination baseline and augmented radiation protection inspection at the Gunnar site. In June 2019 CNSC staff performed a combination baseline and augmented geotechnical inspection at the Gunnar site. The inspectors found that, overall, SRC was in compliance with its licence conditions, with the exception of requirements for labelling radioactive material and for controlling radiation zones. As a result of these instances of non-compliance, which were of low safety significance, enforcement notices were issued to SRC. SRC took immediate corrective actions, which were verified and approved by CNSC staff (figure 9.1). These enforcement actions are now closed.

Figure 9.1: Gunnar – Radiation waste label, 2018

Source: CNSC

The inspection planned for 2020 was postponed due to travel restrictions established because of the COVID-19 pandemic. The next CNSC inspection at the Gunnar site is tentatively scheduled in the fall of 2021.

9.2 Radiation Protection

From 2018 to 2020, CNSC staff rated the radiation protection SCA as “satisfactory”.

Gunnar - radiation protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

Radiation protection program performance

CNSC staff reviewed radiation protection plans, worker dose records and radiation surveys submitted by SRC and conducted an augmented radiation protection inspection at the Gunnar site. As a result, CNSC staff were satisfied with SRC’s implementation of its radiation protection program and the improvements in proper signage and informing nuclear energy workers (NEWs) of their radiation dose levels at the Gunnar site during the review period of 2018 to 2020.

Worker dose control

From 2018 to 2020, workers who were on site for periods exceeding 4 weeks were classified as NEWs and assigned dosimetry. In 2018, of the 87 workers on site, 4 NEWs received a dose greater than the public dose limit of 1 mSv/year, and the maximum individual effective dose received by a NEW was 1.37 mSv.

In 2019, of the 92 workers on site, 4 NEWs received a dose greater than the public dose limit of 1 mSv/year, and the maximum individual effective dose received by a NEW was 1.37 mSv.

In 2020, of the 85 workers on site, none of the NEWs exceeded the annual public dose limit of 1.0 mSv/year, and the maximum individual effective dose received by a NEW was 0.75 mSv. All reported doses were below SRC’s action levels (2.5 mSv/month), and were also below the CNSC’s regulatory dose limit of 50 mSv per year and 100 mSv in a 5-year dosimetry period for workers designated as NEWs.

Passive radon emissions are monitored in the air at the Gunnar site. Between 2018 and 2020, monitoring has identified that there has been a reduction in the radon at the site perimeter (i.e., during 2020, the radon concentration at any of the 10 locations monitored at the site did not exceed 50 Bq/m^3). CNSC staff reviewed monitoring results provided by SRC and confirmed that radon was adequately monitored in order to verify that the public and workers were protected. Long-lived radioactive dust is also monitored; CNSC staff reviewed these results and confirmed that the public and workers were protected.

9.3 Environmental Protection

For the review period of 2018 to 2020, CNSC staff rated the environmental protection SCA as “satisfactory”.

Gunnar - environmental protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

Assessment and monitoring

For the review period of 2018 to 2020, CNSC staff verified that SRC maintained an environmental protection program that verifies the protection of people, and an environmental monitoring program that measures existing conditions at the site.

SRC performed semi-monthly surface water and groundwater monitoring and analyses over the 2018 and 2019 field seasons (May through November). In 2020, the start of the field season was delayed until mid-July 2020 due to the COVID-19 pandemic and ended in mid-November 2020. In addition, 2020 saw the second highest water level at Lake Athabasca in the last 65 years (figure 9.2) which prevented the licensee from beginning work on the remediation of the tailings located at Langley Bay.

Figure 9.2: Gunnar - flooded areas on July 18, 2020

Source: Saskatchewan Ministry of Environment

CNSC staff reviewed the results of SRC's analyses and found that most of the contaminants were consistent with the previous years and with the 2014 Gunnar environmental impact statement [22]. As a result of the ongoing remediation activities at Gunnar, there were increases in uranium concentrations at the monitoring stations located in Langley Bay. CNSC staff will continue to review annual reports to determine whether this is a long-term trend. The ongoing remediation activities are not having a noticeable effect on the water quality at the other monitoring stations. There is no liquid effluent at the Gunnar site; however, there is overland flow and seepage from the site into local water bodies.

In addition to water quality and air monitoring, during the construction phase, SRC retains an independent contractor to walk the site daily to identify any potential impacts to the environment and to assess compliance of the primary contractor.

CNSC staff are satisfied that SRC has maintained an environmental protection program to verify the protection of people and to establish baseline conditions for the site prior to remediation.

9.4 Conventional Health and Safety

For the review period of 2018 to 2020, CNSC staff rated the conventional health and safety SCA as "satisfactory".

Gunnar – conventional health and safety ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

Health and safety program performance

CNSC staff confirmed that SRC's health and safety program has been implemented effectively and employs the good practices of awareness, training, communication and reporting. Examples of these practices include daily toolbox meetings in which health and safety risks are assessed and health and safety meetings to discuss broader health and safety issues on site.

This site has an active monitoring and reporting program for lost-time injuries (LTIs). There have been no LTIs at the Gunnar site in the reporting period from 2018 to 2020.

CNSC staff are satisfied with SRC's performance in the area of conventional health and safety for the Gunnar site.

10 MADAWASKA

Madawaska, a legacy uranium mine located near Bancroft, Ontario, operated from 1957 to 1982 and was decommissioned in the 1980s. EWL Management Ltd. (EWL) is the licensee of the Madawaska mine site under a CNSC waste nuclear substance licence. In October 2020, the licensee submitted a licence application to renew their waste nuclear substance licence for a period of 15 years, the application is currently being reviewed/assessed by CNSC staff. The current licence was issued by a CNSC Designated Officer on July 4, 2011, and is valid until July 31, 2021. For the foreseeable future, the site will remain under long-term monitoring and maintenance.

The site includes the footprint of the mining operation, 2 tailings management areas (TMAs) (figure 10.1), a number of capped and sealed openings, underground workings and 4 tailings dams.

Figure 10.1: Madawaska – vegetative cover on TMA 2

Source: CNSC

In 2018 and 2019, EWL continued rehabilitation/maintenance work on the 2 TMAs. In 2020, due to the restrictions in relation to the pandemic, EWL decided to postpone rehabilitation work at the site. In 2021 and 2022, EWL plans to continue improvement of the physical conditions of the site with the implementation of the following work:

- completion of the upgrades to TMA-1 cover and improvements to the physical stability of the TMA-1 spillway
- completion of upgrade of remaining raises and shaft covers to meet regulatory requirements
- site clean-up post-rehabilitation work including the removal of the temporary construction structures and reclamation of disturbed areas.

A baseline compliance inspection is scheduled for the fall of 2021.

10.1 Performance

For the reporting period of 2018 to 2020, CNSC staff were satisfied with EWL's performance at the Madawaska site for the SCAs of radiation protection, environmental protection, and conventional health and safety. EWL's performance over the reporting period has been stable and met the requirements of the *Nuclear Safety and Control Act* [1] and its associated regulations.

During the geotechnical inspection held in 2018 and the baseline inspection performed in 2019, CNSC staff found that the site was well managed and in compliance with requirements. No enforcement actions were issued as a result of the inspections conducted.

10.2 Radiation Protection

For the review period of 2018 to 2020, CNSC staff rated the radiation protection SCA as "satisfactory".

Madawaska - radiation protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

Radiation protection program performance

For maintenance activities on the tailings, CNSC staff verified that EWL had an effective radiation protection program in place and that all nuclear energy workers (NEWs) at the Madawaska site followed approved dosimetry programs.

Worker dose control

Onsite contractors who are designated as NEWs wore licensed dosimeters. In 2018 and 2019, the average individual effective dose to NEWs at the Madawaska site was less than 0.14 mSv, and the maximum individual effective dose to a NEW was 1.10 mSv. The reported doses to all NEWs were below the licensee's investigation levels and action levels, and were also below the regulatory limit of 50 mSv per year and 100 mSv in a 5-year dosimetry period.

10.3 Environmental Protection

For the review period of 2018 to 2020, CNSC staff rated the environmental protection SCA as "satisfactory". EWL satisfactorily maintained an environmental protection program to verify the protection of the environment at the Madawaska site.

Madawaska - environmental protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

Concentrations in some waterbodies adjacent to the site exceeded the recommended maximum concentrations in the *Canadian Water Quality Guidelines for the Protection of Aquatic Life* [18] for uranium in 2018 through 2020 (i.e., the highest value measured was 50 µg/L in Bow Lake compared to the water quality objective of 15 µg/L). These measurements were consistent with those from previous years. Risk assessments conducted in 2012 concluded that those values would not result in adverse effects on any species of aquatic life from exposure to those concentrations in surface water, sediment and groundwater associated with the Madawaska decommissioned site. With the improvements to water flow and the new cover system that is almost completed for the site, future results should demonstrate that migration of contaminants into the surrounding environment has been limited.

CNSC staff were satisfied that EWL had adequate measures in place to protect the public and the environment from releases from the Madawaska site from 2018 to 2020.

10.4 Conventional Health and Safety

For 2018 to 2020, CNSC staff rated the conventional health and safety SCA as "satisfactory".

Madawaska – conventional health and safety ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

Health and safety program performance

CNSC staff confirmed that EWL's health and safety program has been implemented effectively and employs the good practices of awareness, training, communication and reporting.

CNSC staff also verified that EWL has a robust health and safety program and that all contractors and visitors were required to complete site-specific occupational health and safety training.

This site has an active monitoring and reporting program for lost time incidents (LTIs). There were no LTIs at the Madawaska site during the 2018 and 2019 field seasons.

CNSC staff are satisfied with EWL's performance in the conventional health and safety SCA for the Madawaska site.

SECTION II-B – DECOMMISSIONED URANIUM MINES AND MILLS

11 LORADO

The former Lorado mill site is located 8 kilometres south of Uranium City, Saskatchewan.

The Lorado uranium mill operated from 1957 to 1960 and was abandoned in the 1960s without any decommissioning or remedial work. The Province of Saskatchewan now has ownership of the site under the former Saskatchewan Ministry of the Economy, now the Saskatchewan Ministry of Energy and Resources. The ministry has subsequently appointed the Saskatchewan Research Council (SRC) as the project manager to oversee the ongoing management and remediation of the Lorado site. Issued in 2014, SRC's waste nuclear substance licence for Lorado is valid until April 30, 2023. Figure 11.1 illustrates the soil and vegetative cover on the tailings area of the Lorado site.

Figure 11.1: Lorado – Soil and vegetative cover on tailings area, 2019

Source: CNSC

In 2016, SRC completed all remediation work at the Lorado site. During the review period from 2018 to 2020, the licensee continued to monitor the local environment and the progress of the revegetation of the cover.

In June of 2019, SRC submitted an application to amend [23] their licence to transition their operations into a long-term monitoring and maintenance program and to continue to possess, manage and store nuclear substances that are associated with the Lorado site. The licence was amended in July 2020 with the long-term objective to transfer the remediated safe and stable site into the Saskatchewan Institutional Control Program after a period of 10 to 15 years post-remediation.

11.1 Performance

As a result of the findings from desktop reviews and general compliance inspections, CNSC staff were satisfied with SRC's performance from 2018 to 2020 at the Lorado site, for the applicable SCAs of radiation protection, environmental protection and conventional health and safety.

CNSC staff conducted an inspection of the Lorado site in 2019 which verified that SRC was in compliance with its licence. No compliance actions were issued as a result of the inspection.

11.2 Radiation Protection

For 2018 to 2020, CNSC staff rated the radiation protection SCA as "satisfactory".

Lorado - radiation protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

Post-remediation radiation surveys showed that the radiation dose rate over the tailings management area were in the natural range (background levels, average dose rate on the covered tailings was 0.14 µSv/hr). During the 2019 baseline inspection, CNSC staff confirmed that dose rates were at or below established average background levels on site. As part of the Phase 3 activities, regular monitoring (i.e. gamma surveys) of the tailings to evaluate cover integrity will occur and measures are in place to verify that dose rates remain consistent with the as low as reasonably achievable (ALARA) principle.

11.3 Environmental Protection

For 2018 to 2020, CNSC staff rated the environmental protection SCA as "satisfactory".

Lorado - environmental protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

Assessment and monitoring

SRC's environmental program verifies that the environment and health and safety of persons are protected by identifying, controlling and monitoring all potential releases from remediation activities.

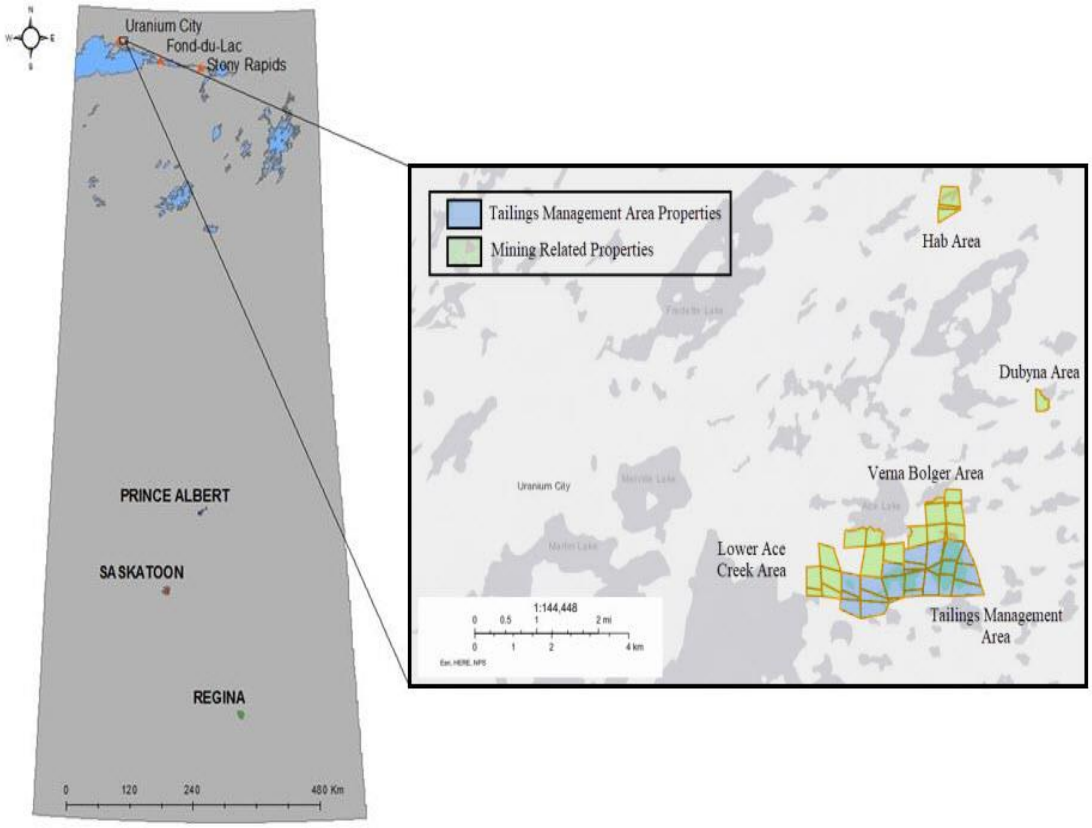
There is no liquid effluent at the Lorado site. SRC's environmental sampling program includes measurement of surface water concentrations for metals, radium-226, and general water quality parameters in local lakes and groundwater. CNSC staff verified that SRC conducted surface water monitoring at several locations to confirm water quality improvement in Nero Lake and Hanson Bay following the placement of the tailings cover. As more data is collected over time at the site, the effectiveness of the remediation works can be verified. SRC have noted a significant increase in wildlife activity on the site since the completion of remediation such as migratory birds feeding, red fox hunting and wolves roaming the area. The public has also been advised of waterbodies from which fish consumption should be limited because of elevated selenium levels, which resulted from past mining and milling activities at the Beaverlodge site and milling at the nearby Lorado site.

12 BEAVERLODGE

Beaverlodge was last reported on in the *Regulatory Oversight Report for Uranium Mines, Mills, Historic and Decommissioned Sites in Canada: 2017* [2]; since then, there have been no significant changes to the site and the site has remained stable. Activities at the site have focused on preparing various properties for eventual transfer to the government of Saskatchewan's Institutional Control Program (ICP).

The decommissioned Beaverlodge uranium mine and mill site is located near Uranium City in northwest Saskatchewan (figure 12.1).

Figure 12.1: Beaverlodge Project – Location and overview



Mining and milling activities began at the Beaverlodge site in 1952, and the mine closed in 1982. The Beaverlodge site consisted of a central mill, underground mines, open pit mines and a tailings management area (TMA). The TMA is located on the Fulton Creek watershed (shown in blue in figure 12.1 and displayed again in figure 12.2). There are also several smaller satellite mines that provided ore during the 3 decades of operation.

Decommissioning commenced shortly after operations ended and was completed to the standards in place at the time of decommissioning (1985). Beaverlodge was the first uranium mining site in Canada to submit a formal decommissioning plan and to be decommissioned under an Atomic Energy Control Board licence. On behalf of the federal government, Cameco Corporation (Cameco) is the licensee and manages the site conducting routine environmental monitoring, environmental investigations and maintenance work, to verify that the site remains safe and secure.

The site consisted of 70 individual properties. Cameco has been conducting remedial activities and preparing supporting documentation to demonstrate that properties can be released from CNSC licensing and transferred to the ICP for provincial management. Five properties were released from CNSC licensing in 2009 and transferred to the ICP.

On December 19, 2019, the Commission accepted the amendment of the CNSC licence to release an additional 20 properties and exempted the Province of Saskatchewan from licensing obligation under the NSCA [1] for 19 Beaverlodge properties, or portions thereof, intended for transfer into the ICP [24]. One property was released from all government programs and monitoring as no follow-up activity was required.

Figure 12.2: Beaverlodge Project – Fookes tailings cover, June 2019

Source: CNSC

On May 27, 2013, the Commission issued a 10-year licence for the Beaverlodge site. As part of its application, Cameco provided a plan for the implementation of additional remediation to support natural recovery of the site, and a timetable for final decommissioning of the site's various licensed areas. Since issuance of that licence, Cameco completed studies and additional remediation work to support an application to release additional portions of the Beaverlodge site into the ICP.

Cameco has expressed its intent to have the remaining properties released from the CNSC licence as soon as feasible. This may be achievable prior to the licence renewal in 2023 or if not, in either 2024 or 2025, for which Cameco may request a short licence extension. A final submission (Closure Report) from Cameco will be required along with verification in the field by both the CNSC and the Saskatchewan Ministry of Environment (SMOE) staff that the performance indicators and regulatory acceptance criteria have been met. CNSC staff will continue their oversight of the Beaverlodge site to verify regulatory compliance.

12.1 Performance

In 2018 to 2020, CNSC staff rated the Beaverlodge site performance as "satisfactory" for all applicable SCAs. The following sections contain additional information on the performance ratings for the SCAs of radiation protection, environmental protection, and conventional health and safety.

12.2 Radiation Protection

For 2018 to 2020, CNSC staff rated the radiation protection SCA as "satisfactory".

Beaverlodge Project - radiation protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

There are no year-round workers at the Beaverlodge site. During the 2018 to 2020 period, Cameco staff and contractors were onsite for limited periods of time for monitoring, mitigation activities and inspections. Based on the outcome of CNSC staff inspections and work practices, CNSC staff concluded that Cameco continued to be effective in controlling radiation doses to workers and the public at the Beaverlodge site.

12.3 Environmental Protection

For 2018 to 2020, CNSC staff rated the environmental protection SCA as "satisfactory".

Beaverlodge Project – environmental protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

CNSC staff reviewed the water quality results from the 2018 to 2020 monitoring programs and found that the contaminant concentrations are generally stable and within the water quality predictions made by Cameco. Comparison of water quality monitoring results with the predictions are one of the performance indicators used to determine if properties can be released from CNSC licensing and transferred to the ICP. In response to a request from CNSC staff, Cameco submitted a model update and Environmental Risk Assessment (ERA) report in September 2020. The report included updated modeling inputs into a new modelling framework which allowed for a fully probabilistic assessment. The environmental performance indicators were also updated accordingly. CNSC staff have accepted conclusions from the report and the updated indicators. The updated ERA will support future applications for release of properties.

There is a precautionary fish consumption advisory in effect which, in 2016, was renamed and is now referred to as a *Healthy Fish Consumption Guidelines* [25]. The public has been advised of the lakes and creeks in the area from which no fish should be consumed. The public has also been advised of those water bodies where fish consumption should be limited due to elevated selenium levels as a result of past mining and milling activities at the Beaverlodge site and milling at the nearby Lorado site.

Consistent with previously accepted assessments, the 2020 ERA concluded that immediate and downstream environments will continue to gradually recover over time. Based on reported use of the land, there are not expected to be risks to humans residing near, or consuming food from areas surrounding the Beaverlodge site. Therefore living a traditional lifestyle and consuming country foods from the area, while respecting the water and fish advisories, can continue to be done safely.

For 2018 to 2020, CNSC staff were satisfied that Cameco had adequate measures in place to protect the public and the environment at the Beaverlodge site.

12.4 Conventional Health and Safety

For 2018 to 2020, CNSC staff rated the conventional health and safety SCA as "satisfactory".

Beaverlodge – conventional health and safety ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

The health and safety risks at the Beaverlodge site are very low for this unoccupied site. The risks are associated with the management of contractors undertaking surveillance, maintenance and any remediation work. As required by the CNSC licence, a contractor management program is in place to mitigate health and safety risks. CNSC staff concluded Cameco satisfactorily maintained a conventional health and safety program that protected the health and safety of workers.

12.5 Update on Engagement Activities

On October 2, 2019, a public hearing was held for the Commission to consider Cameco's request for the release of 20 properties from the Beaverlodge Project CNSC-issued Waste Facility Operating Licence. The Commission granted this request, and within their Record of Decision [24], provided recommendations related to Indigenous engagement. This update has been prepared in response to the 2 recommendations included in paragraph #145 and #162 of the Decision.

Although the COVID-19 pandemic limited in-person meetings and site tours, both Cameco and CNSC staff continued proactive engagement related to the Beaverlodge Project.

Engagement with Athabasca Chipewyan First Nation

An item raised by the Athabasca Chipewyan First Nation (ACFN) during the October 2019 Commission hearing was concerns regarding potential radiation contamination of a forestry dock in Fort Chipewyan. These concerns were related to the historic transport of radioactive material through the river system. In follow-up to the October hearing, Cameco conducted research into the history of the transport of yellowcake from the Beaverlodge property as well as the history of the Northern Transport Route (NTR), which was a water transportation route used to carry uranium ore and ore concentrates from Port Radium, Northwest Territories, to the barge-to-rail transfer point in Fort McMurray, Alberta. Cameco reviewed documentation related to the transport of yellowcake from the Beaverlodge mine and mill and verified there was no record of any material being barged along the NTR. The records indicated that all yellowcake was transported by air from site to its destination. Cameco provided CNSC staff with a memorandum outlining the results of the research, including the investigation and clean-up activities conducted along the NTR as well as the current entity

responsible for any outstanding issues that may arise. CNSC staff requested additional information from Canadian Nuclear Laboratories (CNL), the responsible entity, as well as a contact who could assist if any additional information was required. This information was provided to the ACFN via email in July 2020 along with the invitation to go through the information by either teleconference or videoconference. A follow up email was sent to the ACFN in August 2020; ACFN responded indicating they would review the information and follow-up with CNSC staff. At the time of preparing this CMD, a response had not yet been received from ACFN.

Cameco provided information to CNSC staff on engagement efforts in 2020. These efforts included phone calls, emails and mailed correspondence in an effort to engage the ACFN on the Beaverlodge Project. Cameco verified that it is their intent to continue attempts to engage with the ACFN to better understand their concerns and to share information related to environmental monitoring and traditional land use.

2020 Engagement Activities

As part of Cameco's engagement activities and in follow-up to the 2019 Commission hearing, Cameco increased communications regarding Beaverlodge related activities and plans with the Métis Nation of Saskatchewan (MN-S) and the ACFN in 2020.

A 'boots on the ground' tour and public meeting was planned for the Beaverlodge Project properties in 2020. The intent was to invite First Nations and Métis community representatives to facilitate physical interaction with and provide opportunities for reconnection with the land associated with the Beaverlodge properties. This however, could not be conducted safely due to the pandemic restrictions. In an effort to help those reconnect with the land, a drone pilot was contracted in 2020 to capture footage of the area to facilitate development of a virtual site tour. This virtual tour provided an aerial overview of some of the areas that make up the decommissioned Beaverlodge properties. A link to that video is available on the Beaverlodge website (www.beaverlodgesites.com) and was provided to all invited participants to the virtual meeting. The presentation was also shared via social media on Cameco's YouTube channel in both English and Dene.

As an alternative to an in-person meeting, a virtual public meeting was held on November 18, 2020. The meeting was advertised locally to Uranium City community residents, and invitations were sent to the Uranium City Métis (Local #50) President, Northern Saskatchewan Environmental Quality Committee and the Athabasca Joint Engagement and Environment Subcommittee (AJES). In an effort to help promote the event, this invitation was also made public on the Ya'thi Néné Lands and Resources office social media channel, directed towards the Athabasca Basin community members. In addition, the ACFN (through their Dene Lands and Resources Management organization) and the MN-S (through the Uranium City Métis [Local #50] President) were also invited to attend as they had expressed interest during the October Commission hearing regarding the site and

release of properties from CNSC licensing. Representatives of the CNSC, Saskatchewan Ministry of Energy and Resources, Saskatchewan Ministry of Environment and Cameco provided presentations at this November meeting and were available to answer questions. The presentations described how the various agencies assess the decommissioned Beaverlodge properties and determine if Cameco has met requirements to proceed with transfer of these properties to the ICP. The meeting also provided an opportunity to discuss the proposed plan and schedule for transferring properties to the ICP. The presentations, together with a recording of the public meeting, was posted to Cameco's Beaverlodge website. These presentations and a 2020 Beaverlodge fact sheet were sent to participants as follow-up. In addition, the meeting recording was translated to Dene. Both English and Dene versions were made available by Cameco to Athabasca Basin communities using both the Beaverlodge website and the Ya'thi Néné Lands and Resources Office social media channels. Information regarding the Beaverlodge Project was also provided in the summer 2020 Ya' thi Néné newsletter.

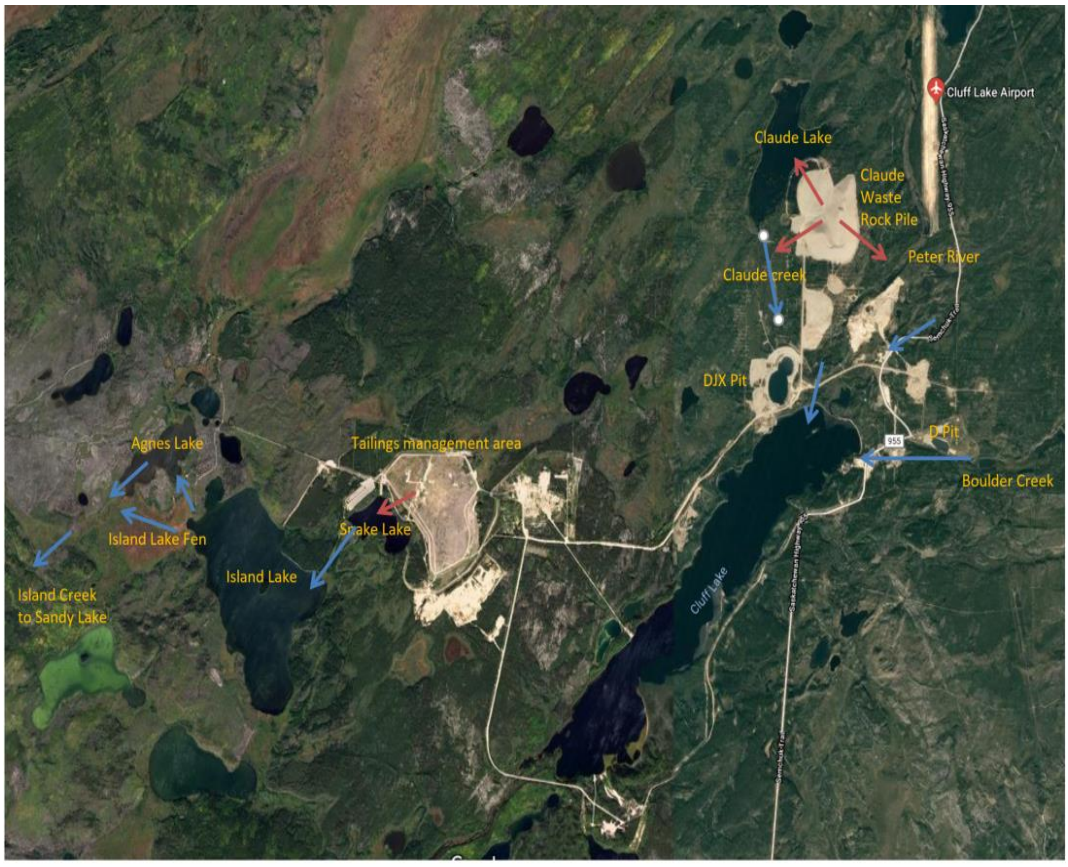
There were no EQC meetings conducted in 2020 due to the COVID-19 pandemic; however, once these meetings resume, Cameco and CNSC staff will regularly attend.

13 CLUFF LAKE

The Cluff Lake Project was last reported on in CNSC's *Regulatory Oversight Report for Uranium Mines and Mills in Canada: 2018* [26], since then, there have been no significant changes to the site and the site remains stable.

The decommissioned Cluff Lake uranium mine and mill is located in northern Saskatchewan, approximately 75 kilometres south of Lake Athabasca and 30 kilometres east of the provincial border with Alberta. Owned and operated by Orano Canada Inc. (Orano), the Cluff Lake Project operated from 1981 to 2002. Following closure, the major decommissioning activities commenced and were largely completed within 5 years. In September 2013, the Cluff Lake Project reached a major milestone when they decommissioned the remaining camp residence and airstrip. Site occupancy was ceased, and access to the site is no longer controlled. Figure 13.1 provides an aerial view of the Cluff Lake area showing key components of the operation.

Figure 13.1: Cluff Lake Project – Aerial view



Source: Orano

The former Cluff Lake Operation consisted of a central mill, above ground tailings management area (TMA), 3 open pits, 2 underground mines, associated waste rock piles, and site infrastructure including an airstrip and camp (figure 13.2).

Figure 13.2: Cluff Lake Project – Pre-decommissioning view, 2009

Source: Orano

As part of decommissioning activities, the Claude pit was completely filled in. The DJ/DJX and D pits were flooded and remain isolated from adjacent natural water bodies. Potentially problematic portions of the surface waste rock piles were placed into the pits, while the remainder of the surface waste rock was contoured, covered and revegetated. The portals and vents to the underground mines were closed and the TMA was contoured, covered and revegetated. All structures were dismantled and disposed of. Figure 13.3 shows the tailings management facility and tailings dam.

Figure 13.3: Cluff Lake Project –Tailings management facility and tailings dam, 2018

Source: CNSC

In July of 2019, the Commission issued Orano a 5-year uranium mine licence renewal for its Cluff Lake Project, valid until July 31, 2024. The licence renewal also reduced the licensed area for sections that were not used for mining and milling from the licence footprint to allow Orano to return the surface leases to the Province of Saskatchewan. There were no issues or concerns identified. The recovery of the site is proceeding as anticipated. In February 2020, Orano submitted an application to transfer responsibility for the Cluff Lake property to the province of Saskatchewan. The application is currently being reviewed by CNSC staff and it is anticipated that Commission proceedings will be held on this application in 2022.

13.1 Performance

For the review period between 2018 to 2020, CNSC staff were satisfied with Orano's performance in all relevant SCAs. Orano's performance over the reporting period of 2018 to 2020 was rated as "satisfactory" and the site continues to be stable, safe and well managed.

13.2 Radiation Protection

For the review period of 2018 to 2020, CNSC staff rated the radiation protection SCA as "satisfactory".

Cluff Lake Project - radiation protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

Orano's radiation protection program is reflective of the low risk of radiation exposure at the Cluff Lake site. Due to the nature of the site activities and mitigation measures in place, radiation doses to the workers and the public are well below the public dose limit of 1 mSv.

Orano monitors radon gas in remediated areas. CNSC staff reviewed the results and concluded that the radon concentrations are consistent with values measured in previous years and generally reflective of concentrations naturally occurring in northern Saskatchewan.

CNSC staff were satisfied with Orano's radiation protection program at Cluff Lake and will continue to monitor the effectiveness of the program in future inspections.

13.3 Environmental Protection

For the review period of 2018 to 2020, CNSC staff rated the environmental protection SCA as "satisfactory".

Cluff Lake Project - environmental protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

The environmental monitoring program at Cluff Lake measures the quality of groundwater, surface water and air. Surface water monitoring confirmed that aquatic life in nearby lakes is protected. Water quality in Island Lake, which received treated effluent from the tailings impoundment area during operations, is generally stable or improving as predicted.

For the review period of 2018 to 2020, CNSC staff were satisfied with the environmental monitoring at Cluff Lake and will continue to assess results to verify that mitigation measures remain effective and stable.

For the review period of 2018 to 2020, CNSC staff concluded that the air and sediment quality were similar to that predicted in the *Saskatchewan Environmental Quality Guidelines* [27] and are satisfied with the results. The site is currently achieving decommissioning surface water quality objectives. For the review period of 2018 to 2020, CNSC staff were satisfied that Orano had adequate measures in place to protect the public and the environment from residual releases from the Cluff Lake site.

13.4 Conventional Health and Safety

For the review period of 2018 to 2020, CNSC staff rated the conventional health and safety SCA as "satisfactory".

Cluff Lake Project – conventional health and safety ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

Orano maintained a conventional health and safety program to protect the health and safety of workers at the Cluff Lake site. This program is reflective of the low risk and unique challenges of the isolated location of the work. Prior to each sampling campaign, safety meetings were held between Orano and consultants.

For the review period of 2018 to 2020, CNSC staff were satisfied with Orano's conventional health and safety program and will continue to monitor the program's effectiveness.

14 RAYROCK

Rayrock was last reported on in the *Regulatory Oversight Report for Uranium Mines, Mills, Historic and Decommissioned Sites in Canada: 2017* [2]. Since then, there have been no significant changes to the site and the site has remained stable.

The Rayrock idle mine site was formerly a uranium mine and mill. It is located in the Northwest Territories, 74 kilometres northwest from the community of Behchoko (formerly the community of Rae) and 156 kilometres northwest of Yellowknife. Figure 14.1 presents an aerial view of the Rayrock idle mine site.

Figure 14.1: Rayrock – aerial view

Source: CNSC

The uranium mine and mill operated from 1957 until 1959, when the site was abandoned. The site was then decommissioned and rehabilitated in 1996 by Indigenous and Northern Affairs Canada (INAC) now Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC). A CNSC Designated Officer issued a renewal of CIRNAC's waste nuclear substance licence on June 30, 2017 for a period of 10 years (until June 30, 2027). Subsequently, CNSC staff issued a licence conditions handbook (LCH) to provide guidance on the compliance strategy for the Rayrock mine site. In September 2020, CIRNAC submitted an application to amend their current waste nuclear substance licence in order to perform remediation work. CNSC staff reviewed the application and requested additional information from the licensee.

14.1 Performance

For the review period of 2018 to 2020, CNSC staff were satisfied with INAC's performance in the SCAs of environmental protection, radiation protection and conventional health and safety. CIRNAC's performance over the reporting period has been stable and has met the requirements of the *Nuclear Safety and Control Act* [1] and its associated regulations.

According to the CNSC's risk-informed baseline inspection plan, Rayrock is subject to a minimum of 1 compliance inspection every 3 years. CNSC staff conducted an inspection in 2019. In 2020, CNSC staff reviewed CIRNAC's response to the findings from this inspection and are satisfied with CIRNAC's corrective actions. The next inspection is tentatively scheduled to take place in 2022.

14.2 Radiation Protection

For the review period of 2018 and 2020, CNSC staff rated the radiation protection SCA as "satisfactory".

Rayrock - radiation protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

With the requested remediation work, the licensee's licence amendment application included a revised radiation protection program, which takes into consideration the need for additional measures related to the remediation work as well as the fact that there will be personnel on site on a regular basis during the remediation project. CNSC staff provided their review comments in late 2020 and the licensee is in the process of incorporating these recommendations into their revised draft program. During the 2019 inspection, CNSC staff confirmed that the licensee's radiation protection program was being followed and used onsite measurements to verify that radiation doses to the workers and the public were well below the public dose limit of 1 mSv.

14.3 Environmental Protection

For the review period of 2018 and 2020, CNSC staff rated the environmental protection SCA as "satisfactory".

Rayrock - environmental protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

Assessment and monitoring

CIRNAC finalized its Human Health and Ecological Risk Assessment (HHERA) for the Rayrock site and determined that exposure to radionuclides in the aquatic and terrestrial environment at the Rayrock mine site does not represent a risk. With the planned remediation work, compliance monitoring, including gamma surveys and general water surveys, will be postponed until after the completion of the Rayrock Remediation Project. A new long-term monitoring program will need to be developed and submitted to the CNSC for review and approval post remediation to reflect the changes to the site. The licensee performed field sampling work in both 2018 and 2019 to finalize the Remedial Action Plan. CNSC staff's review of the HHERA report as well as the 2018/2019 Field Survey results indicate CIRNAC continues to have adequate measures in place at the site to protect the public and the environment. The planned remediation work will only be an improvement upon the sites current state.

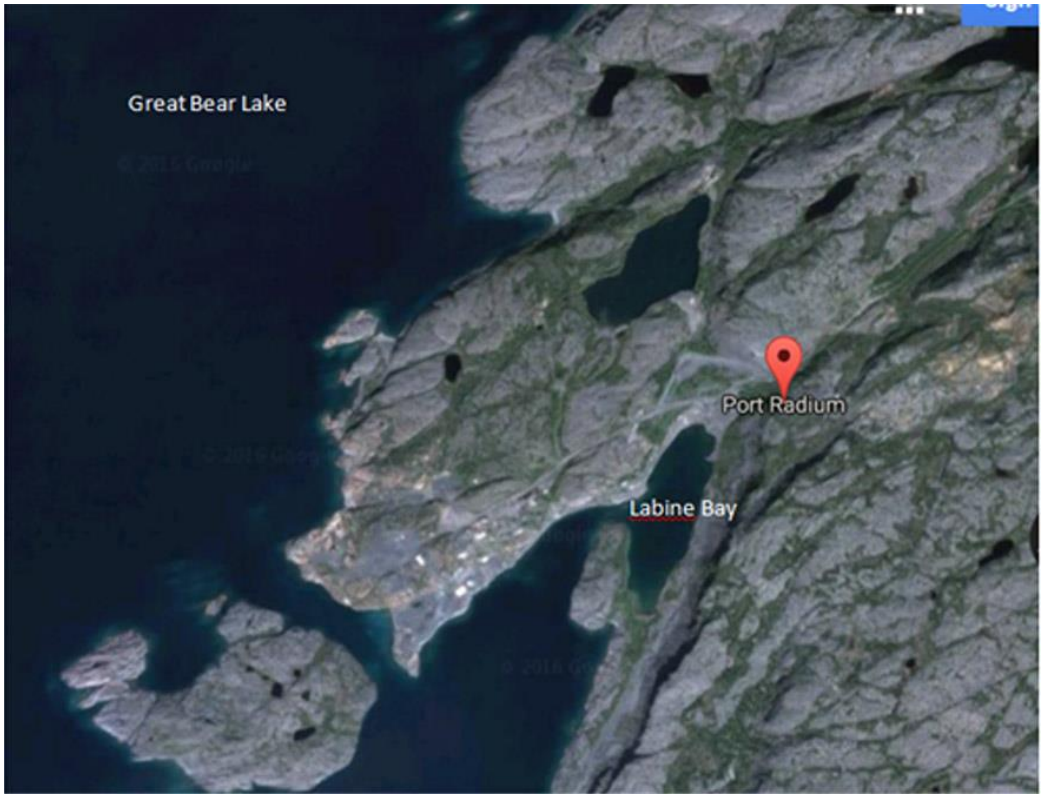
CNSC staff concluded that CIRNAC had adequate measures in place at the Rayrock site to protect the public and the environment.

15 PORT RADIUM

Port Radium was last reported on in the *Regulatory Oversight Report for Uranium Mines and Mills in Canada: 2017* [2]. Since then, there have been no significant changes to the site and the site remains stable.

The Port Radium idle mine site is located in the Northwest Territories at Echo Bay on the eastern shores of Great Bear Lake, about 265 kilometres east of the Dene community of Deline at the edge of the Arctic Circle (figure 15.1).

Figure 15.1: Port Radium – Idle mine site



Source: Google Earth

The mine was in operation for 50 years, from 1932 to 1982. The site covers approximately 12 hectares and is estimated to contain 1.7 million tonnes of uranium and silver tailings. The site was partially decommissioned in 1984, according to the standards at that time. In 2006, the Government of Canada reached an agreement with the local community and completed the remediation of the site in 2007 under a CNSC waste nuclear substance licence granted to Indigenous and Northern Affairs Canada (INAC) now Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC). On December 31, 2016, a CNSC Designated Officer issued a licence renewal to CIRNAC for a period of 10 years (until December 31, 2026), in order to allow continued long-term maintenance and monitoring of the Port Radium site. In 2017, CNSC staff issued a licence conditions handbook to provide guidance on the compliance strategy for the Port Radium site.

15.1 Performance

From 2018 to 2020, CNSC staff were satisfied with CIRNAC's performance in the radiation protection, environmental protection, and conventional health and safety SCAs.

According to CNSC's risk-informed baseline inspection plan, Port Radium is subject to a minimum of 1 compliance inspection every 3 years. CNSC staff planned on conducting a baseline compliance inspection during the summer of 2020 however, as a result of the pandemic, the inspection has been postponed until the summer of 2022.

15.2 Radiation Protection

For the review period of 2018 to 2020, CNSC staff rated the radiation protection SCA as "satisfactory".

Port Radium - radiation protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

There were no year-round workers at the Port Radium site during 2018 to 2020, but licensee staff and contractors were on site for limited periods of time for site visits, monitoring and inspections. Based on the outcome of CNSC staff inspections and work practices, CNSC staff concluded CIRNAC has been effectively controlling radiation doses at the site.

CIRNAC's radiation protection program reflects the low risk of radiation exposure at the site.

Based on site measurements, CNSC staff verified that radiation doses to the workers and the public were well below the public dose limit of 1 mSv.

CNSC staff will verify the program's implementation in the next scheduled compliance inspection.

15.3 Environmental Protection

For the review period of 2018 to 2020, CNSC staff rated the environmental protection SCA as "satisfactory".

Port Radium - environnemental protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

In 2017, CIRNAC submitted a revised long-term monitoring plan for CNSC's review. CNSC staff provided comments and questions to CIRNACs submission in 2018 and 2019. CIRNAC is currently planning additional engagement activities with the Deline community and leadership prior to finalizing the long-term monitoring plan as well as to discuss the Silverpoint Tailings Containment Area shoreline monitoring and repair plan. These engagement sessions were postponed due to travel restriction as a result of the pandemic. The long-term monitoring event, which occurs over the span of 15 years, is planned for the summer of 2022; as such, no monitoring activities were undertaken for the 2018 to 2020 review period. As the Port Radium site sampling has been postponed until 2022, there is no new sampling data. However, due to previous years' data and the stability of the decommissioned site, CNSC staff were satisfied that CIRNAC continues to have adequate measures in place at the Port Radium site to protect the public and the environment.

16 AGNEW LAKE

Agnew Lake Tailings Management Area (ALTMA) was last reported on in the *Regulatory Oversight Report for Uranium Mines, Mills, Historic and Decommissioned Sites in Canada: 2017* [2]; since then, there have been no significant changes to the site and the site has remained stable.

The ALTMA is located about 25 kilometres northwest of Nairn Centre, Ontario. The uranium mine site was decommissioned and monitored by Kerr Addison Mines from 1983 until 1988. The site was then turned over to the Province of Ontario in the early 1990s. In November 2018, The Ministry of Energy, Northern Development and Mines (ENDM), now The Ministry of Northern Development, Mines, Natural Resources and Forestry (NDMNRF), submitted an application to renew the current CNSC licence for a period of 5 years as well as amend their radioactive waste inventory to add approximately 20,000 m^3 of niobium bearing material classified as naturally occurring radioactive material (NORM) from the former Beaucage Mine near North Bay. The additional niobium bearing material as well as a layer of clean soil will be used to make repairs to the cover of the existing ALTMA TMA to better cover these tailings and add approximately 20,000 m^3 to the current inventory of 510,000 m^3. On July 29, 2020, the CSNC Designated Officer issued ENDM an amended waste nuclear substance licence for ALTMA and the current licence is valid until July 31, 2025. For the foreseeable future, the site is expected to remain under long-term monitoring and maintenance.

16.1 Performance

For the review period of 2018 to 2020, CNSC staff were satisfied with NDMNRF's performance in the SCAs of radiation protection, environmental protection and conventional health and safety. NDMNRF's performance over the reporting period has been stable and met the requirements of the NSCA [1] and its associated regulations.

Repair to the cover of the TMA and the addition of the niobium bearing material is scheduled to begin during the summer of 2021. A baseline compliance inspection of ALTMA is scheduled for the fall of 2021.

16.2 Radiation Protection

For the review period of 2018 to 2020, CNSC staff rated the radiation protection SCA as "satisfactory".

Agnew Lake - radiation protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

NDMNRF posted radiation-warning signage (figure 16.1) and conducted a public dose assessment of the ALTMA, confirming that the estimated dose to the public was below the regulatory limit of 1 mSv/year. CNSC staff reviewed the dose assessment findings in 2017 to confirm that the licensee was in compliance and that their radiation protection program was up to date. CNSC staff have requested that a new radiation survey be performed once remediation work on the tailings cover is completed to demonstrate the effectiveness of the new cover material. CNSC staff will report on these findings in 2022, the next regulatory oversight report that includes the decommissioned sites.

Figure 16.1: Agnew Lake – Radiation warning sign

Source: ENDM

16.3 Environmental Protection

For the review period of 2018 to 2020, CNSC staff rated the environmental protection SCA as “satisfactory”.

Agnew Lake - environmental protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

Assessment and monitoring

ENDM measures contaminant concentrations in surface water at several locations around the site. The last reported measurements were submitted to the CNSC in the ENDM Agnew Lake 2020 annual report. CNSC staff reviewed the results and found that contaminant concentrations in water bodies in and around the site were below the maximum concentrations specified in Ontario's *Surface Water Quality Objectives* [28] with the exception of aluminum, boron, cobalt, copper, iron, uranium and zinc, which were slightly above surface water objectives for at least 1 sampling point within the licensed area. These measurements were consistent with those from previous years. CNSC will continue to monitor the surface water results during and post the addition of both niobium bearing and clean cover material to verify that the remediation work is performing as designed and improving the overall water quality at the site.

For the review period of 2018 to 2020, CNSC staff were satisfied that ENDM had adequate measures in place at ALTMA to protect the public and the environment from releases from the site.

17 BICROFT

Bicroft was last reported on in the *Regulatory Oversight Report for Uranium Mines, Mills, Historic and Decommissioned Sites in Canada: 2017* [2]; since then, there have been no significant changes and the site has remained stable.

The Bicroft tailings storage facility, owned and operated by Barrick Gold Corporation (Barrick Gold), is located on the south side of Highway 118, approximately 2 kilometres west of Cardiff, Ontario. In September 2020, the licensee submitted an application to renew their waste nuclear substance licence for the Bicroft site. The licence renewal was issued by a CNSC Designated Officer to Barrick Gold on February 24, 2021, and is valid until February 29, 2036. For the foreseeable future, the site is expected to remain under long-term monitoring and maintenance (see figure 17.1).

Figure 17.1: Bicroft – Spillway of Pond A at the tailings management facility, 2017

Source: CNSC

The Bicroft facility was constructed to contain tailings from mining operations that were carried out at the nearby Bicroft mine, which operated from 1956 to 1962. The uranium tailings stored in the Bicroft tailings storage site resulted from the processing of low-grade uranium ore at the Bicroft mine. Remediation work included vegetation of exposed tailings in 1980 and upgrading of dams in 1990 and 1997. Areas of the site are now used for occasional recreational use by the local snowmobile club.

17.1 Performance

For the period of 2018 to 2020, CNSC staff were satisfied with Barrick Gold's performance in the SCAs of radiation protection, environmental protection and conventional health and safety at the Bicroft site. The licensee's performance over the reporting period has been stable and met the requirements of the *Nuclear Safety and Control Act* [1] and its associated regulations.

During the October 2018 baseline/geotechnical onsite compliance inspection, CNSC staff found that the site was well managed and maintained, and that satisfactory environmental protection measures and procedures were in place. As an example, the licensee continued maintenance improvements by removing vegetation on certain dams and beaver cuttings to protect the overall integrity of the dams, as well as performing maintenance work to Dam H which included additional material being placed on the toe berm.

17.2 Radiation Protection

For the review period of 2018 to 2020, CNSC staff rated the radiation protection SCA as "satisfactory".

Bicroft - radiation protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

There were no year-round workers at the Bicroft site during 2018 to 2020, but licensee staff and contractors were on site for limited periods of time for monitoring, mitigation activities and inspections. Based on the outcome of CNSC staff inspections and work practices, CNSC staff concluded that Barrick Gold has been effectively controlling radiation doses at the Bicroft site.

Barrick Gold's radiation protection program reflects the low risk of radiation exposure at the site. Because of the nature of the site activities and mitigation measures in place, radiation doses to the workers and the public were well below the public dose limit of 1 mSv in 2018 to 2020.

17.3 Environmental Protection

For the review period of 2018 to 2020, CNSC staff rated the environmental protection SCA as "satisfactory".

Bicroft - environmental protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

Water quality sampling is carried out every 5 years at the site. Sampling last occurred during the 2020 field season. Barrick Gold has an environmental sampling program for the Bicroft site and sampling results were provided to the CNSC in its 2020 annual report.

CNSC staff reviewed Barrick Gold's 2016 dam safety review for the Bicroft site and provided recommendations to enhance the dam safety program. The licensee responded to these recommendations and CNSC staff requested additional information, which the licensee responded to in December 2018. Barrick Gold performed maintenance work on Dam H in 2020 and has plans to implement maintenance work on additional dams during the upcoming field seasons. For the period from 2018 to 2020, CNSC staff remained satisfied that Barrick Gold Corporation had adequate measures in place at the Bicroft site to protect the public and the environment.

18 DYNO

Dyno was last reported on in the *Regulatory Oversight Report for Uranium Mines, Mills, Historic and Decommissioned Sites in Canada: 2017* [2]; since then, there have been no significant changes and the site has remained stable.

The Dyno closed mine property is located at Farrel Lake, about 30 kilometres southwest of Bancroft, Ontario. The mill circuit at Dyno operated between 1958 and 1960. The property consists of an abandoned sealed underground uranium mine; a mill, which has been demolished; capped openings; a tailings area; 1 dam with a toe berm; and various roadways (figure 18.1). The site is managed and monitored by EWL Management Ltd. (EWL), which holds a CNSC waste nuclear substance licence for Dyno. EWL submitted a licence renewal request in early 2018; the licence was renewed and issued by the CNSC Designated Officer on January 31, 2019, and remains valid until January 31, 2034. The site is expected to remain under long-term monitoring and maintenance for the foreseeable future.

Figure 18.1: Dyno – Dam and toe berm, 2017

Source: EWL Management

18.1 Performance

For the years from 2018 to 2020, CNSC staff were satisfied with EWL's performance in the SCAs of radiation protection, environmental protection and conventional health and safety. Performance over the reporting period at the Dyno site was stable and met the requirements of the *Nuclear Safety and Control Act* [1] and its associated regulations.

During the baseline/geotechnical compliance inspection conducted in October of 2018, CNSC staff found that the site was well managed and maintained. There were satisfactory environmental protection measures and procedures in place.

18.2 Radiation Protection

From 2018 to 2020, CNSC staff rated the radiation protection SCA as “satisfactory”.

Dyno - radiation protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

There were no year-round workers at the Dyno site from 2018 to 2020, but licensee staff and contractors were on site for limited periods of time for monitoring, mitigation activities and inspections. Gamma dose rates around the site were estimated to be 0.267 mSv/year. Based on the low exposure times and dose rates, and the outcome of CNSC staff inspections and work practices, CNSC staff concluded that EWL is effectively controlling radiation doses to workers and the public.

The licensee’s radiation protection program is reflective of the low risk of radiation exposure at the site. Due to the nature of the site activities and mitigation measures in place, radiation doses to the workers and the public are well below the public dose limit of 1 mSv.

18.3 Environmental Protection

For the period of 2018 to 2020, CNSC staff rated the environmental protection SCA as “satisfactory”.

Dyno - environmental protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

The Dyno site has an environmental sampling program. EWL provided sampling results to the CNSC in its annual reports for 2018, 2019 and 2020. Water quality sampling is carried out every 2 years at the site and was last conducted during the 2020 field season. CNSC staff reviewed the results and concluded that all locations for uranium surface water samples met provincial water quality objectives during the last 2 water quality reports conducted during the 2018 and 2020 field seasons.

CNSC staff performed a baseline/geotechnical compliance inspection of the Dyno site in the October of 2018 and concluded that the dam met the safety standards in the Canadian Dam Association's *Dam Safety Guidelines* [29]. As a result of the inspection, CNSC staff requested that the licensee repair a large hole observed on the downstream slope of the dam; this was completed by the licensee in early November of 2018.

For the years from 2018 to 2020, CNSC staff were satisfied that EWL had adequate measures in place at the Dyno site to protect the public and the environment.

19 ELLIOT LAKE

Elliot Lake was last reported on in the *Regulatory Oversight Report for Uranium Mines, Mills, Historic and Decommissioned Sites in Canada: 2017* [2]; since then there have been no significant changes and the site has remained stable.

Rio Algom Limited (RAL) is the owner and licensee of 9 decommissioned uranium mines in the Elliot Lake area of northeastern Ontario: Stanleigh, Quirke, Panel, Spanish, American, Milliken, Lacnor, Buckles and Pronto, as well as some peripheral areas. The Panel mine was the last to operate and ceased operation in 1990. Decommissioning for the entire Elliot Lake area concluded in 2001 with the completion of the vegetative cover at the Pronto site. Figure 19.1 shows the spillway inlet of Quirke Dam M at the Quirke decommissioned mine site.

Figure 19.1: Elliot Lake – Spillway at the Quirke mine site

Source: CNSC

The mine sites and associated tailings management areas (TMAs) are managed under a single CNSC waste facility operation licence, which is of indefinite term. The sites have all been decommissioned and the TMAs are in the long-term care and maintenance phase. RAL conducts site-specific and regional environmental monitoring programs, operates the effluent treatment plants, inspects and maintains the sites in the Elliot Lake area. The long-term plan for these sites is to reach a state where water treatment is no longer required and reliance on physical works can be reduced.

19.1 Performance

CNSC staff conducted annual compliance inspections in 2018 and 2019 and found that the sites were in good condition and well managed by the licensee. No enforcement actions were issued during this period as the result of these inspections.

For the review period of 2018 to 2020, CNSC staff were satisfied with RAL's performance in the SCAs of radiation protection, environmental protection and conventional health and safety.

RAL's performance in the environmental protection SCA was rated as "below expectations" for 2017 because of radium releases from the Stanleigh effluent treatment plant that exceeded the allowable limits specified in the licence. This exceedance was reported to the Commission on January 17, 2018. As a result of this exceedance, the CNSC issued an information request pursuant to subsection 12(2) of the *General Nuclear Safety and Control Regulations* [30] regarding what steps were required to modify the treatment facility to bring radium-226 levels within compliance limits, as well as how long it would take to implement such changes. CNSC staff reviewed the licensee's submission and concluded that RAL completed the information requests by increasing monitoring and installing physical barriers to mitigate impacts, by making improvements to the effluent treatment system by the addition of a preformed barite solution, and finally establishing that a project plan with effective timelines were in place to ensure radium-226 concentrations were returned to be within licensed limits. Currently, the final discharge's yearly averages in radium for Stanleigh were 0.255 Bq/L for 2018, 0.182 Bq/L for 2019, and 0.168 Bq/L for 2020, which is a continuous reduction from the 0.289 Bq/L annual average for 2017.

19.2 Radiation Protection

As a result of CNSC staff reviews of the licensee's radiation protection data from 2018 to 2020, CNSC staff rated the radiation protection SCA as "satisfactory".

Elliot Lake - radiation protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

CNSC staff verified that there were no gamma doses above the detection threshold recorded for nuclear energy workers at the RAL properties using licensed dosimetry services from 2018 to 2020.

19.3 Environmental Protection

For the review period of 2018 to 2020 CNSC staff rated the environmental protection SCA as “satisfactory”.

Elliot Lake - environmental protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

Assessment and monitoring

RAL has an extensive water treatment and monitoring program at all licensed TMAs. RAL’s monitoring program is coordinated with Denison Mines Inc. and consists of 3 integrated aspects: the TMA Operational Monitoring Program, the Source Area Monitoring Program and the Serpent River Watershed Monitoring Program. Data from these programs is reported to the CNSC monthly and annually, and is compiled into a State of the Environment report every 5 years.

For the years from 2018 to 2020, CNSC staff were satisfied that adequate measures were in place at the RAL properties to protect the public and the environment.

20 DENISON AND STANROCK

Denison and Stanrock were last reported on in the *Regulatory Oversight Report for Uranium Mines, Mills, Historic and Decommissioned Sites in Canada: 2017* [2]; since then, there have been no significant changes and the sites have remained stable.

Denison Mines Inc. is the licensee for the 2 closed uranium mines of Denison and Stanrock in the Elliot Lake area of northeastern Ontario. The Denison and Stanrock sites are licensed individually under separate licences with indefinite licence periods.

The licences cover the physical works such as dam structures, effluent treatment plants and fencing, associated with the decommissioned mine and mill tailings. The licensee conducts onsite inspection programs and verifies that local and area-wide environmental monitoring programs are in place. Figure 20.1 provides a view of Dam 16 at the Denison mine site area.

Figure 20.1: Denison – Dam 16

Source: CNSC

The Denison and Stanrock mine sites were decommissioned in 1997 and 1999 respectively, and there are no mining or milling structures remaining. The tailings management areas (TMAs) are in the long-term care and maintenance phase, which includes water treatment, source and watershed monitoring. The Denison mine site contains 2 TMAs that are covered by water and contain a total of 63 million tonnes of uranium mine tailings. The Stanrock site is a dry TMA with a head pond upstream of Dam A and contains 6 million tonnes of uranium mine tailings.

20.1 Performance

For the review period of 2018 to 2020, CNSC staff were satisfied with the licensee's performance in the SCAs of radiation protection, environmental protection, and conventional health and safety. The licensee's performance at the Denison and Stanrock sites has been stable and met requirements of the *Nuclear Safety and Control Act* [1] and its associated regulations.

In 2018 and 2019, CNSC staff inspected the sites and found they were well managed and had no compliance issues. CNSC staff confirmed the dams and associated structures were in good operating condition and appeared well maintained. Effluent water quality at all discharge locations was in compliance with licence limits.

20.2 Radiation Protection

For the review period of 2018 to 2020, CNSC staff rated the radiation protection SCA as "satisfactory".

Denison and Stanrock - radiation protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

From 2018 to 2020, CNSC staff verified that there were no gamma doses above the detection threshold recorded for nuclear energy workers at the Denison and Stanrock properties using licensed dosimeters.

20.3 Environmental Protection

For the review period of 2018 to 2020, CNSC staff rated the environmental protection SCA as "satisfactory". An environmental protection program was satisfactorily maintained at the Denison and Stanrock facilities to verify that the environment was protected.

Denison and Stanrock - environmental protection ratings

2018	2019	2020
SA	SA	SA

SA = satisfactory

Effluent and emissions control

CNSC staff reviewed air emissions monitoring results for radon annual averages from 2018 to 2020 and were satisfied with the results at the Denison and Stanrock facilities.

CNSC staff verified that the effluent water quality for constituents of potential concern consistently met discharge criteria at all TMAs.

For the review period of 2018 to 2020 CNSC staff were satisfied that adequate measures were in place to protect the public and the environment at the Denison and Stanrock sites.

21 DELORO

The Deloro mine site is located approximately 65 kilometres east of Peterborough, Ontario. This site began operation as an underground gold mine in the 1860s, and the historical mining, refining, and manufacturing operation closed in 1961. The mining and industrial operations resulted in large volumes of by-products that were deposited on the Deloro site as waste. This waste legacy includes soil, sediment, groundwater and surface water that are contaminated with arsenic, cobalt, copper, nickel and small quantities of low-level radioactive waste. Arsenic is the main contaminant of concern at the Deloro site. Low-level radioactive waste materials containing uranium and its decay products, from historic refining operations in Port Hope, constitute up to 6% of the waste, and coexist with the non-radioactive hazardous wastes. The Ministry of the Environment, Conservation and Parks (MECP) assumed responsibility for the site and the required environmental cleanup when the previous owner abandoned the site. Since 1979, the site has been under the care and control of the MECP. The licensee, MECP, implemented a comprehensive environmental protection program and an ongoing environmental monitoring program. Due to the elevated levels of arsenic, the Deloro mine site will continue to be managed under the Ontario Provincial Regulatory regime, which will require post-closure monitoring and maintenance of the entire Deloro site.

The remediation of the Deloro mine site was organized into 3 separate cleanup projects: Tailings Management Area (TMA), Industrial Mine Area (IMA) and Young's Creek Area (YCA). Remediation of both the TMA and IMA were completed in 2012 and 2016, respectively. Post-remediation, the radiation levels of the 2 remediated areas (TMA and IMA) were below conditional clearance levels. As such, these areas were removed from the CNSC licensed area at the time of the last renewal in October 2017.

Since the renewal in 2017, remediation of the YCA continued with a focus on areas with dose rates greater than 1 microsievert/hour (µSv/h). Contaminated sediment with a dose rate above 1 µSv/h (highest dose rate in the YCA), was excavated down to native clean clay. The contaminated sediment was placed in geotextile containers that are in a containment cell and secured under a permanent gravel cover, as shown in figure 21.1. No further radiological remediation was required in these areas.

Figure 21.1: Deloro – Aerial view of Young's Creek Area (cell and sediment removal area)

Source: Ministry of Environment, Conservation and Parks

Following these remediation activities, CNSC staff verified radiation levels during an inspection in December 2018 at the YCA at the Deloro mine site. The measurements ranged from 0.05 to 0.18 µSv/h, which is below the background range of 0.05 to 0.22 µSv/h for the area.

In 2019, MECP submitted an application to request that the CNSC revoke MECPs waste nuclear substance licence (WNSL). CNSC staff reviewed MECPs application and determined that with the completion of the remediation activities described above, the YCA no longer posed an unreasonable radiological risk to workers, the public or the environment. CNSC staff also verified that MECP has met the requirements for conditional clearance defined in the *Nuclear Substances and Radiation Devices Regulations* [31].

In August of 2019, the CNSC Designated Officer, pursuant to paragraph 37(2)(c) of the *Nuclear Safety and Control Act* [1], revoked MECP's WNSL for the Deloro mine site, WNSL-W1-3301.0/2022.

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20. *Surface Water Quality Objectives*, Interim Edition, EPB 356, Water Security Agency, Regina, Saskatchewan. June 2015

21. *Canada Labour Code*, R.S.C., 1985, C. L-2

22. CMD 14-H5, Request for an Environmental Assessment and Licensing Decision for *Saskatchewan Research Council, Gunnar Remediation Project*, September 2014, (e-Doc 4496660)

23. Record of Decision, Application from Saskatchewan Research Council for the Amendment of the Waste Nuclear Substance Licence of the Lorado Former Mill Site", July 2020, (e-Doc 6314039)

24. CNSC Record of Decision DEC 19-H6 In the Matter of Cameco Corporation *Application to remove 20 properties from the Beaverlodge Waste Facility Operating Licence to enable the transfer of 19 properties into the Saskatchewan Institutional Control Program*, December 19, 2019 (Section 12)

25. Saskatchewan Ministry of Environment, *Healthy Fish Consumption Guidelines*, 2016

26. CMD 19-M36, Annual Program Report, *Regulatory Oversight Report for Uranium Mines and Mills in Canada: 2018*

27. *Saskatchewan Environmental Quality Guidelines*

28. Ontario's Surface Water Quality Objectives

29. Canadian Dam Association. *Dam Safety Guidelines, 2007*, revised 2013

30. *General Nuclear Safety and Control Regulations*, SOR/2000-202

31. *Nuclear Substances and Radiation Devices Regulations*, SOR/2000-207

32. CNSC REGDOC-3.6, Glossary of CNSC Terminology

GLOSSARY

For definitions of terms used in this document, see CNSC's REGDOC-3.6, *Glossary of CNSC Terminology* [32], which includes terms and definitions used in the *Nuclear Safety and Control Act* [1] and the regulations made under it, and in CNSC regulatory documents and other publications. REGDOC-3.6 is provided for reference and information.

A. FACILITY LICENSING INFORMATION

The following tables present CNSC licensing information for the facilities discussed in this report.

A-1: Operating Uranium Mines and Mills – Licensing Information

Licensee/site/licence #	Licence effective	Last licence amendment	Licence expiration
Cameco Corporation **Cigar Lake Operation** Uranium Mine Licence UML-MINE-CIGAR.01/2021	July 1, 2013	November 4, 2020	June 30, 2021
Cameco Corporation **McArthur River Operation** Uranium Mine Licence UML-MINE-McARTHUR.01/2023	November 1, 2013	June 26, 2019	October 31, 2023
Cameco Corporation **Rabbit Lake Operation** Uranium Mine and Mill Licence UMOL-MINEMILL-RABBIT.00/2023	November 1, 2013	-	October 31, 2023
Cameco Corporation **Key Lake Operation** Uranium Mill Licence UML-MILL-KEY.01/2023	November 1, 2013	July 29, 2020	October 31, 2023
Orano Canada Inc. **McClean Lake Operation** Uranium Mine and Mill Operating Licence UMOL-MINEMILL-McCLEAN.01/2027	July 1, 2017	July 12, 2018	June 30, 2027

A-2: Historic and Decommissioned Mines and Mills – Licensing Information

Licensee/site/licence #	Licence effective	Last licence amendment	Licence expiration
Saskatchewan Research Council **Gunnar Legacy Uranium Mine Site** Waste Nuclear Substance Licence WNSL-W5-3151.00/2024	January 14, 2015	-	November 30, 2024
EWL Management Ltd. **Madawaska Decommissioned Mine & Tailings Management Site** Waste Nuclear Substance Licence WNSL-W5-3100.1/2021		December 18, 2012	July 31, 2021
Saskatchewan Research Council **Former Lorado Mill Site** Waste Nuclear Substance Licence WNSL-W5-3150.01/2023	May 1, 2013	July 6, 2020	April 30, 2023
Cameco Corporation **Beaverlodge** Waste Facility Operating Licence WFOL-W5-2120.1/2023	June 1, 2013	December 19, 2019	May 31, 2023
Orano Canada Inc. **Cluff Lake Project** Uranium Mine Licence UML-MINEMILL-CLUFF.00/2024	August 1, 2019	-	July 31, 2024
Department of Indian Affairs and Northern Development Canada **Rayrock Idle Mine Site** Waste Nuclear Substance Licence WNSL-W5-3208.0/2027	June 27, 2017	-	June 30, 2027
Indigenous and Northern Affairs Canada **Port Radium Mine Site** Waste Nuclear Substance Licence WNSL-W5-3207.0/2026	December 30, 2016	-	December 31, 2026
Ministry of Northern Development, Mines, Natural Resources and Forestry (Ministry of Energy, Northern Development and Mines) **Agnew Lake Tailings Management Area** Waste Nuclear Substance Licence WNSL-W5-3102.1/2025	July 29, 2020	-	July 31, 2025
Barrick Gold Corporation **Bicroft Tailings Storage Facility** Waste Nuclear Substance Licence WNSL-W5-3103.1/2021	December 14, 2010	February 24, 2011	February 28, 2021

Licensee/site/licence #	Licence effective	Last licence amendment	Licence expiration
EWL Management Ltd. **Dyno Closed Mine Site** Waste Nuclear Substance Licence WNSL-W5-3101.1/2034	January 30, 2019	-	January 31, 2034
Rio Algom Limited **Elliot Lake Historic Sites Facility** Radioactive Waste Facility Operating Licence WFOL-W5-3101.03/indf	January 1, 2006	June 7, 2007	Indefinite
Denison Mines Inc. **Denison Mining Facility** Uranium Mine Decommissioning Licence UMDL-MINEMILL-DENISON.02/indf	December 15, 2004	September 17, 2010	Indefinite
Denison Mines Inc. **Stanrock Mining Facility** Uranium Mine Decommissioning Licence UMDL-MINEMILL-STANROCK.02/indf		September 17, 2010	Indefinite
Ontario Ministry of the Environment, Conservation and Parks **Deloro Mine Site** WNSL-W1-3301.00/2022	October 25, 2017	August 7, 2019 (Revoked)	N/A

B. LIST OF INSPECTIONS

The following tables present CNSC's inspections by facility and safety control area (SCA) for the facilities discussed in this report.

Table B-1: Operating Uranium Mines and Mills - Inspections by facility and SCA

Facility	Method	Safety and control area	Notices of non-compliance	Inspection report issued
Cigar Lake Operation	Onsite	Management system; operating performance; safety analysis; physical design; conventional health and safety; human performance management; waste management; security; packaging and transport	0	April 22, 2020
	Remote	Radiation protection; conventional health and safety; human performance management	1	July 16, 2020
	Remote	Fitness for service; safety analysis; environmental protection	0	October 1, 2020
	Remote	Environmental protection; radiation protection	0	March 31, 2021
McArthur River Operation	Remote	Safety analysis; physical design; radiation protection; conventional health and safety; emergency management and fire protection; safeguards and non-proliferation; packaging and transport	1	November 13, 2020
	Remote	Radiation protection	3	January 12, 2021
	Remote	Fitness for service; safety analysis; environmental protection; conventional health and safety	0	December 18, 2020
Rabbit Lake Operation	Postponed	Postponed to March 2021	N/A	N/A
	Remote	Fitness for service	0	September 14, 2020

Facility	Method	Safety and control area	Notices of non-compliance	Inspection report issued
Key Lake Operation	Onsite	Management system; conventional health and safety	0	June 12, 2020
	Remote	Fitness for service	1	November 2, 2020
	Remote	Safety analysis; environmental protection; radiation protection, conventional health and safety; human performance management	0	December 3, 2020
	Remote	Management system; environmental protection; radiation protection; conventional heath and safety; emergency management and fire protection	3	December 9, 2020
McClean Lake Operation	Onsite	Fitness for service; safety analysis; environmental protection; radiation protection; conventional health and safety	0	June 18, 2020
	Remote	Radiation protection	0	July 8, 2020
	Remote	Management system	5	August 25, 2020
	Remote	Operating performance; radiation protection; conventional health and safety; emergency management and fire protection	0	February 17, 2021

Table B-2: Historic and Decommissioned Mines and Mills - Inspections by facility and SCA

Facility	Method	Safety and control area	Notices of non-compliance	Inspection report issued
Gunnar	Postponed	Postponed to November 2021	N/A	N/A
	Onsite	Management system; physical design; environmental protection; radiation protection; conventional health and safety; emergency management and fire protection: waste management; security	0	August 26, 2019
Madawaska	Postponed	Postponed to October 2021	N/A	N/A
	Onsite	Management system; fitness for service	0	January 27, 2020
	Onsite	Management system; fitness for service; physical design; environmental protection; radiation protection; conventional health and safety; emergency management and fire protection; waste management; security	0	February 26, 2019
Lorado	Onsite	Fitness for service; environmental protection; radiation protection; waste management	0	July 31, 2019
Beaverlodge	Onsite	Physical design; environmental protection; radiation protection; conventional health and safety; other: public information and disclosure	0	October 14, 2020
	Onsite	Operating performance; environmental protection; radiation protection; conventional health and safety; other: public information and disclosure	1	July 8, 2019
	Onsite	Operating performance; environmental protection; radiation protection; conventional health and safety; other: public information and disclosure	0	June 28, 2018

Facility	Method	Safety and control area	Notices of non-compliance	Inspection report issued
Cluff Lake	Postponed	Postponed to October 2021	N/A	N/A
	Onsite	Management system; safety analysis; environmental protection; radiation protection; conventional health and safety; waste management	0	August 16, 2018
Rayrock	Onsite	Fitness for service; environmental protection; radiation protection; conventional health and safety; waste management	1	September 12, 2019
Port Radium	Postponed	Postponed to February 2022	N/A	N/A
Agnew Lake	Postponed	Postponed to October 2021	N/A	N/A
Bicroft	Onsite	Fitness for service; environmental protection; radiation protection; conventional health and safety; waste management; security	0	February 27, 2019
Dyno	Onsite	Fitness for service; environmental protection; radiation protection; conventional health and safety; waste management; security	1	February 26, 2019
Elliot Lake	Onsite	Fitness for service	0	April 28, 2020
Denison and Stanrock	Onsite	Physical design	0	April 28, 2020
Deloro	Onsite	Physical design; radiation protection	0	March 5, 2019

C. SAFETY AND CONTROL AREA DEFINITIONS

The CNSC evaluates how well licensees meet regulatory requirements and CNSC performance expectations for programs in 14 safety and control areas (SCAs). The SCAs are grouped into 3 functional areas: management, facility and equipment, and core control processes.

Table C-1: Safety and Control Area Framework

Safety and Control Area Framework			
Functional area	**Safety and control area**	**Definition**	**Specific areas**
Management	Management system	Covers the framework that establishes the processes and programs required to ensure an organization achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy safety culture.	▪ Management system ▪ Organization ▪ Performance assessment, improvement and management review ▪ Operating experience (OPEX) ▪ Change management ▪ Safety culture ▪ Configuration management ▪ Records management ▪ Management of contractors ▪ Business continuity
	Human performance management	Covers activities that enable effective human performance through the development and implementation of processes that ensure a sufficient number of licensee personnel are in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.	▪ Human performance program ▪ Personnel training ▪ Personnel certification ▪ Initial certification examinations and requalification tests ▪ Work organization and job design ▪ Fitness for duty
	Operating performance	Includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.	▪ Conduct of licensed activity ▪ Procedures ▪ Reporting and trending ▪ Outage management performance ▪ Safe operating envelope ▪ Severe accident management and recovery ▪ Accident management and recovery

Safety and Control Area Framework			
Functional area	**Safety and control area**	**Definition**	**Specific areas**
Facility and equipment	Safety analysis	Covers maintenance of the safety analysis that supports the overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventative measures and strategies in reducing the effects of such hazards.	▪ Deterministic safety analysis ▪ Hazard analysis ▪ Probabilistic safety analysis ▪ Criticality safety ▪ Severe accident analysis ▪ Management of safety issues (including R&D programs)
	Physical design	Relates to activities that impact the ability of structures, systems and components to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.	▪ Design governance ▪ Site characterization ▪ Facility design ▪ Structure design ▪ System design ▪ Component design
	Fitness for service	Covers activities that impact the physical condition of structures, systems and components to ensure that they remain effective over time. This area includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.	▪ Equipment fitness for service / equipment performance ▪ Maintenance ▪ Structural integrity ▪ Aging management ▪ Chemistry control ▪ Periodic inspection and testing
Core control processes	Radiation protection	Covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. The program must ensure that contamination levels and radiation doses received by individuals are monitored, controlled and maintained ALARA.	▪ Application of ALARA ▪ Worker dose control ▪ Radiation protection program performance ▪ Radiological hazard control ▪ Estimated dose to public

Safety and Control Area Framework			
Functional area	**Safety and control area**	**Definition**	**Specific areas**
	Conventional health and safety	The implementation of a program to manage workplace safety hazards and to protect workers.	▪ Performance ▪ Practices ▪ Awareness
	Environmental protection	Covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities.	▪ Effluent and emissions control (releases) ▪ Environmental management system ▪ Assessment and monitoring ▪ Protection of people ▪ Environmental risk assessment
	Emergency management and fire protection	Covers emergency plans and emergency preparedness programs that exist for emergencies and for non-routine conditions. This area also includes any results of participation in exercises.	▪ Conventional emergency preparedness and response ▪ Nuclear emergency preparedness and response ▪ Fire emergency preparedness and response
	Waste management	Covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. This area also covers the planning for decommissioning.	▪ Waste characterization ▪ Waste minimization ▪ Waste management practices ▪ Decommissioning plans
	Security	Covers the programs required to implement and support the security requirements stipulated in the regulations, the licence, orders, or expectations for the facility or activity.	▪ Facilities and equipment ▪ Response arrangements ▪ Security practices ▪ Drills and exercises

Safety and Control Area Framework			
Functional area	**Safety and control area**	**Definition**	**Specific areas**
	Safeguards and non-proliferation	Covers the programs and activities required for the successful implementation of the obligations arising from the Canada/ International Atomic Energy Agency (IAEA) safeguards agreements, as well as all other measures arising from the *Treaty on the Non-Proliferation of Nuclear Weapons*.	▪ Nuclear material accountancy and control ▪ Access and assistance to the IAEA ▪ Operational and design information ▪ Safeguards equipment, containment and surveillance ▪ Import and export
	Packaging and transport	Programs that cover the safe packaging and transport of nuclear substances to and from the licensed facility.	▪ Package design and maintenance ▪ Packaging and transport ▪ Registration for use
Other Matters of Regulatory Interest			
▪ Environmental assessment ▪ CNSC consultation – Indigenous ▪ CNSC consultation – other ▪ Cost recovery ▪ Financial guarantees ▪ Improvement plans and significant future activities ▪ Licensee public information program ▪ Nuclear liability insurance			

D. SAFETY AND CONTROL AREA RATING METHODOLOGY

Performance ratings used in this report are defined as follows:

Satisfactory (SA)

Safety and control measures implemented by the licensee are sufficiently effective. In addition, compliance with regulatory requirements is satisfactory. Compliance within the safety and control area or specific area meets requirements and the Canadian Nuclear Safety Commission (CNSC) expectations. Any deviation is only minor, and any issues are considered to pose a low risk to the achievement of regulatory objectives and the CNSC's expectations. Appropriate improvements are planned.

Below expectations (BE)

Safety and control measures implemented by the licensee are marginally ineffective. In addition, compliance with regulatory requirements falls below expectations. Compliance within the safety and control area or specific area deviates from requirements or CNSC expectations to the extent that there is a moderate risk of ultimate failure to comply. Improvements are required to address identified weaknesses. The licensee or applicant is taking appropriate corrective action.

Unacceptable (UA)

Safety and control measures implemented by the licensee are significantly ineffective. In addition, compliance with regulatory requirements is unacceptable and is seriously compromised. Compliance within the overall safety and control area or specific area is significantly below requirements or CNSC expectations or there is evidence of overall non-compliance. Without corrective action, there is a high probability that the deficiencies will lead to an unreasonable risk. Issues are not being addressed effectively, no appropriate corrective measures have been taken, and no alternative plan of action has been provided. Immediate action is required.

The following rating is no longer used by the CNSC. It is defined below for informational purposes only. This rating may appear in historic data.

Fully satisfactory (FS)

Safety and control measures implemented by the licensee are highly effective. In addition, compliance with regulatory requirements is fully satisfactory, and compliance within the safety and control area or specific area exceeds requirements and CNSC expectations. Overall, compliance is stable or improving, and any problems or issues that arise are promptly addressed.

E. SAFETY AND CONTROL AREA RATINGS

Table E-1: Safety and control area ratings for Cigar Lake Operation, 2016–20

Safety and control area	2016	2017	2018	2019	2020
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table E-2: Safety and control area ratings for McArthur River Operation, 2016–20

Safety and control area	2016	2017	2018	2019	2020
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table E-3: Safety and control area ratings for Rabbit Lake Operation, 2016–20

Safety and control area	2016	2017	2018	2019	2020
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table E-4: Safety and control area ratings for Key Lake Operation, 2016–20

Safety and control area	2016	2017	2018	2019	2020
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	FS	FS	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table E-5: Safety and control area ratings for McClean Lake Operation, 2016–20

Safety and control area	2016	2017	2018	2019	2020
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table E-6: Applicable SCA ratings for historic (remediated) sites, 2016–20

Safety and control area	Gunnar	Madawaska
Radiation protection	SA	SA
Conventional health and safety	SA	SA
Environmental protection	SA	SA

Table E-7: Applicable SCA ratings for decommissioned sites, 2016–20

Safety and control area	Lorado	Beaverlodge	Cluff Lake	Rayrock	Port Radium	Agnew Lake	Bicroft	Dyno	Elliot Lake	Denison and Stanrock	Deloro
Radiation protection	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA

F. FINANCIAL GUARANTEES

The following tables outline the financial guarantees, as of December 31, 2020, for the uranium mine, mill, historic, and decommissioned sites discussed in this report.

Table F-1: Operating Uranium Mines and Mills – financial guarantees:

Facility	Canadian dollar amount
Cigar Lake Operation	$61,790,000
McArthur River Operation	$42,100,000
Rabbit Lake Operation	$202,700,000
Key Lake Operation	$222,500,000
McClean Lake Operation	$107,241,000
Total	$636,331,000

Table F-2: Historic and Decommissioned Sites – financial guarantees:

Facility	Canadian dollar amount
Gunnar	Responsibility of provincial government
Madawaska	$4,041,472
Lorado	Responsibility of provincial government
Beaverlodge	Responsibility of provincial government
Cluff Lake	$3,496,920
Rayrock	Responsibility of federal government
Port Radium	Responsibility of federal government
Agnew Lake	Responsibility of provincial government
Bicroft	$2,691,000
Dyno	$1,871,543
Elliot Lake	$32,749,000
Denison & Stanrock	$2,480,000
Total	$47,329,935

G. WORKER DOSE DATA

Table G-1 shows the total number of nuclear energy workers (NEWs) monitored at each of the 5 uranium mines and mills for 2020. An individual who is required to work with a nuclear substance or in a nuclear industry is designated as a NEW if he or she has a reasonable probability of receiving an individual effective dose greater than the prescribed effective dose limit for a member of the public (i.e., 1 millisievert [mSv] in a calendar year).

Table G-1: Number of NEWs at uranium mines and mills, 2020

	Cigar Lake	McArthur River	Rabbit Lake	Key Lake	McClean Lake
Total NEWs	861	172	128	302	369

The following table compares the average and maximum individual effective dose for the 5 operating uranium mines and mills.

Table G-2: Radiation dose data for NEWs at uranium mines and mills, 2020

Facility	Average individual effective dose (mSv/year)	Maximum individual effective dose (mSv/year)	Regulatory limit
Cigar Lake Operation	0.38	2.82	**50 mSv/year**
McArthur River Operation	0.27	2.94	
Rabbit Lake Operation	0.70	2.93	
Key Lake Operation	0.35	2.11	
McClean Lake Operation	0.67	4.28	

Tables G-3 to G-7 show a 5-year trend (from 2016 to 2020) of the average and maximum effective annual doses to NEWs at the 5 uranium mines and mills. Each of these tables also identifies the maximum 5-year dose to an individual NEW at each uranium mine and mill. No radiation dose at any facility exceeded the regulatory effective dose limit during 2020.

Table G-3: Radiation dose data for NEWs, Cigar Lake Operation, 2016–20

Dose data	2016	2017	2018	2019	2020	Regulatory limit
Total NEWs	1,243	1,107	824	875	861	**N/A**
Average individual effective dose (mSv)	0.39	0.34	0.47	0.57	0.38	**50 mSv/year**
Maximum individual effective dose (mSv)	5.53	3.36	7.28	3.70	2.82	**50 mSv/year**
Maximum dose for an individual in current 5-year period (mSv) 2016–2020	19.43					**100 mSv/5-year dosimetry period**

Table G-4: Radiation dose data for NEWs, McArthur Rive Operation, 2016–20

Dose data	2016	2017	2018	2019	2020	Regulatory limit
Total NEWs	1,064	958	595	136	172	**N/A**
Average individual effective dose (mSv)	0.85	0.79	0.15	0.33	0.27	**50 mSv/year**
Maximum individual effective dose (mSv)	7.02	5.73	2.67	2.82	2.94	**50 mSv/year**
Maximum dose for an individual in current 5-year period (mSv) 2016–2020	13.65					**100 mSv/5-year dosimetry period**

Table G-5: Radiation dose data for NEWs, Rabbit Lake Operation, 2016–20

Dose data	2016	2017	2018	2019	2020	Regulatory limit
Total NEWs	739	153	166	119	128	**N/A**
Average individual effective dose (mSv)	0.85	0.4	0.46	0.75	0.70	**50 mSv/year**
Maximum individual effective dose (mSv)	4.95	1.56	1.7	2.73	2.93	**50 mSv/year**
Maximum dose for an individual in current 5-year period (mSv) 2016–2020	8.52					**100 mSv/5-year dosimetry period**

Table G-6: Radiation dose data for NEWs, Key Lake Operation, 2016–20

Dose data	2016	2017	2018	2019	2020	Regulatory limit
Total NEWs	837	684	481	260	302	**N/A**
Average individual effective dose (mSv)	0.62	0.66	0.19	0.27	0.35	**50 mSv/years**
Maximum individual effective dose (mSv)	5.37	5.39	2.02	1.64	2.11	**50 mSv/years**
Maximum dose for an individual in current 5-year period (mSv) 2016–2020	14.09					**100 mSv/5-year dosimetry period**

Table G-7: Radiation dose data for NEWs, McClean Lake Operation, 2016–20

Dose data	2016	2017	2018	2019	2020	Regulatory limit
Total NEWs	510	334	330	323	369	**N/A**
Average individual effective dose (mSv)	1.04	0.91	0.90	0.93	0.67	**50 mSv/year**
Maximum individual effective dose (mSv)	6.94	5.12	5.50	4.70	4.28	**50 mSv/year**
Maximum dose for an individual in current 5-year period (mSv) 2016–2020	20.49					**100 mSv/5-year dosimetry period**

H. RADIOLOGICAL ACTION LEVEL EXCEEDANCES REPORTED TO THE CNSC

Canadian Nuclear Safety Commission (CNSC) staff reviewed and were satisfied with the remedial actions taken by the licensees for the radiological action level exceedances reporting in table H-1. Table H-1 notes the details of each event, the corrective actions taken by the licensee and the CNSC's associated significance ratings. Table H-2 lists the rating definitions and examples of safety significance across fuel cycle facilities.

Table H-1: Uranium mines and mills – exceedances of radiological action levels in 2020

Facility	Action level exceedance	Corrective action	Significance rating
Cigar Lake Operation	In September 2020, Cameco reported that a worker had exceeded the weekly action level of 1 mSv. A welder was repairing cracks in the base of the 480-clarifier tank while working under a radiation work permit and wearing a welding powered air purifying respirator. During these activities, the monitoring pump failed after 49 minutes and the welder used a second pump being worn by the watchperson initially to finish the work for the day. When both pump filters were analyzed, the first pump indicated a potential unprotected exposure of around 1.8 mSv. Urine sampling was commenced and assessed by corporate health physicists. A maximum exposure of 0.68 mSv was allocated based on the urine samples, which in combination with other smaller exposures received by the worker in previous days resulted in his 7-day total being around 1.17 mSv.	The investigation for this event resulted in 9 corrective actions pertaining to proper ventilation setup, improved hazard recognition, proper use of dust monitoring devices, and procedural changes ensure timely follow up monitoring that may be required. CNSC staff reviewed the corrective actions and found them to be acceptable.	Medium
McArthur River Operation	None reported	N/A	N/A

Facility	Action level exceedance	Corrective action	Significance rating
Rabbit Lake Operation	None reported	N/A	N/A
Key Lake Operation	None reported	N/A	N/A
McClean Lake Operation	None reported	N/A	N/A

Table H-2: CNSC Radiation protection rating definitions and examples

Radiation protection		
Safety significance	**Definition**	**Fuel cycle facility specific examples**
High	Exposures to multiple workers in excess of regulatory limits. Widespread contamination to several persons or to a place.	Incident that results in, or has reasonable potential for, a worker to exceed regulatory limits. Examples: ▪ nuclear energy worker (NEW) exceeding 50 millisievert (mSv)/year or 100 mSv/5 years ▪ non-NEW exceeding 1 mSv
Medium	Exposure to a worker in excess of regulatory limits. An incident that would result in a licensee exceeding action level. Limited contamination that could affect a few persons or a limited area.	Incident that results in or has reasonable potential to exceed an action level. Example: ▪ doses to workers of 1 mSv/week or 5 mSv/quarter
Low	Increased dose below reportable limits. Contamination that could affect a worker.	Incident that results in, or has reasonable potential to exceed, the highest administrative level.

I. REPORTABLE RELEASES TO THE ENVIRONMENT (SPILLS) AND CNSC RATING DEFINITIONS

Canadian Nuclear Safety Commission (CNSC) staff reviewed and were satisfied with the remedial actions taken by the licensees in response to the spills presented in table I-1 and concluded that these spills resulted in no residual impacts to the environment. Table I-1 notes the details of each spill, the corrective actions taken by the licensee and the CNSC's spill significance ratings. Table I-2 lists the spill rating definitions and gives examples of safety significance across fuel cycle facilities.

Table I-1: Uranium mines and mills reportable releases to the environment, 2020

Facility	Details	Corrective actions	Significance rating
Cigar Lake Operation	No reportable releases in 2020.	N/A	N/A
McArthur River Operation	No reportable releases in 2020.	N/A	N/A
Rabbit Lake Operation	No reportable releases in 2020.	N/A	N/A
Key Lake Operation	On March 17, 2020, approximately 3,000 litres of untreated water overflowed from the raw water tank within the reverse osmosis water treatment plant building and was released to the ground outside of the building.	Spilled material was collected and placed on the Gaertner special waste pad. The uninterruptible power supply affecting the system communications at the reverse osmosis plant was repaired. In addition, a management of change was initiated so that if communication is lost for greater than 1 minute the raw water well pumps will kick out to prevent overflow.	Low
Key Lake Operation	On October 27, 2020, approximately 12,000 litres of untreated water was released from the mine shop building to the ground. When filling a hydrovac truck from the potable supply line and left was left open which overflowed the truck, wash bay sumps and ultimately flowed outside of the building.	The water froze on surface and was collected and transferred to the above ground tailings management facility. Basic cause investigation was completed and workers were provided coaching on the requirements to remain with equipment that is in operation or that is being loaded or unloaded at all times.	Low

Facility	Details	Corrective actions	Significance rating
McClean Lake Operation	On February 18, 2020, the Sulphuric Acid Plant operator began offloading a trailer when ~360 kg of molten sulphur were released through an improperly sealed discharge valve. The operator had slowly opened the offloading valve assembly to check for leaks, and none was apparent. He went into the Acid Plant to retrieve a tool. When he returned, sulphur was discharging onto the ground. He connected the offloading hose and stopped the flow.	The frozen sulphur was scraped up and disposed of in the contaminated landfill. In response to the release, Orano implemented following corrective actions: ▪ The Sulphuric Acid Plant operator was coached to ensure that the truck driver is present when the offload is performed, as per standard practice. ▪ Orano engaged with NRT on potential valve improvements. NRT responded that the style of valves cannot be changed, but they are considering implementing annual replacement. CNSC staff were satisfied with the corrective actions taken.	Low
McClean Lake Operation	On February 21, 2020, operator of the solvent extraction circuit discovered a discharge of ethylene glycol underneath the ammonia bullet tanks. A vent valve on top of the vaporizer was partially open, which allowed the glycol to leak out of the piping through the uncapped vent. The probable cause was a falling ice chunk that hit the valve handle.	The contaminated snow and soil were cleaned-up and disposed of in the Sue C contaminated landfill. Orano implemented following corrective actions: ▪ The open vent valve was closed and the vent was capped to prevent a recurrence. ▪ Additionally, the vent and drain valves on all of the ammonia vaporizers were capped. CNSC staff were satisfied with the corrective actions taken.	Low
McClean Lake Operation	On June 11, 2020, maintenance personnel removed the temperature sensors from the 3 anhydrous ammonia vaporizers to calibrate in the maintenance shop. When the vaporizer. A sensor was removed, liquid anhydrous ammonia was released through the fitting. The	Affected soil was scraped and placed in the hydrocarbon landfarm. Soil samples confirmed low concentrations downstream and downwind. Orano implemented following corrective actions:	Low

Facility	Details	Corrective actions	Significance rating
	personnel immediately left the area and paged the ERT. The ERT use water monitors to control the vapor plume, then isolated the leak. Approximately 34.4m^3 of anhydrous ammonia was released. The ammonia rich water reported to the site run off pond and then the TMF.	▪ The fitting that was the source of the release was plugged. ▪ The roadway where the water flowed to the ditch. ▪ A third party review of the ammonia storage system provided recommendations bringing the ammonia system up to code, implement best practices, and develop benchmark processes for working on or near the anhydrous ammonia bullet tanks. ▪ A long-term groundwater monitoring program is being developed. ▪ CNSC staff were satisfied with the corrective actions taken.	
McClean Lake Operation	July 11, 2020, a hole in a pipe leading out of the 93% acid tank released approximately 457 m^3 into the concrete secondary containment berm and the acid plant. When the affected areas were inspected, 3 small holes were found that allowed acid to report to an underground void space of approximately 3 m^3.	A third party concrete specialist repaired all areas of the secondary containment berm and the acid plant floor. Orano took following corrective action: ▪ The acid tank and associated piping was thickness tested and repaired/replaced, where necessary. CNSC staff were satisfied with the corrective actions taken.	Low

Table I-2: CNSC environmental protection spill rating definitions and examples

Environmental protection		
Safety significance	**Definition**	**Fuel cycle facility-specific examples**
High	Nuclear or hazardous substances being released to the environment exceeding regulatory limits (including public exposure) or that results in significant impact to the environment.	Incident that results in, or has reasonable potential to have, a significant or moderate impact or extensive future remediation. Examples: ▪ impairment of ecosystem functions ▪ effluent licence limit exceedance ▪ spill into fish bearing water ▪ fish kill
Medium	Nuclear or hazardous substances being released to the environment exceeding action levels (including public exposure) or that result in impact to the environment outside the licensing basis.	Incident that results in, or has reasonable potential to have, a minor impact or that requires some future remediation. Examples: ▪ effluent action level exceedance ▪ spills to environment (including atmosphere) with short-term or seasonal impacts
Low	Release of hazardous or nuclear substances to the environment below regulatory limits.	Incident that results in, or has reasonable potential to have, a negligible impact. Examples: ▪ effluent administrative level-exceedance ▪ spills to environment (including atmosphere) with no future impacts

J. ENVIRONMENTAL ACTION LEVEL AND REGULATORY LIMIT EXCEEDANCES REPORTED TO THE CNSC

Canadian Nuclear Safety Commission (CNSC) staff reviewed and were satisfied with the corrective actions taken by the licensees for the environmental action level and regulatory exceedances reporting in table J-1. Table J-1 notes the details of each event, the corrective actions taken by licensees and the CNSC's associated significance ratings. Table J-2 lists the rating definitions and examples of safety significance across fuel cycle facilities.

Table J-1: Uranium mines and mills – environmental action level exceedances, 2020

Facility	Action level or regulatory limit exceedance	Corrective action	Significance rating
Cigar Lake Operation	None reported	N/A	N/A
McArthur River Operation	None reported	N/A	N/A
Rabbit Lake Operation	None reported	N/A	N/A
Key Lake Operation	None reported	N/A	N/A
McClean Lake Operation	On March 28, 2020, Orano reported that an effluent composite sample collected at the JEB Water Treatment Plant exceeded the interim selenium action level in the McClean Lake Operation Environmental Code of Practice (0.078 mg/L).	Orano intends to continue releasing effluent that periodically exceeds the interim action level. Subsequent exceedances will be tracked and reported in the quarterly and annual reports, in conjunction with the corresponding reporting of selenium mass loadings.	Low

Table J-2: CNSC Environmental protection rating definitions and examples

Environmental protection		
Safety significance	**Definition**	**Fuel cycle facility-specific examples**
High	Nuclear or hazardous substances being released to the environment exceeding regulatory limits (including public exposure) or that results in significant impact to the environment.	Incident that results in, or has reasonable potential to have, a significant or moderate impact or extensive future remediation. Examples: ▪ impairment of ecosystem functions ▪ effluent licence limit exceedance ▪ spill into fish bearing water ▪ fish kill
Medium	Nuclear or hazardous substances being released to the environment exceeding action levels (including public exposure) or that result in impact to the environment outside the licensing basis.	Incident that results in, or has reasonable potential to have, a minor impact or that requires some future remediation. Examples: ▪ effluent action level exceedance ▪ spills to environment (including atmosphere) with short-term or seasonal impacts
Low	Release of hazardous or nuclear substances to the environment below regulatory limits.	Incident that results in, or has reasonable potential to have, a negligible impact. Examples: ▪ effluent administrative level-exceedance ▪ spills to environment (including atmosphere) with no future impacts

K. LOST-TIME INJURIES

A lost-time injury (LTI) is a workplace injury that results in the worker being unable to return to work for a period of time. Table K-1 outlines the LTI's reported in the 2020 reporting period at the 5 operating uranium mines and mills. Table K-2 lists the rating definitions.

Table K-1: Uranium mines and mills – Lost-time injuries (LTIs), 2020

Facility	Incident	Corrective action	Significance rating
Cigar Lake Operation	No LTIs were reported	N/A	N/A
McArthur River Operation	No LTIs were reported	N/A	N/A
Rabbit Lake Operation	No LTIs were reported	N/A	N/A
Key Lake Operation	No LTIs were reported	N/A	N/A
McClean Lake Operation	On March 16, 2020, a worker was drilling a 5/8 hole in a steel beam with a hand drill when the drill bit jammed. The drill rotated and injured the worker's right hand.	Immediate corrective action was to replace the normal hand drill with one that has an anti-rotation mechanical overload clutch. In addition, Orano used the incident to reaffirm use of field level hazard assessments within Orano's "Pathway to Safety – STOP, THINK AND ACT" with employees through routine safety huddles.	Medium

Facility	Incident	Corrective action	Significance rating
McClean Lake Operation	On May 13, 2020, a worker was kneeling down while cleaning the #1 calciner hearth. As the worker stood up, their right knee locked.	Orano took action and encouraged workers to work collaboratively with their supervisors to ensure that they are doing tasks that will not put their health in jeopardy. Orano followed up with communication to all employees and supervisors regarding the modified work program including the ability to accommodate workers for occupational and non-occupational injuries.	

Table K-2: CNSC Conventional health and safety rating definitions

Safety significance	Definition
High	Fatality or serious injury
Medium	Serious injury or lost-time accident
Low	Minor injury

L. ANNUAL RELEASES OF RADIONUCLIDES TO THE ENVIRONMENT

Introduction

Operating uranium mines and mills in northern Saskatchewan have process waters, which require capture, treatment and release through a final point of control. This appendix represents the total annual release of relevant radionuclides from these facilities from 2016 through 2020.

Releases for total uranium are reported as kilograms (kg) while releases of uranium-238 progeny are reported in megabecquerels (MBq).

CNSC staff have commenced publishing annual releases of radionuclides to the environment from nuclear facilities on the CNSC Open Government Portal.

Liquid releases to surface waters

The uranium mines and mills in northern Saskatchewan have process waters requiring interception, collection and treatment prior to release. Total uranium and a number of uranium-238 progeny are monitored at the operating uranium mines and mills in northern Saskatchewan. The total annual load of relevant radionuclides from these facilities is provided in table L.1.

Table L-1: Total annual load of uranium (kg) and relevant uranium-238 progeny (MBq) released in liquid effluent to surface waters from the northern Saskatchewan uranium mines and mills from 2016 to 2020

Facility and Year	Uranium (kg)	Thorium-230 (MBq)	Radium-226 (MBq)	Lead-210 (MBq)	Polonium-210 (MBq)
Cigar Lake Mine					
2016	2.36	4.21	2.71	8.69	6.41
2017	0.72	4.57	3.05	9.27	4.86
2018	0.18	3.61	2.33	7.21	3.38
2019	0.24	3.36	2.81	6.72	12.93
2020	0.07	3.66	2.47	7.31	11.88
McArthur River Mine – Mine Water Treatment Plant Discharge					
2016	12.7	26.7	151.6	51.6	100.5
2017	12.9	24.5	161.5	49.0	96.4
2018	15.7	23.7	150.9	47.3	22.2
2019	20.8	23.7	125.8	47.4	12.2
2020	19.6	23.4	114.9	53.2	11.9
McArthur River Mine – Shaft #3 Discharge					
2016	0.0762	N/A	10.80	N/A	N/A
2017	0.1953	2.14	20.64	4.29	1.07
2018	0.2992	1.18	37.01	2.35	0.59
2019	0.3574	1.47	42.27	2.94	0.73
2020	0.3820	1.76	43.63	3.53	1.04
Rabbit Lake Mine and Mill					
2016	326.9	89.9	32.9	359.6	89.9
2017	274.0	117.0	25.6	311.9	78.0
2018	135.8	84.4	26.4	337.5	84.4
2019	106.1	78.6	25.2	196.6	78.6
2020	80.3	75.6	24.0	75.6	32.1
Key Lake Mill – Treated Mill Effluent Discharge					
2016	4.8	77.0	41.7	53.9	15.4
2017	7.3	69.2	61.8	23.8	7.7
2018	17.9	31.5	95.6	27.0	7.3
2019	29.7	24.5	110.1	24.5	7.3
2020	38.4	29.6	53.3	29.6	13.3
Key Lake Mill – Reverse Osmosis Plant Discharge					
2016	15.3	N/A	23	N/A	N/A
2017	6.5	N/A	23	N/A	N/A
2018	8.5	N/A	25	N/A	N/A
2019	14.1	N/A	24	N/A	N/A
2020	27.3	N/A	24	N/A	N/A
McClean Lake Mill – Combined release from the JEB and Sue Water Treatment Plants					
2016	6.5	20.2	12.0	122.1	61.3
2017	5.7	18.8	11.7	88.5	30.8
2018	9.9	21.2	13.5	86.1	32.7
2019	5.9	17.1	10.3	33.3	37.0
2020	4.9	15.6	15.9	31.2	21.7

M. LINKS TO WEBSITES

Benefits from Northern Mining

Cameco Corporation

Cameco Corporation - Beaverlodge

Cameco Corporation – Cigar Lake Operation

Cameco Corporation – McArthur River/Key Lake Operations

Cameco Corporation – Rabbit Lake Operation

CNSC Fact Sheet on natural background radiation

CNSC Independent Environmental Monitoring Program

CNSC Indigenous Engagement

Eastern Athabasca Regional Monitoring Program

Health Canada's Guidelines for Canadian Drinking Water Quality

National Pollutant Release Inventory

Northern Saskatchewan Environmental Quality Committee

Orano Canada Inc.

Ontario's Surface Water Quality Objectives

Saskatchewan Environmental Quality Guidelines

N. LIST OF INDIGENOUS COMMUNITIES

List of Indigenous communities and groups whose traditional and/or treaty territories are in proximity to:

Saskatchewan Sites

Athabasca Chipewyan First Nation

Birch Narrows Dene Nation

Black Lake First Nation

Buffalo River Dene Nation

Clearwater River Dene Nation

English River First Nation

Fond du Lac First Nation

Hatchet Lake First Nation

Lac La Ronge Indian Band

Métis Nation-Saskatchewan

Pinehouse Kineepik Métis

Prince Albert Grand Council

Ya'thi Néné Lands and Resources Office

Elliot Lake Area Sites

Atikameksheng Anishnabek

Métis Nation of Ontario (Region 4)

Mississauga First Nation

Sagamok Anishnawbek Nation

Serpent River First Nation

Thessalon First Nation

Whitefish River First Nation

Southern Ontario Area Sites

Métis Nation of Ontario (Region 6 and 8)

Mohawks of the Bay of Quinte

Williams Treaties First Nations, which include:

- Alderville First Nation
- Chippewas of Beausoleil First Nation
- Chippewas of Georgina Island First Nation
- Chippewas of Rama First Nation
- Curve Lake First Nation
- Hiawatha First Nation
- Mississaugas of Scugog Island First Nation

Northwest Territories Area Sites

Port Radium Mine (Sahtu settlement area)

- Déljnę First Nation
- Rayrock Mine (Tlicho settlement area)
- Dechi Laot'i First Nations
- Dog Rib Rae
- Gameti First Nation
- Wha Ti First Nation

O. ACRONYMS

ACFN	Athabasca Chipewyan First Nation
AJES	Athabasca Joint Engagement and Environment Subcommittee
ALARA	As Low As Reasonably Achievable
ALTMA	Agnew Lake Tailings Management Area
AREVA	AREVA Resources Canada Inc. (now Orano Canada Inc.)
BCP	Business Continuity Plan
BE	Below Expectations
Bq/L	Becquerels per litre
Bq/m^3	Becquerels per cubic meter
Cameco	Cameco Corporation
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
CLEANS	Cleanup of Abandoned Northern Sites
CMD	Commission Member Document
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
COPC	Contaminants of Potential Concern
DPM	Disintegrations Per Minute
EARMP	Eastern Athabasca Regional Monitoring Program
ECCC	Environment and Climate Change Canada
ENDM	Ministry of Energy, Northern Development and Mines
EQC	Environmental Quality Committee
EPR	Environmental Protection Report
ERA	Environmental Risk Assessments
EWL	EWL Management Ltd.
FS	Fully Satisfactory
HHERA	Human Health and Ecological Risk Assessment
HHRA	Human Health Risk Assessment
IAEA	International Atomic Energy Agency
ICMM	International Council on Mining and Metals
ICP	Institutional Control Program
ICRP	International Commission on Radiological Protection

IEMP	Independent Environmental Monitoring Program
IMA	Industrial Mine Area
INAC	Indigenous and Northern Affairs Canada
JEB	John Everett Bates
Kg	Kilograms
LCH	Licence Conditions Handbook
LLRD	Long-lived Radioactive Dust
LTI	Lost-Time Injury
mASL	Metres Above Sea Level
MBq	megabecquerels
MDMER	*Metal and Diamond Mining Effluent Regulations*
MECP	Ministry of the Environment, Conservation and Parks
mg/L	milligram per litre
MMER	*Metal Mines Effluent Regulations*
MN-S	Metis Nation-Saskatchewan
Mkg	Million kilograms
mSv	Millisievert
mSv/hr	Macrosievert per hour
NDMNRF	Ministry of Northern Development, Mines, Natural Resources and Forestry
NEW	Nuclear Energy Workers
NORM	Naturally Occurring Radioactive Material
NSCA	*Nuclear Safety and Control Act*
NPRI	*National Pollutant Release Inventory*
NRT	Northern Resource Trucking
NTR	Northern Transport Route
Orano	Orano Canada Inc.
p-mSv	Person-millisieverts
PAD	Personal Alpha Dosimeter
PFP	Participant Funding Program
PPE	Personal Protective Equipment
PM	Preventative Maintenance
RAL	Rio Algom Limited

RCOP	Radiation Code of Practice
REGDOC	Regulatory Document
RnG	Radon Gas
RnP	Radon Progeny
SA	Satisfactory
SAMP	Selenium Adaptive Management Plan
SCA	Safety and Control Area
SO_2	Sulphur Dioxide
SRC	Saskatchewan Research Council
TID-EP	Technical Information Document – Environmental Performance
TMA	Tailings Management Area
TMF	Tailings Management Facility
TRIR	Total Recordable Incident Rate
TSP	Total Suspended Particulate
TSS	Total Suspended Solids
U	Uranium
UA	Unacceptable
UPS	Uninterruptible Power Supply
WNSL	Waste Nuclear Substance Licence
WTP	Water Treatment Plant
YCA	Young's Creek Area