Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

CMD 25-H12.1-Ref14

Date: 2026-01-12

Reference from NexGen Energy Ltd.

Référence de NexGen Energy Ltd

In the matter of

À l'égard de

NexGen Energy Ltd.

NexGen Energy Ltd.

Licence application to prepare a site for and construct its Rook 1 uranium mine and mill project

Demande de permis concernant la préparation de l'emplacement et la construction de son projet de mine et d'usine de concentration d'uranium Rook I

Commission Public Hearing
Part 2

Audience publique de la Commission
Partie 2

February 9-12, 2026

Les 9 - 12 février 2026

Document ID: QQQVZZNDK725-166150894-9631

Canada

Volume 2, Part 4: Rook I Project Environmental Impact Statement Baseline Annexes

Rook I Project

Environmental Impact Statement

Annex VI: Terrain and Soils Baseline Report

TERRAIN AND SOILS BASELINE REPORT FOR THE ROOK I PROJECT

Prepared for:

NexGen Energy Ltd.

Prepared by:

Golder Associates Ltd.

March 2022

Executive Summary

This terrain and soils baseline report is a component of a comprehensive baseline program that documents the natural and socio-economic environments in the anticipated area of the Rook I Project (Project). The terrain and soils baseline program was undertaken to provide context from which effects on terrain and soils from the Project could be assessed in the Rook I Environmental Impact Statement (EIS).

A maximum disturbance area was used to account for potential changes to the Project footprint during continuing design activities so that adverse effects are not underestimated. The maximum disturbance area for terrain and soils is approximately 913 ha, and the spatial boundary was delineated to include the Project footprint plus a 100 m buffer around the outermost facilities, as well as the associated access road plus by a 100 m buffer. A local study area (LSA) was established to capture the combined potential direct and indirect effects of the Project on terrain and soils resources. The LSA is approximately 4,560 ha and is defined by a 1 km buffer around the maximum disturbance area.

Terrain and soils field programs, including terrain and soil classification and soil chemistry analysis, were completed in 2018 and 2019. Information from the terrain and soils field programs was used to determine soil mapping and map unit designation for the maximum disturbance area, and soil suitability for reclamation and soil sensitivities for the LSA.

The objectives of the terrain and soils baseline study, to obtain information on terrain and sensitive terrain, characterize existing soil quality and distribution and determine baseline soil chemistry and evaluate soil sensitivities within the maximum disturbance area and LSA, have been met. The data and subsequent evaluation of the terrain and soils present in the maximum disturbance area meet the requirements for submission under the *Environmental Assessment Act* (Saskatchewan) and the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) following the Generic Guidelines for the Preparation of an Environmental Impact Statement Pursuant to CEAA 2012.

Soil sensitivities within the maximum disturbance area and LSA were determined, and included sensitivity to erosion, acidification, compaction, and potential for permafrost. Uppermost soil texture as well as percent slope and slope length landscape attributes were used to assess water erosion potential with ratings adapted from Transportation Association of Canada guidelines (TAC 2005). Water erosion potential for most soils was Low, based on the dominantly sandy and loamy sand texture. Wind erosion ratings for dominant mineral soil subgroups were defined utilizing textural classes for the uppermost mineral horizon and a dimensionless index described by Coote and Pettapiece (1989). Generally, the wind erosion risk is High based on sandy textured mineral upper soil horizons. Soils with Low wind erosion ratings were associated with organic horizons. Wind erosion potential for organics was interpreted using guidance from Campbell et al. (2002).

Assessments of the soil sensitivity to acidification were evaluated using the chemical criteria from Holowaychuk and Fessenden (1987). Within the maximum disturbance area and LSA, the upland landscape positions containing well-drained and sandy textured soils were found to be most sensitive to acidification. Wetlands and Organic soils (within bogs, fens, and swamps) throughout the LSA were found to have a lower sensitivity to acidification. Permafrost potential was evaluated for each soil subgroup based on drainage, soil texture, and topography.

Brunisolic soils are the dominant subgroups in the maximum disturbance area and LSA and were found to have a Low permafrost potential rating. Organic soils were found to have a Low to Moderate potential to contain permafrost. Soil compaction potential was evaluated based on soil texture and soil moisture regime as outlined in the land management handbook *Developing Timber Harvesting Prescriptions to Minimize Site Degradation* (Lewis et al. 1989). Brunisolic and Gleysolic soils in the Project were determined to have Low sensitivity to compaction under moist soil conditions.

The results indicate the terrain in most of the maximum disturbance area and LSA is composed of undulating to hummocky upland landscape with high relief that is very stony at surface. Soil inspections during the field programs indicate that the maximum disturbance area and LSA predominantly consist of loamy sand textured soils formed from glaciofluvial parent material and outwash depositional settings. Soils were predominantly classified as coarse-grained Brunisolic soils. In topographically lower areas, Gleysolic and Organic soil orders were found. Reclamation suitability was assessed using the soil quality criteria from Alberta Agriculture (1987), and the suitability of the upper lift mineral soils is rated as Poor (Section 4.2.4, Soil Suitability for Reclamation) due to the general soil profile texture within the maximum disturbance area and LSA. Soil chemistry results from the field programs indicated that concentrations of metals within the soil do not exceed the Soil Quality Guidelines for the Protection of Environmental and Human Heath, and radionuclide analysis identified no values exceeding the Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials.

If referencing this report, please use for the following citation:

Golder (Golder Associates Ltd.). 2022. Terrain and Soils Baseline Report for the Rook I Project. Prepared for NexGen Energy Ltd.

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FIGURES

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Abbreviation and Units of Measure

Abbreviations	Definition
ALS	Australian Laboratory Services
CanSIS	Canadian Soil Information System
CCME	Canadian Council of Ministers of the Environment
CEAA 2012	*Canadian Environmental Assessment Act, 2012*
CEC	cation exchange capacity
EC	electrical conductivity
EXP	exposure area
GPS	Global Positioning System
LSA	local study area
NexGen	NexGen Energy Ltd.
pH	potential of hydrogen
Project	Rook I Project
REF	reference area
SAR	sodium adsorption ratio
SIL1	Survey Intensity Level 1
SIL2	Survey Intensity Level 2
SMU	soil map unit
SRC	Saskatchewan Research Council
TLU	Traditional Land Use

Units and Symbols	Definition
%	percent
°C	degrees Celsius
<	less than
>	greater than
Bq/g	becquerels per gram
cm	centimetre
dS/m	decisiemens per metre
ha	hectare
km	kilometre
m	metre
mEq	milliequivalents
mg/L	milligrams per litre

1.0 INTRODUCTION

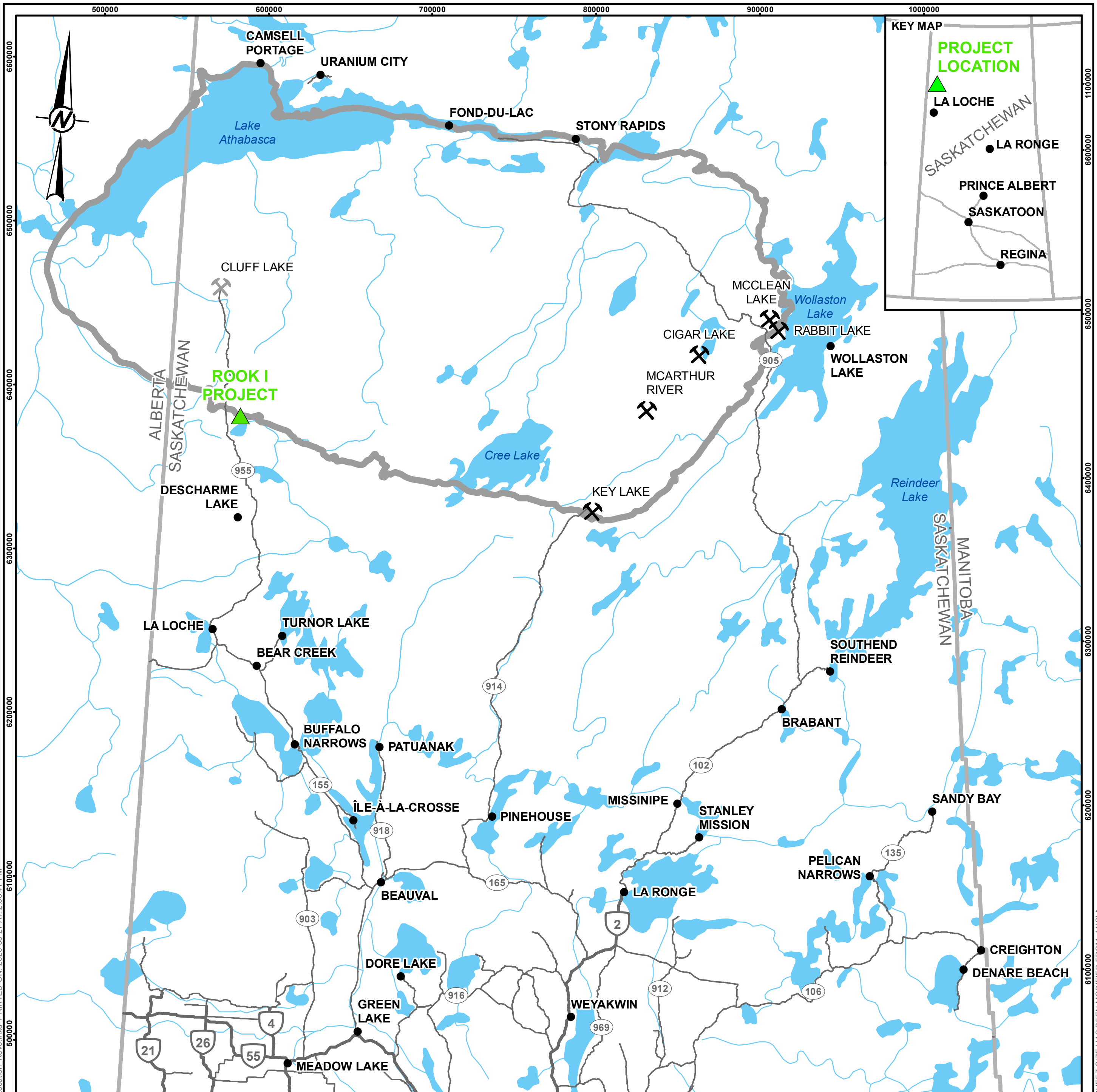
The Rook I Project (Project) is a proposed new uranium mining and milling operation that is 100% owned by NexGen Energy Ltd. (NexGen). The Project would be located in northwestern Saskatchewan, approximately 40 km east of the Saskatchewan-Alberta border, 130 km north of the town of La Loche, and 640 km northwest of the city of Saskatoon (Figure 1). The Project would reside within Treaty 8 territory and within the Métis Homeland. At a regional scale, the Project would be situated within the southern Athabasca Basin adjacent to Patterson Lake, and along the upper Clearwater River system (Figure 2). Access to the Project would be from an existing road off Highway 955. The Project would include underground and surface facilities to support the extraction and processing of uranium ore from the Arrow deposit, a land-based, basement-hosted, high-grade uranium deposit.

The terrain and soils baseline report represents a component of a comprehensive baseline program that documents the natural and socio-economic environments in the anticipated area of the Project. The terrain and soils baseline program was undertaken to provide context from which Project environmental terrain and soil effects could be assessed in the Environmental Impact Statement (EIS).

Since exploration at the Project commenced in 2013, NexGen has engaged regularly and established relationships with local First Nation and Métis Groups (collectively referred to as Indigenous Groups) and northern communities, specifically those closest and with greatest access to the proposed Project. NexGen respects the rights of Indigenous Peoples and the unique relationship Indigenous Peoples have with the environment, and recognizes the importance of full and open discussion with interested or potentially affected Indigenous communities regarding the development, operation, and decommissioning of the proposed Project. Engagement activities to date, as well as future planned engagement activities, reflect the value NexGen places on meaningful engagement with Indigenous and northern communities who could be potentially affected by the proposed Project. Engagement mechanisms have included, but are not limited to: meetings with leadership, workshops and community information sessions, Project site tours, establishing Joint Working Groups to support the gathering and incorporation of Indigenous and Local Knowledge throughout the Environmental Assessment (EA) process, and providing funding for Traditional Land Use (TLU) Studies[1] to understand how the proposed Project may interact with the Indigenous communities' traditional use of the anticipated area of the Project.

Feedback received during engagement activities was documented for contribution to the EIS for the Project; examples of feedback received include discussion of concerns, interests, potential adverse effects, mitigation, and design alternatives. Many baseline studies were initiated in advance of formal engagement on the EA for the Project; however, engagement during the execution of baseline studies has helped inform the understanding of baseline conditions and confirmed components of the natural and socio-economic environments that required study. A summary of feedback related to the terrain and soils baseline program is presented in Appendix A Joint Working Group Feedback Applicable to Terrain and Soils Baseline.

[1] Traditional Land Use (TLU) Studies include all land use studies developed by the Project's affected Indigenous Groups, including Traditional Land Use and Occupancy studies, Traditional Knowledge and Use studies, and Indigenous Rights and Knowledge studies, henceforth referred collectively as TLU Studies.



LEGEND

- POPULATED PLACE
- URANIUM MINING FACILITY (ACTIVE)
- URANIUM MINING FACILITY (DECOMMISSIONED)
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- WATERCOURSE
- WATERBODY
- ATHABASCA BASIN BOUNDARY
- PROJECT LOCATION

0 100 200

1:3,500,000 KILOMETRES

REFERENCE(S)

1. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 12 DATUM: NAD 83

CLIENT

NexGen Energy Ltd.

PROJECT

ROOK I PROJECT

TITLE

LOCATION OF THE ROOK I PROJECT, SASKATCHEWAN

CONSULTANT

GOLDER

YYYY-MM-DD	2020-03-27
DESIGNED	SS
PREPARED	NO/AK
REVIEWED	JMC
APPROVED	MM

PROJECT NO.	PHASE	REV.	FIGURE
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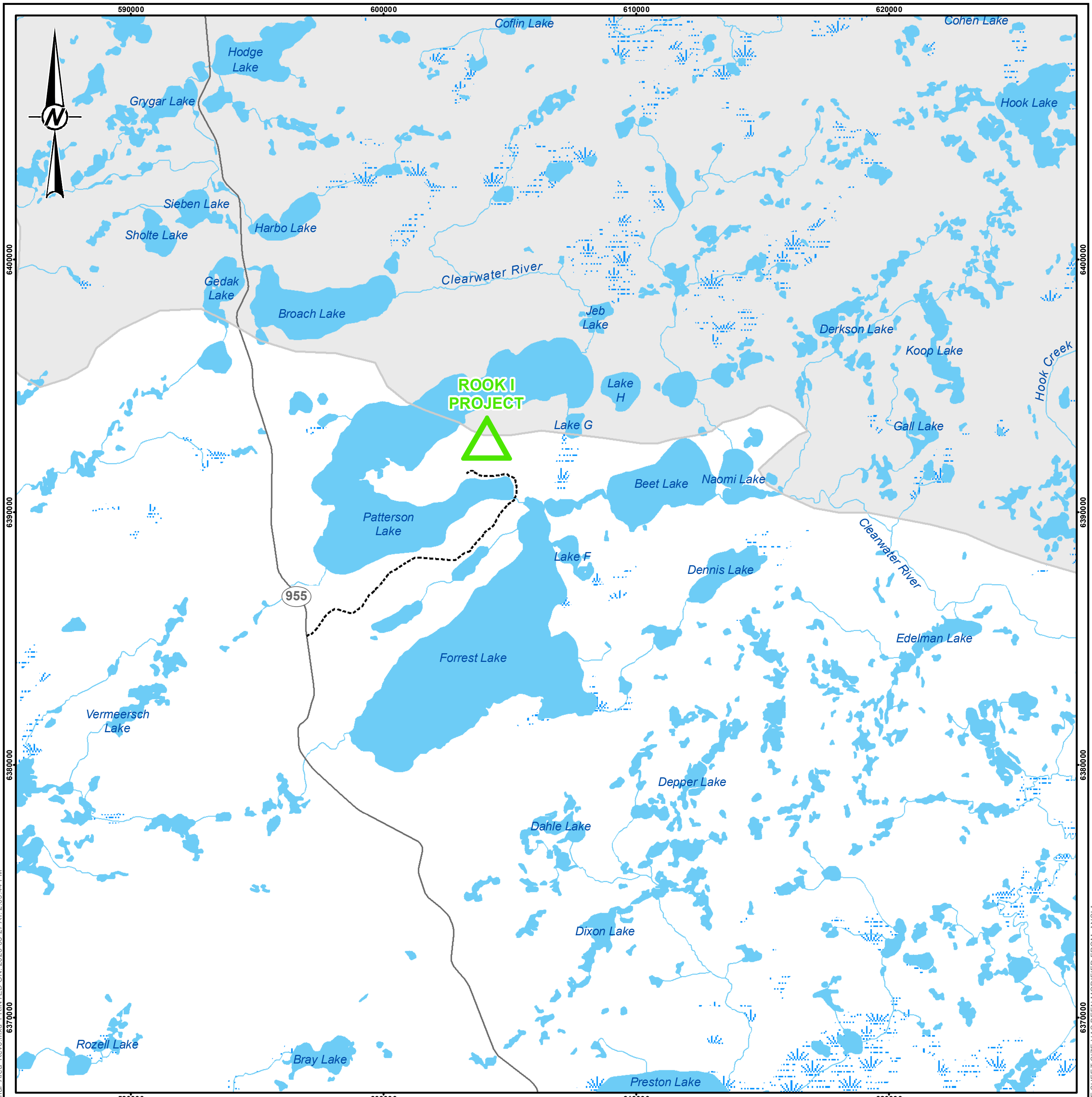

LEGEND

- SECONDARY HIGHWAY
- WATERCOURSE
- WATERBODY
- WETLAND
- ATHABASCA BASIN
- PROJECT LOCATION
- EXISTING ACCESS ROAD

0 5,000 10,000

1:225,000 METRES

REFERENCE(S)

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PROJECTION: UTM ZONE 12 DATUM: NAD 83

CLIENT

NexGen Energy Ltd.

PROJECT

ROOK I PROJECT

TITLE

REGIONAL AREA OF THE ROOK I PROJECT

CONSULTANT

GOLDER

YYYY-MM-DD	2020-03-27
DESIGNED	JMC
PREPARED	NO/AK
REVIEWED	JMC
APPROVED	MM

PROJECT NO.	PHASE	REV.	FIGURE
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2.0 STUDY OBJECTIVES

A terrain and soils baseline study was completed to describe the existing terrain and soils conditions prior to potential development of the Project. This study describes the existing terrain distribution, and soil distribution and conditions. Terrain and soil distribution refers to the amount or abundance and spatial configuration of terrain and soil. Soil conditions (i.e., quality) are defined as the potential for compaction, rutting, erosion, and admixing, as well as sensitivity to acidification and dust deposition. Soil conditions affect the capability of soil to support plants and functionally effective vegetation ecosystems and associated wildlife habitats.

The objectives of the 2018 and 2019 terrain and soils baseline program were to:

- obtain information on terrain and sensitive terrain within the maximum disturbance area and local study area (LSA);
- characterize existing soil quality and distribution within the maximum disturbance area and LSA; and
- determine baseline soil chemistry and evaluate soil sensitivities within the maximum disturbance area and LSA.

3.0 STUDY AREAS

The proposed Project is located within the Firebag Hills Landscape Area, which is within the Mid-Boreal Upland Ecoregion of the Boreal Plain Ecozone of Saskatchewan (Acton et al. 1998). The Firebag Hills Landscape Area consists of mainly gently to strongly rolling morainic plains extending as far south as the Clearwater River Valley, east to the Alberta-Saskatchewan border, north past Patterson Lake, and east to the Boreal Shield Ecozone (Acton et al. 1998).

A maximum disturbance area was used to account for potential changes from the Project during continuing design activities so that adverse effects are not underestimated (i.e., the maximum disturbance area is larger than the Project footprint). The maximum disturbance area represents the smallest scale of assessment and an area where the potential direct effects of the proposed Project on terrestrial components can be assessed accurately and precisely. For the Project, the maximum disturbance area contains existing disturbance from Rook I exploration activities, the proposed Project footprint (e.g., mill, waste rock management area, effluent treatment facility, camp, airstrip, and upgraded access road), a 100 m buffer around the outermost Project facilities (e.g., airstrip, sewage treatment facilities, explosives magazine storage and access road). The maximum disturbance area is approximately 913 ha.

The LSA was established to capture the combined potential direct and indirect effects of the Project on terrain and soils resources and provides context for assessing effects. The LSA is approximately 4,560 ha and is defined by a 1 km buffer around the maximum disturbance area. The outer boundary of the LSA represents the furthest extent to which Project effects on soils and terrain are likely to occur (e.g., effects from dust deposition [Walker and Everett 1987; Meininger and Spatt 1988]). The maximum disturbance area is entirely within the LSA; the evaluation of soils and terrain will be discussed in terms of the LSA throughout this baseline report.

A terrain and soils regional study area was not established for the Project as no measurable ecological effects on terrain and soils are predicted from direct physical disturbance and dust deposition beyond the LSA (Walker and Everett 1987; Meininger and Spatt 1988).

4.0 METHODS

4.1 Review of Existing Information

A preliminary review of existing literature and mapping for soils and terrain in the study areas, and digital and satellite imagery, was completed. The terrain and soils baseline data review was focused on the maximum disturbance area and LSA (Figure 3). An understanding of existing soil and terrain information is a critical component for preliminary mapping and field program planning. Resources include, but are not limited to:

- *The Ecoregions of Saskatchewan* (Acton et al. 1998);
- Saskatchewan Soil Information System (SLRU 2004); and
- Saskatchewan Map Units, Detail 1:100,000 Soil Survey Information (SLRU 2004).

4.2 Approach

In designing the field study, locations of soil inspection sites were varied based on terrain complexity and were selected such that each dominant soil group was inspected. The density of soil inspections within the maximum disturbance area was completed at a Survey Intensity Level 2 (SIL2) (Agriculture Canada 1981). A SIL2 requires a minimum of one soil inspection site per 30 ha and at least one inspection in over 90% of delineated map polygons. This SIL2 density and polygon visitation represents a detailed soil survey (Agriculture Canada 1982), which allowed for the identification of site-specific soil characteristics (i.e., specific areas that require special soil handling) and increased the accuracy and precision of soil mapping (1:5,000) for the maximum disturbance area.

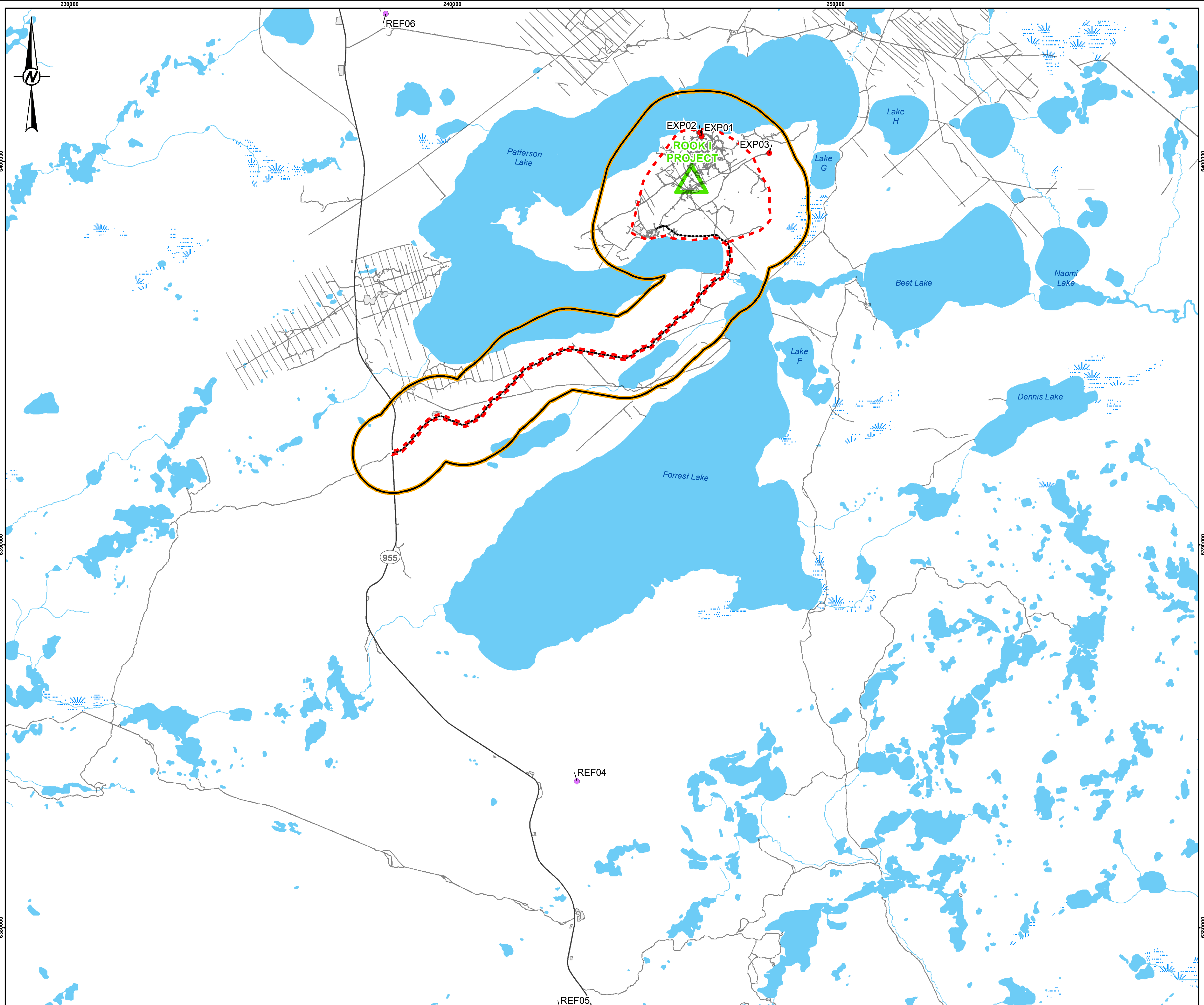
The 2018 baseline field program was completed between 10 October 2018 and 16 October 2018. A total of 112 soil inspection sites were surveyed in 2018, with 96 locations occurring in the maximum disturbance area and 16 in the LSA. In 2019, soil classification and soil sampling were completed between 5 August 2019 and 12 August 2019 at the vegetation plots per the Vegetation Chemistry Characterization Report (Annex VII.3). An additional 30 soil inspection sites were surveyed in 2019 at the vegetation plots. In total, 142 soil inspection sites were surveyed (Figure 4) during the 2018 and 2019 field programs, and terrain and soil data and samples were used for soil classification, mapping descriptions, and chemical analysis.

The following terrain information was collected at each soil inspection site:

- slope gradient, class, position, and length;
- surface expression and terrain/landform; and
- geographic location (by GPS).

At each soil inspection site, detailed profile information was collected to parent material (i.e., C horizon) or to a maximum depth of 120 cm for mineral soils and 2 m for Organic soils. The following soil information was collected at each soil inspection site:

- horizon type, depth, and texture;
- stoniness and roots;
- soil structure, consistence, and colour;
- effervescence and mottling;
- parent material; and
- soil drainage.



LEGEND

- PROJECT LOCATION
- EXISTING ACCESS ROAD
- WATERCOURSE
- WATERBODY
- WETLAND

SOIL SURVEY LOCATIONS

- EXPOSURE PLOT SOIL SURVEY LOCATION
- REFERENCE PLOT SOIL SURVEY LOCATION
- LOCAL STUDY AREA
- MAXIMUM DISTURBANCE AREA
- EXISTING DISTURBANCE

0 2,000 4,000

1:101,000 METRES

REFERENCE(S)

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2. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

PROJECTION: UTM ZONE 12 DATUM: NAD 83

CLIENT

NexGen Energy Ltd.

PROJECT

ROOK I PROJECT

TITLE

SOILS AND TERRAIN BASELINE OVERVIEW

CONSULTANT

GOLDER

YYYY-MM-DD	2021-06-09
DESIGNED	JN
PREPARED	PS/NO
REVIEWED	KH
APPROVED	JV

PROJECT NO.	PHASE	REV.	FIGURE
1899581	2002	0	3

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4.2.1 Terrain Analysis and Correlation with Soil Map Units

The terrain analysis component integrated data from the field program to develop soil map units (SMUs) based on soil characteristics and terrain features that captured the range of variability in soil subgroups present within the maximum disturbance area and LSA. At each soil inspection site, the parent material classification was noted and used as a basis for delineating SMUs. Terrain classification was delineated by combining SMUs with similar properties. For example, all SMUs with glaciofluvial parent materials were merged to produce larger units having similar morphological characteristics. Therefore, the terrain unit names reflect surficial material characteristics.

4.2.2 Soil Classification and Mapping

4.2.2.1 Soil Classification and Mapping Guidelines

Based on information obtained during the 2018 field program, soils were classified to the subgroup level according to the *Canadian System of Soil Classification, Third Edition* (SCWG 1998). Brunisolic soils were classified to the great group level based on soil pH of the B horizon. Organic soil profiles were classified based on an organic layer of greater than 40 cm and a dominating organic middle tier. Gleysolic soils were classified based on colour and mottling properties indicated by prolonged periods of saturation (SCWG 1998).

Soil mapping was completed following guidelines outlined in *A Soil Mapping System for Canada: Revised* (Agriculture Canada 1981). Soils were generally grouped into three landscape (i.e., terrain) areas: upland landscape positions for well-drained soils; depressional (Organic) landscape positions for very poorly drained soils; and transition landscape positions (i.e., between upland and wetland positions) for poorly to imperfectly drained soils (possibly exhibiting peaty phase characteristics).

4.2.2.2 Soil Map Unit Designation for the Maximum Disturbance Area and Local Study Area

Soil mapping involved the correlation of field observations and soil classification with publicly available satellite imagery for the extent of the maximum disturbance area and LSA. CanVec (1:50,000) (Government of Canada 2013) topographic data were used to identify general relief and changes in terrain. Soil inspection information was applied considering principles of geomorphology and surficial geology in combination with ground-truthed soil patterns. Soils in the maximum disturbance area were mapped to Survey Intensity Level 1 (SIL1) at 1:5,000 scale, and soils in the LSA were mapped to a 1:20,000 scale, consistent with SIL2 (Valentine and Lidstone 1985).

The primary characteristics used to group soil types into SMUs included dominant soil texture, parent material, soil subgroup, drainage, surface stoniness, and terrain (slope and surface expression). Soil map units (i.e., soil polygons) were created for the maximum disturbance area and LSA after considering relationships between map resources, satellite imagery, and field data. As there are no published soil surveys for the maximum disturbance area and LSA, names for SMUs were assigned based on the dominant parent material (mineral or organic) within the map unit area.

Soil subgroups within SMUs were defined as dominant, sub-dominant, or inclusions based on the proportion of each soil subgroup present in the SMU. Dominant soil subgroups represent the most common soil subgroup within the map unit and typically occupied 60% to 100% of the map unit. Sub-dominant soil subgroups represent a minor proportion of the map unit (typically 20% to 40%). Inclusions represent soil subgroups that occupy a minor amount (approximately 15% to 20%) of the map unit area and are generally found sporadically and infrequently. Soil subgroups that represented less than 15% of the map unit were not mapped.

4.2.3 Soil Chemistry

4.2.3.1 2018 Baseline Program

During the 2018 field survey, samples from each soil horizon (i.e., A, B, and BC/C) of the dominant soil orders (Brunisolic, Gleysolic, Regosolic, and Organic [SCWG 1998]) were collected at five soil inspection sites. Four of the five soil inspection sites were classified within the Brunisolic soil order, and one soil inspection site was classified within the Organic soil order. The samples were analyzed for chemistry and other soil quality properties to confirm the soil subgroup classification. Samples were collected using a trowel and were stored in sealed plastic bags during transport to the Australian Laboratory Services (ALS) and Saskatchewan Research Council (SRC) laboratories. The samples were analyzed for the following parameters:

- potential of hydrogen (pH);
- electrical conductivity (EC);
- sodium adsorption ratio (SAR);
- soluble cations (calcium, magnesium sodium, potassium);
- cation exchange capacity (CEC; A horizon only);
- base saturation; and
- particle size distribution.

Baseline leachable metal chemistry is an indicator of soil quality, which can influence the growth and health, and leachable metal concentrations, in plants. Therefore, samples that were collected at the five soil inspection sites were also analyzed for a suite of leachable metals (i.e., aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium, tungsten, uranium, vanadium, zinc, and zirconium) for each horizon.

4.2.3.2 2019 Exposure and Reference Vegetation Plots Program

In the 2019 field survey, soil samples were collected at the same locations as baseline vegetation chemistry samples to provide integration between the two baseline components and to meet potential requirements for future long-term effects monitoring programs. Exposure (EXP) and Reference (REF) vegetation plots [2] were pre-selected where suitable habitat most likely to support both blueberry and lichen species intersected with either the dominant (south-southeast) or subdominant (west) wind direction. Soil samples for metal and radionuclide analyses were collected at the same exposure and reference sites (Figure 3).

Three exposure sampling sites and three reference sampling sites were identified. The three exposure sites are located within the LSA (two within and one outside the maximum disturbance area) to capture potential Project-related effects.

[2] The exposure area encompassed sampling sites within 1 km of the anticipated Project footprint; the reference area encompassed sampling sites beyond 5 km from the anticipated Project footprint. Vegetation chemistry sampling is discussed further in the *Vegetation Chemistry Baseline Report*.

The three reference sites are located outside of the LSA and approximately 750 m from Highway 955 to limit the effects of dust deposition from the highway, while still allowing accessibility for long-term monitoring.

Between 6 August 2019 and 12 August 2019, a composite sample consisting of three subsamples of the topsoil horizons (surface organic and A horizons) was collected at each of the exposure and reference sites. The composite samples were analyzed for the following parameters:

- potential of hydrogen (pH);
- electrical conductivity (EC);
- sodium adsorption ratio (SAR);
- soluble cations (calcium, magnesium sodium, potassium);
- cation exchange capacity (CEC; A horizon only);
- base saturation; and
- leachable metal concentrations.

Radionuclides (i.e., lead-210, polonium-210, radium-226, thorium-228, thorium-230, and thorium-232) were sampled in the 2019 field survey as a baseline for a potential long-term effects monitoring program and to provide data for the ecological risk assessment.

4.2.4 Soil Suitability for Reclamation

Soil physical and chemical characteristics were used to estimate soil limitations for reclamation. Soil field observations and analytical results were compared to the criteria for evaluating the suitability of topsoil material (i.e., upper lift) and the suitability of subsoil material (i.e., lower lift) for re-vegetation in the Northern Forest Region, as outlined by the Alberta Soil Advisory Committee in *Soil Quality Criteria Relative to Disturbance and Reclamation* (Alberta Agriculture 1987). Soil reclamation suitability interpretations for individual map units were based on the specific physical and chemical characteristics. Reclamation suitability classes were determined for the topsoil material (upper lift) based on modal characteristics and average depths of Litter (L), Fermented (H), Humus (H) (Agriculture Canada 1982), and A horizons. The topsoil typically captures soil characteristics within the top 30 cm of the soil profile (Alberta Agriculture 1987). Reclamation suitability classes for the subsoil material (lower lift) were determined based on modal characteristics and average depths of B, BC, and C horizons to a depth of 1 m.

Parameters such as coarse soil textures, stoniness/rockiness, moisture content, and soil reaction (i.e., pH) tend to limit soil reclamation suitability. For example, soils that are gravelly (with more than 50% coarse fragments) and coarse textured (loamy sand to sand) are generally considered unsuitable or poor for reclamation purposes. The specific end land use can also affect the reclamation suitability rating. For example, certain factors that may be a limitation for agriculture may not be a limitation for forestry. Where pH may be a limitation, the limits presented are pertinent to both the reclamation objective, such as erosion control, and the eventual end land use (Alberta Agriculture 1987). The criteria used to rank reclamation suitability are presented in Table 1 and Table 2. The most limiting property (i.e., rating) determines the ultimate reclamation suitability rating for each horizon or layer.

Table 1: Reclamation Suitability of Topsoil Material for Re-vegetation

Rating/Property	Good	Fair	Poor	Unsuitable
Reaction (pH)	5.0-6.5	4.0-5.0, 6.5-7.5	3.5-4.0, 7.5-9.0	<3.5, >9.0
Salinity (EC) (dS/m)	<2	2-4	4-8	>8
Sodicity (SAR)	<4	4-8	8-12	>12
Saturation (%)	30-60	20-30, 60-80	15-20, 80-120	<15, >120
Stoniness/Rockiness (% area)	<30 / <20	30-50 / 20-40	50-80 / 40-70	>80 / >70
Texture[(a)]	fSL, vfSL, L, SiL, SL	CL, SCL, SiCL	LS, SiC, C, HC, S	n/a
Moist consistency	Very friable, friable	Loose, firm	Very firm	Extremely firm
$CaCO_3$ equivalent (%)	<2	2-20	20-70	>70

Source: Adapted from Table 8. Criteria for Evaluating the Suitability of Surface Material (Upper Lift) for Re-Vegetation in the Northern Forest Region (Alberta Agriculture 1987).
a) C = clay; CL = clay loam; fSL = fine sandy loam; HC = heavy clay; L = loam; LS = loamy sand; S = sand; SCL = sandy clay loam; SiC = silty clay; SiCL = silty clay loam; SL = sandy loam; SiL = silt loam; vfSL = very fine sandy loam.
$CaCO_3$ = calcium carbonate; EC = electrical conductivity; dS/m = decisiemens per metre; n/a = not applicable; SAR = sodium adsorption ratio; < = less than; > = greater than.

Table 2: Reclamation Suitability of Subsoil Material for Re-vegetation

Rating/Property	Good	Fair	Poor	Unsuitable
Reaction (pH)	5.0-7.0	4.0-5.0, 7.0-8.0	3.5-4.0, 7.5-9.0	<3.5, >9.0
Salinity (EC) (dS/m)	<3	3-5	4-8	>8
Sodicity (SAR)	<4	4-8	8-12	>12
Saturation (%)	30-60	20-30, 60-80	15-20, 80-100	<15, >100
Stoniness/Rockiness (% area)	<30 / <15	30-50 / 15-30	50-70 / 30-50	>70 / >50
Texture[(a)]	fSL, vfSL, L, SiL, SL	CL, SiC, SiCL	LS, C, HC, S	Bedrock
Moist consistency	Very friable, friable, firm	Loose, very firm	Extremely firm	Hard rock
$CaCO_3$ equivalent (%)	<5	5-20	20-70	>70

Source: Adapted from Table 9. Criteria for Evaluating the Suitability of Subsurface Material (Lower Lift) for Re-Vegetation in the Northern Forest Region (Alberta Agriculture 1987).
a) C = clay; CL = clay loam; fSL = fine sandy loam; HC = heavy clay; L = loam; LS = loamy sand; S = sand; SCL = sandy clay loam; SiC = silty clay; SiCL = silty clay loam; SL = sandy loam; SiL = silt loam; vfSL = very fine sandy loam.
$CaCO_3$ = calcium carbonate; EC = electrical conductivity; dS/m = decisiemens per metre; n/a = not applicable; SAR = sodium adsorption ratio; < = less than; > = greater than.

4.2.5 Soil Sensitivities in the Local Study Area

Soil sensitivities that have the potential to affect soil quality include erosion, acidification, permafrost, and compaction. Changes to soil quality may influence the ability of soil to support vegetation.

4.2.5.1 Water and Wind Erosion Sensitivities

The risk of soil erosion from water or wind is influenced by many factors, including soil particle size, organic matter content, water content, permeability, topography, slope gradient, vegetation cover, natural events (e.g., freeze-thaw), and human activities that cause soil disturbance (Cruse et al. 2001; Campbell et al. 2002; TAC 2005).

Erosion from water and wind differ by the processes that move detached soil particles, and each process of erosion affects soil differently. The outcome of soil erosion is important because of potential effects that could be caused beyond the potentially eroded area. These effects could include sedimentation of adjacent waterbodies and the release of chemicals from the soil into surface water, which may alter water quality (Kuhn and Bryan 2004).

Soil erosion risk is one of the primary concerns for disturbed soils because the removal of vegetation cover exposes soil materials to wind and water. Depending on terrain and soil characteristics, with continuous exposure of soil to wind or rain, soil materials may be eroded, washed, or blown away, and may result in the loss of uppermost material (topsoil) and a reduction in soil quality.

Water and wind erosion sensitivity ratings were assigned to SMUs within the maximum disturbance area and LSA and are described in more detail in Section 4.2.5.1.1, Water Erosion Sensitivity and Section 4.2.5.1.2, Wind Erosion Sensitivity.

4.2.5.1.1 Water Erosion Sensitivity

The potential for soil erosion by water is affected by soil texture, organic matter content, water content, permeability, topography, slope gradient, and vegetation cover. Finer textured clayey soils tend to be less prone to erosion by water than silty soils (TAC 2005), especially when the soil structure has been disturbed by freeze-thaw or human activity (Cruse et al. 2001). The higher permeability of sandy-textured soils contributes to a lower potential for over-land flow of water, thus decreasing the potential for soil erosion. In areas where slope gradient and slope length increases, so does the potential for soil erosion regardless of soil texture.

Determining soil erosion potential by water was based on methods described by Transportation Association of Canada (TAC 2005). Water erosion ratings and potentials were assigned to SMUs within the maximum disturbance area and LSA based on characteristics of terrain and soils (i.e., slope length, gradient, and topsoil texture) recorded during the 2018 and 2019 field programs (Table 3). The uppermost mineral soil horizon textures of soil subgroups were used to determine the water erosion rating as the first step in determining water erosion potential. Soils are categorized as having High, Medium, or Low sensitivity ratings (Table 3). The water erosion potential was then determined based on the water erosion rating, dominant slope class, and dominant slope length (Table 4). Water erosion potentials were then assigned to map units within the maximum disturbance area and LSA. In areas where slope gradient increased, so did the potential for soil erosion regardless of soil texture. Water erosion potentials were based on bare, unprotected soils.

Table 3: Criteria for Determining Water Erosion Rating

Soil Texture	Water Erosion Rating
Silt, silty loam, loam	High
Sandy loam, silt clay loam, sandy clay loam, silty clay, clay loam[(a)]	Medium
Sandy clay, clay, heavy clay, loamy sand, sand	Low

Source: Adapted National Guide to Erosion and Sediment Control on Roadway Projects (TAC 2005).
a) Clay loam is not present in TAC (2005); however, clay loam has been included in the Medium range as it is coarser than clay (Low) and finer than silt clay (High) in the texture triangle (SCWG 1987).

Table 4: Criteria for Determining Water Erosion Potential

Slope Gradient	Water Erosion Rating[(a)]	Slope Length	
		<70 m	>70 m
0% to 10%	Low	Low	Low
	Medium	Low	Moderate
	High	Moderate	High
10% to 20%	Low	Low	Moderate
	Medium	Moderate	High
	High	High	High
>20%	Low	Moderate	Moderate
	Medium	High	High
	High	High	High

Source: Adapted from Table 4-2 in the National Guide to Erosion and Sediment Control on Roadway Projects (TAC 2005; City of Calgary 2011).
a) determined from Table 3.
< = less than; > = greater than.

4.2.5.1.2 Wind Erosion Sensitivity

The potential for soil erosion by wind is affected by vegetation cover, wind velocity, soil water content, and soil texture. In general, coarse (i.e., sandy) textured soils are more prone to wind erosion than finer (i.e., clay) textured soils (Coote and Pettapiece 1989). Sandy-textured soils typically do not have a well-developed soil structure. The lack of soil structure is due to limited soil aggregation or adhesion of the soil particles, which does not allow the formation of larger and more stable soil aggregates that are less likely to be moved by wind. Organic soils are typically less prone to wind erosion unless they have dried out or are disturbed (Campbell et al. 2002). Wind erosion of Organic soils is a function of the degree of peat decomposition; thus, the more highly decomposed the organic soil is, the greater the risk for wind erosion.

Wind erosion ratings were assigned to the SMUs within the maximum disturbance area and LSA (Table 5). Mineral soil sensitivity was based on the topsoil horizon texture and a dimensionless index described by Coote and Pettapiece (1989) (Table 5). Wind erosion ratings for Organic soils were assigned based on degree of peat decomposition (Campbell et al. 2002) (Table 5). Wind erosion ratings were based on disturbed, bare soils for mineral soils and on dry, disturbed conditions for Organic soils.

Table 5: Criteria for Determining Wind Erosion Rating

Soil Texture	Wind Erosion Rating
Very fine sand, sand, coarse sand, loamy sand, gravelly sand, humic	High
Sandy loam, loam, silty loam, sandy clay loam, sandy clay, mesic	Moderate
Silt, silty clay loam, clay loam, silty clay, clay, heavy clay, fibric	Low

Source: Adapted from Coote and Pettapiece (1989) and Campbell et al. (2002).

4.2.5.2 Soil Sensitivity to Acidification

Soil sensitivity to acidification is a measure of soil's susceptibility to experience a decrease in pH after experiencing acid inputs. Soil sensitivity to acidification is inversely related to soil buffering capacity.

The SMUs in the maximum disturbance area and LSA were rated for sensitivity to acidification (Table 6), with ratings being based on the sensitivity to the loss of basic cations (primarily calcium, magnesium, and potassium), sensitivity to acidification, and sensitivity to solubilization of aluminum.

The sensitivity of mineral soils to acidification was evaluated using the chemical criteria published by Holowaychuk and Fessenden (1987) (Table 6). In general, neutral to alkaline mineral soils with pH values greater than 6.5 have a lower sensitivity to acidification because of an increased buffering capacity (Holowaychuk and Fessenden 1987). As CEC increases, the associated soil pH can be less and remain less sensitive to acidic inputs. Soils that are high in clay and organic matter content were characterized as having a higher CEC, and therefore a Low sensitivity to acidification.

Table 6: Criteria for Rating the Sensitivity of Mineral Soils to Acidic Inputs

Cation Exchange Capacity (mEq/100 g)	pH	Overall Sensitivity
<6	<4.6-6.5	High
	>6.5	Low
6 to 15	<4.6	High
	4.6-6.0	Moderate
	>6.0	Low
>15	<4.6	High
	4.6-5.5	Moderate
	>5.6	Low

Source: Modified from Holowaychuk and Fessenden 1987.
mEq/100 g = milliequivalents of ammonium cation adsorbed by 100 grams of dry soil; < = less than; > = greater than.

Selected soil samples collected during the 2018 field program were analyzed for CEC. Samples that were not submitted for laboratory CEC analysis were supplemented with CEC ranges derived from data presented in Holowaychuk and Fessenden (1987) and soil texture (Table 7) to estimate the sensitivities of soils to acidification. For soil samples where pH was obtained along with CEC, the values were considered in the determination of acidification sensitivity.

Table 7: Cation Exchange Capacity Relationship to Soil Texture

Texture	Typical Range of Cation Exchange Capacities (mEq/100 g)
Sand and loamy sand	<6
Sandy loam	6-15
Loam and silt loam	12-22
Clay loam and silty clay loam	20-30
Clay	25-45

Source: Derived from soil data presented in Holowaychuk and Fessenden 1987.
mEq/100 g = milliequivalents of ammonium cation adsorbed by 100 grams of dry soil; < = less than; > = more than.

The sensitivity rating for Organic soil was based on the type of wetland (e.g., bog, poor fen, moderate-rich fen, and extreme-rich fen) (Turchenek et al. 1998).

These criteria are based on the pH, CEC, and base saturation of the surface layer of organic soil in each wetland type, as well as the pH and base cation content of the associated pore water.

In general, moderate-rich and extreme-rich fens (i.e., Organic soils with moderate to high nutrient status and neutral pH or higher) tend to be least susceptible to acidification (Table 8). In moderate-rich fens, water supply comes from surface water or groundwater, which is typically mineral-rich and neutral in pH. Fens are not hydrologically isolated, and therefore receive mineral-rich surface or groundwater, which influences the soil pH and nutrient content. Due to incoming water, the acid buffering capacity is replenished, and water is eventually discharged from the wetland through lateral flow. Organic soils that occur in moderate-rich fens are least susceptible to acidification and therefore have a Low sensitivity rating (Table 8).

Table 8: Criteria for Rating the Sensitivity of Wetland Soils to Acidic Inputs

Wetland Type	Sensitivity to:		Overall Sensitivity Rating
	Base Loss	Acidification	
Extreme-rich fen	Low	Low	Low
Moderate-rich fen	Low to Moderate	Low	Low
Bog and poor fen	Moderate to High	Moderate	Moderate

Source: Turchenek et al. 1998.

Bogs are hydrologically isolated; all water in bogs comes from precipitation falling on the bog itself, and thus bogs are very low in nutrients and more acidic than fens. In addition, a larger volume of organic (i.e., peat) material is present at the surface of bogs that can react with incoming acidity. Poor fens, although slightly higher in nutrient status and pH than bogs, represent an ecosite between bogs and rich fens. Peat accumulation in poor fens is ongoing, and influence of underlying mineral material is reduced as compared to richer fen types. In poor fens, there is less material present to react with incoming acidity, and buffering capacity may not be replenished as quickly through water inputs. Organic soils that occur in bogs and in poor fens are most susceptible to acidification and therefore have a Moderate sensitivity rating (Table 8).

4.2.5.3 Permafrost Potential

Permafrost is defined as permanently frozen soil or rock and incorporated ice and organic material that remains at or below 0°C for a minimum of two years due to natural climatic factors (van Everdingen 1998). The distribution and thickness of permafrost is influenced by various factors including climate, topography, peat thickness, winter snow accumulation, hydrology, and subsurface geology (Williams and Burn 1996). Peat thickness, vegetation cover, micro-topography (i.e., presence of hummocks), and moisture content are important variables in predicting the presence of permafrost (Williams and Burn 1996).

Permafrost soils are sensitive to ground disturbances as changes to topsoil materials can alter the soil thermal regime and result in warming of the soil to a greater depth, causing persistent ice to melt (Hayhoe and Tarnocai 1993). This melting can result in differential thaw settling, slumping, and increased wind and water erosion potential (Burgess and Harry 1990; Hayhoe and Tarnocai 1993). The potential effects of disturbance on permafrost soils depends on soil ice content, soil type, drainage, and vegetative cover (Magnusson and Stewart 1987). Organic soils in wetlands are particularly sensitive to disturbance and the melting of ice because of the low bulk densities and potentially high ice content (Magnusson and Stewart 1987).

However, depressional topography, high moisture content, dense vegetation cover, thickness of snow cover, and thickness of surface organic matter can have an insulating effect on permafrost (i.e., keep it frozen) (Judge 1973; Tarnocai 1984; Zoltai 1995; Williams and Burn 1996).

Permafrost potential ratings for each soil subgroup within the maximum disturbance area and LSA were assigned based on drainage, soil texture, and topography observed during the 2018 and 2019 field programs. Fine-textured soils with poor to imperfect drainage were rated as having a Low to Moderate permafrost potential, whereas coarse-textured soils with moderate to rapid drainage were rated as having a Very Low potential for permafrost. If present, Cryosolic soils were rated as having a High potential for permafrost.

4.2.5.4 Sensitivity to Compaction

Soil capability to support vegetation can be reduced if soil becomes compacted. Soil compaction can also influence reclamation success by altering plant establishment and subsequent plant growth. Compaction of topsoil (A horizon) and subsoil (B horizon and C horizons) can lead to a decrease in long-term productivity because of an increase in soil bulk density and soil strength, reductions in soil aeration and soil oxygen, reduced water infiltration and available soil water, restricted root growth, reductions in soil microbiological activity, and lowered nutrient uptake by vegetation (Heuer et al. 2008; Blouin et al. 2008).

Generally, well-drained, coarse- and medium-textured soils (i.e., loams, sandy loam, loamy sand, loam) are less prone to compaction than fine-textured soils (i.e., silty clay loam, silty clay, clay loam, and clay). However, sensitivity to compaction can change based on soil moisture conditions (Lewis et al. 1989). For example, loamy-textured soils under wet conditions are more prone to compaction than the same soil texture under dry conditions. In finer-textured soil (i.e., clayey), saturated conditions may exist due to poor drainage (i.e., the smaller soil pore sizes related to these textures can reduce water movement through the soil), and as soil moisture increases, so does soil sensitivity to compaction.

Compaction ratings for SMUs in the maximum disturbance area and LSA were determined under moist soil conditions using the criteria outlined in Table 9. Gleysolic soils and the associated peaty phases were assigned compaction ratings based on soil texture under wet (saturated) soil conditions. Organic soils were not assigned compaction ratings.

Table 9: Criteria for Determining Compaction Ratings of Soils

Soil Texture	Compaction Rating[a]		
	Dry	Moist	Wet
Sandy (sand, loamy sand)	Low	Low	Moderate
Loamy (sandy loam, loam)	Low	Moderate	High
Silty (silt, silty loam)	Moderate	High	Very High
Clayey (sandy clay, silty clay, sandy clay loam, clay loam, silty clay, clay)	High	Very High	Very High

Source: Modified from Lewis et al. 1989.
a) Based on a coarse fragment content of less than 35% (if coarse fragment content is between 35% and 70% loamy and silty are grouped together and compaction rating is moderate, and clayey is high).

4.3 Quality Assurance and Quality Control

Quality assurance (QA) and quality control (QC) practices determine data integrity and are relevant to all aspects of the study, from sample collection to data analysis and reporting. The QA encompasses management and technical practices designed to confirm that the data generated are of consistent high quality. The QC is an aspect of QA and includes the procedures used to measure and evaluate data quality, and the corrective actions to be taken when data quality objectives are not met.

4.3.1 Quality Assurance

Quality assurance applicable to this study covers internal and external management. One field crew member was responsible for managing the sample shipping process for the field program to confirm that samples were properly labelled, documentation was completed, and samples were delivered to the laboratory in a timely manner. The other member of the field crew was designated as the laboratory liaison. The laboratories selected for the analysis of the 2018 and 2019 samples were ALS and SRC, respectively. Both ALS and SRC are accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA). Under CALA's accreditation program, performance evaluation assessments are conducted annually for laboratory procedures, methods, and internal quality control. The ALS Laboratory Group certificate of analysis and the SRC laboratory Quality Control Report are included in Appendix B Chemical Analysis Results.

Internal QA included use of appropriately trained personnel for each task and senior review of work products at appropriate milestones, use of standardized data manipulation/summary tools, and filing of data and Project information according to standardized protocols.

4.3.2 Quality Control

The QC program consisted of the collection and analysis of field replicate samples, and laboratory QC analysis. Laboratory QC analysis included a variety of techniques, such as the analysis of reference materials, control samples, and spike recovery measurements to verify the validity of the analytical results. If QC issues were identified, the samples were re-analyzed, or other corrective action was undertaken to demonstrate that the analytical results were within the expected measurement uncertainty.

5.0 RESULTS

Of the 112 soil inspection sites surveyed in the maximum disturbance area and LSA in 2018, 106 soil inspection sites were classified to be mineral soils (94.6%), and 6 soil inspection sites were classified as Organic soils (5.4%). In 2019, the six soil inspection sites surveyed at the reference and exposure sites (Section 4.1.2) were all classified as mineral soils. Terrain and soils information for all soil inspection sites are available in Appendix C Soils Inspection Site Data.

5.1 Terrain

During the 2018 and 2019 field programs, it was observed that the terrain in most of the maximum disturbance area and LSA comprised undulating to hummocky upland landscape with high relief and dominant surface stoniness class of Very Stony (i.e., 3% to 15% of ground surface covered). Soil inspections during the surveys indicated that the maximum disturbance area and LSA predominantly consist of loamy sand textured soils formed from glaciofluvial parent material and outwash depositional settings.

5.1.1 Parent Material Classification

Parent material types were derived from the genetic composition of landform classification in the CanSIS (Agriculture Canada 1982). The CanSIS parent material types were used to delineate glaciofluvial parent materials and organic fens as terrain units. Parent material types and associated terrain units, and the associated total distributions within LSA (entirely containing the maximum disturbance area), are summarized in Table 10. The dominant terrain unit in the LSA is glaciofluvial and accounts for 3,303.6 ha (72.5%). The fen peat terrain unit (organic) accounts for 245.7 ha (5.4%) of the LSA. The water map unit accounts for 904.6 ha (19.8%) of the LSA and includes areas with open water on a year-round basis. The existing anthropogenic (i.e., human-based) disturbance unit accounts for 105.7 ha (2.3%) of the and LSA and includes features such as roads, cutlines and clearings, public trails, Highway 955, and infrastructure associated with the Rook I exploration site.

Table 10: Distribution of Terrain/Map Units in the Local Study Area

Terrain Units	Area	
	(ha)	(%)
Glaciofluvial	3,303.6	72.5
Fen peat	245.7	5.4
Water	904.6	19.8
Existing anthropogenic disturbance	105.7	2.3
Total	**4,559.6**	**100.0**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

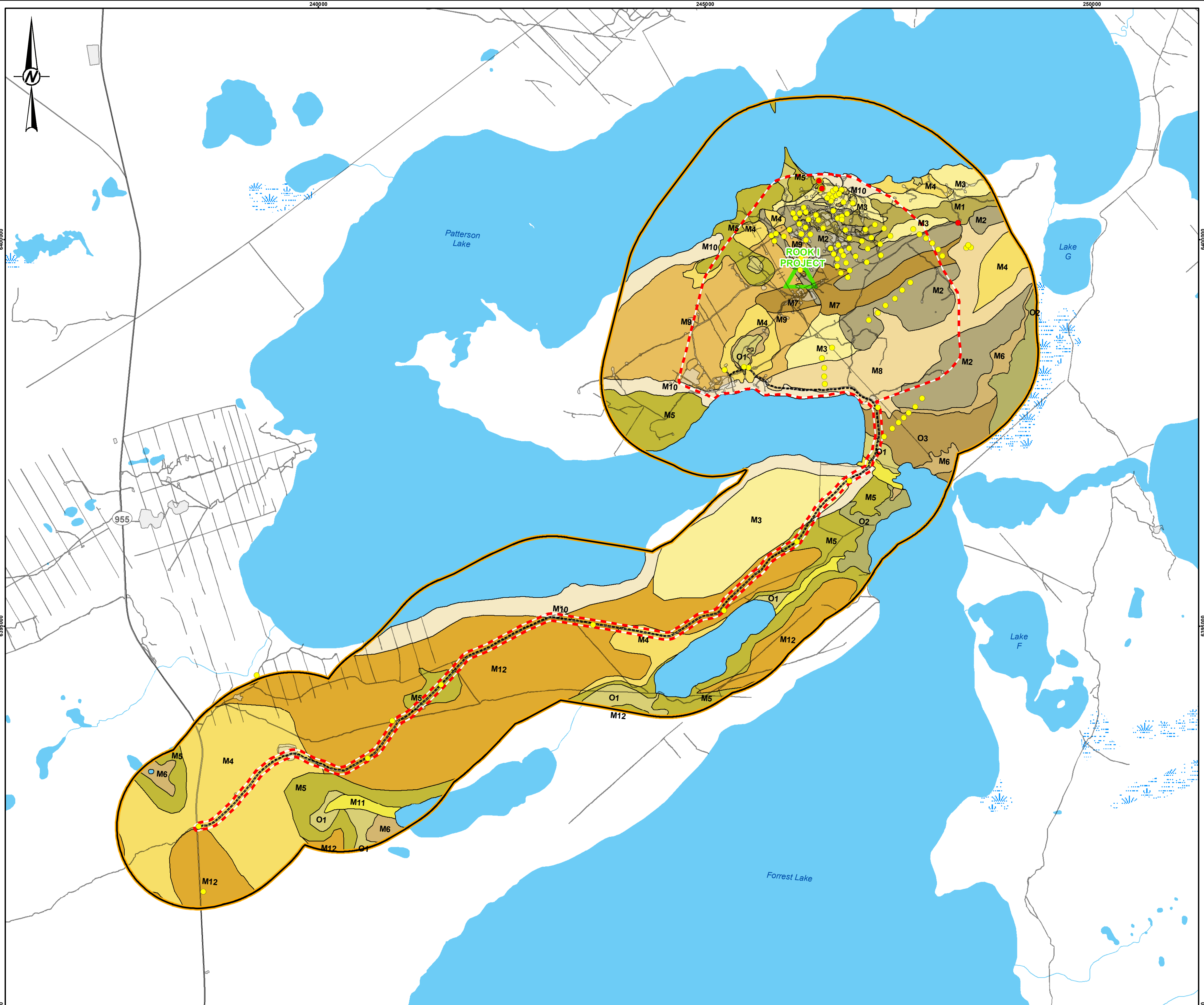
5.2 Soils

Soils in this landscape are dominantly Brunisolic soils that have been developed on sandy glacial till deposits (Acton et al. 1998). Lower areas and depressions in the landscape are typically poorly drained and contain Organic and Gleysolic soils. Within the Fort Hills Landscape Area, the surficial deposits are predominantly loamy sand glacial tills and glaciofluvial deposits; however, glacial tills were not identified within the Project LSA. Organic deposits are found above sandy tills in local depressional areas (Acton et al. 1998).

Brunisolic soils were generally found at upland landscape positions. The one soil inspection site, at which Gleysolic soil were found, was in a transition area between an upland landscape position and a depressional landscape position (i.e., wetlands). The Organic soils were found in depressional areas.

Soils classified within the Brunisolic order include Eluviated Dystric Brunisol and Gleyed Eluviated Brunisol. The one soil inspection site classified within the Gleysolic order was classified as an Orthic Gleysol. Soils classified within the Organic order included Mesic Fibrisol, Fibric Mesisol, Terric Mesisol, and Terric Humisol.

Soil mapping was completed within the maximum disturbance area and LSA, 15 SMUs have been delineated based on soil characteristics and terrain features that capture the range of variability in soil subgroups present (Figure 4). The 15 SMUs include 12 mineral map units—Mineral-1 (M1) through Mineral-12 (M12)—and three Organic SMUs—Organic-1 (O1), Organic-2 (O2), and Organic-3 (O3).



LEGEND

- PROJECT LOCATION
- EXISTING ACCESS ROAD
- SECONDARY HIGHWAY
- WATERCOURSE
- WATERBODY
- WETLAND
- SOIL SURVEY LOCATION
- EXPOSURE PLOT SOIL SURVEY LOCATION
- LOCAL STUDY AREA
- MAXIMUM DISTURBANCE AREA
- EXISTING DISTURBANCE

SOIL MAP UNITS

- M1
- M2
- M3
- M4
- M5
- M6
- M7
- M8
- M9
- M10
- M11
- M12
- O1
- O2
- O3
- WATER

0 1,000 2,000

1:50,000 METRES

REFERENCE(S)

1. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

PROJECTION: UTM ZONE 12 DATUM: NAD 83

CLIENT

NexGen Energy Ltd.

PROJECT

ROOK I PROJECT

TITLE

SOIL MAP UNITS AND SURVEY LOCATIONS WITHIN THE MAXIMUM DISTURBANCE AREA AND LOCAL STUDY AREA

CONSULTANT

GOLDER

YYYY-MM-DD	2021-06-10
DESIGNED	JN
PREPARED	NO
REVIEWED	KH
APPROVED	JV

PROJECT NO.	PHASE	REV.	FIGURE
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Soil mapping was completed within the maximum disturbance area and the LSA. Since the LSA contains the maximum disturbance area entirely, the following discussion of SMUs uses the boundaries of the LSA. Detailed descriptions of the distribution (%) and area (ha) of each SMU within LSA are provided in Table 11. There is approximately 904.6 ha (19.8%) of water delineated within the LSA, as well as 105.7 ha (2.3%) of existing anthropogenic disturbances. The majority (72.5%) of the LSA is composed of mineral SMUs, with the M12 SMU encompassing the largest proportion of the LSA (893.0 ha or 19.6%). The M11 SMU covers the smallest area of the LSA (32.3 ha or 0.7%). There is approximately 245.7 ha (5.4%) of Organic SMUs within the LSA.

Table 11: Description and Distribution of Soil Map Units within the Local Study Area

Soil Map Unit Name (Map Unit Symbol)	Proportion of LSA		Soil Subgroups in the Soil Map Unit[a]	Landform	Stoniness (% of surface covered)	Texture
	Area (ha)	Percent (%)				
Mineral-1 (M1)	49.4	1.1	**Dominantly** Eluviated Dystric Brunisols	Hummocky and ridged – high relief	15-50	Loamy sand
Mineral-2 (M2)	286.2	6.3	**Dominantly** Eluviated Dystric Brunisols **Inclusions** of Gleyed Eluviated Dystric Brunisols	Undulating and rolling	0.1-15	Loamy sand, sand
Mineral-3 (M3)	314.8	6.9	**Dominantly** Eluviated Dystric Brunisols **Inclusions** of Gleyed Eluviated Dystric Brunisols	Hummocky and ridged – high relief	15-50	Sand
Mineral-4 (M4)	508.0	11.1	**Dominantly** Eluviated Dystric Brunisols **Sub-dominantly** Gleyed Eluviated Dystric Brunisols **Inclusions** of Gleysolic soils	Nearly level to undulating	0.1-15	Loamy sand, sand, and sandy loam
Mineral-5 (M5)	395.2	8.7	**Dominantly** Gleyed Eluviated Dystric Brunisols **Sub-dominantly** Eluviated Dystric Brunisols **Inclusions** of Gleysolic soils and Terric Mesisols	Undulating	0.1-15	Loamy sand, sand
Mineral-6 (M6)	69.5	1.5	**Dominantly** Orthic Gleysols **Sub-dominantly** Terric Mesisols **Inclusions** of Gleyed Eluviated Dystric Brunisols	Level to nearly level	<0.01-15	Loamy sand, sand
Mineral-7 (M7)	71.8	1.6	**Dominantly** Eluviated Dystric Brunisols **Inclusions** of Gleyed Eluviated Dystric Brunisols	Hummocky and ridged – low relief	0.1-3	Loamy sand
Mineral-8 (M8)	196.1	4.3	**Dominantly** Eluviated Dystric Brunisols **Inclusions** of Gleyed Eluviated Dystric Brunisols	Hummocky and ridged – high relief	15->50	Loamy sand
Mineral-9 (M9)	260.6	5.7	**Dominantly** Eluviated Dystric Brunisols **Sub-dominantly** Gleyed Eluviated Dystric Brunisols	Undulating to low relief	0.1-15	Loamy sand, sand
Mineral-10 (M10)	226.8	5.0	**Dominantly** Eluviated Dystric Brunisols **Inclusions** of Gleyed Eluviated Dystric Brunisols	Inclined to level	3-15	Sandy loam

Table 11: Description and Distribution of Soil Map Units within the Local Study Area

Soil Map Unit Name (Map Unit Symbol)	Proportion of LSA		Soil Subgroups in the Soil Map Unit[(a)]	Landform	Stoniness (% of surface covered)	Texture
	Area (ha)	Percent (%)				
Mineral-11 (M11)	32.3	0.7	**Dominantly** Gleyed Eluviated Dystric Brunisols **Sub-dominantly** Eluviated Dystric Brunisols and Gleysolic soils; **Inclusions** of Terric Mesisols	Associated with watercourses and drainage channels	<0.01-15	Loamy sand, sand
Mineral-12 (M12)	893.0	19.6	**Dominantly** Eluviated Dystric Brunisols; **Inclusions** of Gleyed Eluviated Dystric Brunisols and Gleysolic soils	Undulating and rolling	0.01-3	Loamy sand, sand, and sandy loam
Organic-1 (O1)	78.5	1.7	**Dominantly** Terric Mesisols; **Inclusions** of Gleysolic soils	Level to nearly level	<0.01	n/a, sand, loamy sand
Organic-2 (O2)	80.2	1.8	**Dominantly** Typic Mesisols; **Inclusions** of Terric Mesisols	Level to nearly level	<0.01	n/a
Organic-3 (O3)	87.0	1.9	**Dominantly** Typic Mesisols **Sub-dominantly** Terric Mesisols; **Inclusions** of Gleysolic soils and Gleyed Eluviated Dystric Brunisols	Level with mineral soil hummocks	<0.01	n/a, loamy sand
Water	904.6	19.8	n/a	n/a	n/a	n/a
Existing anthropogenic disturbance	105.7	2.3	n/a	n/a	n/a	n/a
Total	**4,559.6**	**100.0**	**n/a**	**n/a**	**n/a**	**n/a**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.
a) Dominant soil subgroup(s) = cover 60% to 100% of the soil map unit area; co-dominant soil subgroup(s) = near equal proportion of the soil map unit area covered; sub-dominant soil subgroup(s) = cover 20% to 40% of the soil map unit area; inclusions = cover 15% to 20% of the soil map unit area. The LSA includes the maximum disturbance area and is based on a 1 km buffer around the maximum disturbance area.
LSA = local study area; n/a = not applicable.

5.2.1 Soil Map Unit Characteristics

5.2.1.1 Mineral Soil Map Units

The mineral SMUs combined make up approximately 3,303.6 ha (72.5%) of the LSA. The mineral SMUs differ from one another based on the distribution of dominant or co-dominant upland (i.e., mineral) soils, inclusions of mineral soils, and/or inclusions of wetland (i.e., Organic) or transition (i.e., mineral or peaty phase mineral) soils. The mineral SMUs also differ based on terrain and soil development such as slope class range, drainage, and surface stoniness. The SMU characteristics are described in more detail in Appendix D Soil Map Characteristics.

Mineral-1 (M1)

The M1 SMU covers approximately 49.4 ha (1.1%) of the LSA. The M1 SMU consists of rapidly drained to moderately well-drained Eluviated Dystric Brunisols developed on hummocky and high relief ridged topography (i.e., >2% to 30% slopes). The SMU also contains moderately coarse (i.e., loamy sand) glaciofluvial materials that are exceedingly stony to excessively stony (i.e., 15% to >50% of surface covered).

Mineral-2 (M2)

The M2 SMU covers approximately 286.2 ha (6.3%) of the LSA. The M2 SMU dominantly consists of rapidly drained to moderately well-drained Eluviated Dystric Brunisols developed on undulating and rolling landscapes (i.e., >2% to 15% slopes). The SMU contains moderately coarse to coarse textured (i.e., loamy sand, sand) glaciofluvial materials that are moderately stony to very stony (i.e., 0.1% to 15% of surface covered). Inclusions of Gleyed Eluviated Dystric Brunisols may also occur at lower slope positions within the SMU.

Mineral-3 (M3)

The M3 SMU covers approximately 314.8 ha (6.9%) of the LSA. The M3 SMU dominantly consists of rapidly drained Eluviated Dystric Brunisols developed on hummocky and high relief ridged landscapes (i.e., >5% to 45% slopes). The SMU contains coarse-textured (i.e., sand) glaciofluvial materials that are exceedingly stony to excessively stony (i.e., 15% to >50% of surface covered). Inclusions of Gleyed Eluviated Dystric Brunisols may also occur at lower slope positions within the SMU.

Mineral-4 (M4)

The M4 SMU covers approximately 508.0 ha (11.1%) of the LSA. The M4 SMU dominantly consists of moderately well to imperfectly drained Eluviated Dystric Brunisols developed on nearly level to undulating landscapes (i.e., 0% to 5% slopes). The SMU contains moderately coarse to coarse textured (i.e., loamy sand, sand, sandy loam) glaciofluvial materials that are moderately stony to very stony (i.e., 0.1% to 15% of surface covered). In addition, the SMU sub-dominantly consists of Gleyed Eluviated Dystric Brunisols that are generally found at lower slope positions. Inclusions of imperfectly to poorly drained Gleysolic soils developed on moderately coarse textured (i.e., loamy sand) glaciofluvial material may also occur within the SMU and are generally found in the lower slope positions, swales between undulations, hummocks, or ridges, and in transitions to areas of poor drainage.

Mineral-5 (M5)

The M5 SMU covers approximately 395.2 ha (8.7%) of the LSA. The M5 SMU dominantly consists of moderately well drained Gleyed Eluviated Dystric Brunisols developed on undulating landscapes (i.e., >0.5% to 5% slopes). The SMU contains moderately coarse to coarse textured (i.e., loamy sand, sand) glaciofluvial materials that are moderately stony to very stony (i.e., 0.1% to 15% of surface covered). In addition, the SMU sub-dominantly consists of Eluviated Dystric Brunisols that may occur sporadically within the unit on hummocky to undulating reliefs at higher slope positions. Inclusions of imperfectly to poorly drained Gleysolic soils and poorly to very poorly drained Terric Mesisols may also occur within the SMU. Gleysolic soils developed on moderately coarse textured (i.e., loamy sand) glaciofluvial material are generally found in the lower slope positions, swales between undulations, hummocks, or ridges, and in transitions to areas of poor drainage. In contrast, Terric Mesisols composed of organic (i.e., peat) material occur in depressions (i.e., 0% to 0.5% slopes) and low slope areas with very poor drainage.

Mineral-6 (M6)

The M6 SMU covers approximately 69.5 ha (1.5%) of the LSA. The M6 SMU dominantly consists of imperfectly to very poorly drained Orthic Gleysols developed on undulating level to nearly level landscapes (i.e., 0% to 2% slopes). The SMU contains moderately coarse to coarse textured (i.e., loamy sand, sand) glaciofluvial materials that are non-stony to slightly stony (i.e., <0.01% to 0.1% of surface covered). In addition, the SMU sub-dominantly consists of poorly to very poorly drained Terric Mesisols composed of organic (peat) material and occur in depressions (i.e., slopes 0% to 0.5%) and low elevation areas with very poor drainage. Inclusions of Gleyed Eluviated Dystric Brunisols may also occur in transitions to upland areas within the SMU.

Mineral-7 (M7)

The M7 SMU covers approximately 71.8 ha (1.6%) of the LSA. The M7 SMU dominantly consists of rapidly drained to well-drained Eluviated Dystric Brunisols developed on hummocky and low relief ridged landscapes (i.e., >0.5% to 10% slopes). The SMU contains moderately coarse (i.e., loamy sand) glaciofluvial materials that are moderately stony (i.e., 0.1% to 3% of surface covered). In addition, inclusions of Gleyed Eluviated Dystric Brunisols may be found at lower slope to near level positions. Evidence of clay eluviation in the B horizon of the soil profile was observed in 10% to 20% of the Brunisolic soils within the SMU.

Mineral-8 (M8)

The M8 SMU covers approximately 196.1 ha (4.3%) of the LSA. The M8 SMU dominantly consists of rapidly drained Eluviated Dystric Brunisols developed on hummocky and high relief ridged landscapes (i.e., >5 to 45% slopes). The SMU contains moderately coarse (i.e., loamy sand) glaciofluvial materials that are exceedingly stony to excessively stony (i.e., 15% to >50% of surface covered). In addition, inclusions of Gleyed Eluviated Dystric Brunisols may be found at lower slope positions or in transitional areas. Evidence of clay eluviation in the B horizon of the soil profile was observed in 20% to 40% of the Brunisolic soils within the SMU.

Mineral-9 (M9)

The M9 SMU covers approximately 260.6 ha (5.7%) of the LSA. The M9 SMU dominantly consists of well-drained to moderately well-drained Eluviated Dystric Brunisols developed on low relief undulating landscapes (i.e., >0.5% to 10% slopes). The SMU contains moderately coarse to coarse-textured (i.e., loamy sand, sand) glaciofluvial materials that are moderately stony to very stony (i.e., 0.1% to 15% of surface covered). In addition, the SMU sub-dominantly consists of Gleyed Eluviated Dystric Brunisols that occur in lower slope positions within the SMU.

Mineral-10 (M10)

The M10 SMU covers approximately 226.8 ha (5.0%) of the LSA. The M10 SMU dominantly consists of rapidly drained to well-drained Eluviated Dystric Brunisols developed on level to inclined landscapes (i.e., >0.5% to 15% slopes). The SMU contains moderately coarse (i.e., sandy loam) glaciofluvial materials that are very stony (i.e., 3% to 15% of surface covered). In addition, inclusions of Gleyed Eluviated Dystric Brunisols may occur in lower slope positions within the SMU.

Mineral-11 (M11)

The M11 SMU is the smallest SMU and covers approximately 32.3 ha (0.7%) of the LSA. The M11 SMU dominantly consists of moderately well-drained to very poorly drained Gleyed Eluviated Dystric Brunisols developed in association with watercourses and drainage channels (i.e., >0.5% to 5% slopes). The SMU contains moderately coarse to coarse textured (i.e., loamy sand, sand) glaciofluvial materials that are non-stony to very stony (i.e., <0.01% to 15% of surface covered). In addition, the SMU sub-dominantly consists of Eluviated Dystric Brunisols, which generally occur on mid to upper slope positions. Imperfectly drained Gleysolic soils that develop in the lower slope positions, swales between undulations, low positions of hummocks or ridges, and in transitions to areas of poor drainage may also occur within the SMU. In contrast, inclusions of very poorly drained Terric Mesisols composed of organic (i.e., peat) material may occur in depressions (i.e., 0% to 0.5% slopes) and low slope areas.

Mineral-12 (M12)

The M12 SMU is the most abundant SMU in the LSA and covers approximately 893.0 ha (19.6%). The M12 SMU dominantly consists of rapidly drained to moderately well-drained Eluviated Dystric Brunisols developed on undulating and rolling landscapes (i.e., >0.5% to 10% slopes). The SMU contains moderately coarse to coarse textured (i.e., loamy sand, sand, sandy loam) glaciofluvial materials that are slightly stony to moderately stony (i.e., 0.01% to 3% of surface covered). Inclusions of Gleyed Eluviated Dystric Brunisols, and Orthic Gleysols may occur within the SMU in transition areas and in lower slope positions with imperfect to poor drainage.

5.2.1.2 Organic Soil Map Units

The Organic SMUs combined make up approximately 245.7 ha (5.4%) of the LSA. The Organic SMUs differ from each other based on the distribution of dominant wetland (i.e., organic) soils and sub-dominant or inclusion upland or transition (i.e., mineral or mineral peaty phase) soils. The Organic SMUs also differ based on terrain and soil development.

Organic-1 (O1)

The O1 SMU covers approximately 78.5 ha (1.7%) of the LSA. The O1 SMU dominantly consists of very poorly drained Terric Mesisols developed on level to nearly level topography (i.e., 0% to 0.5% slopes), with moderately decomposed organic materials (i.e., fen peat) overlying moderately coarse to coarse textured (loamy sand, sand, sandy loam) glaciofluvial deposits. Inclusions of Gleysols and Gleyed variants of upland mineral soils are generally found in areas of transition to areas with better drainage.

Organic-2 (O2)

The O2 SMU covers approximately 80.2 ha (1.8%) of the LSA. The O2 SMU dominantly consists of very poorly drained Typic Mesisols developed on level to nearly level topography (i.e., 0% to 0.5% slopes), with moderately decomposed organic (i.e., fen peat) materials.

Mesisols are generally found in depressions, low plains and swales between undulations, hummocks, or ridges of bedrock. Inclusions of Terric Mesisols may also occur sporadically within the SMU.

Organic-3 (O3)

The O3 SMU covers approximately 87.0 ha (1.9%) of the LSA. The O3 SMU dominantly consists of very poorly drained Typic Mesisols and sub-dominantly Terric Mesisols that developed on level areas with mineral soil hummocks to nearly level areas (i.e., 0% to 5% slopes), with moderately decomposed organic materials (i.e., fen peat) overlying moderately coarse (i.e., loamy sand) glaciofluvial deposits. Inclusions of Gleysols and Gleyed variants of upland mineral soils such as Gleyed Eluviated Dystric Brunisols may occur within the SMU and are generally found in transition areas and/or moderately well drained areas.

5.2.2 Soil Chemistry and Reclamation Suitability

Analytical chemistry results for soil samples collected in 2018 and 2019 within the maximum disturbance area and LSA are presented in Appendix D. The chemistry results indicated that the pH ranged from 2.86 to 5.20 for all the soil horizons that were analyzed in 2018 and 2019. The B horizon pH values ranged from 3.83 to 4.56 and are considered acidic. The pH for the B horizon is also utilized for the Brunisolic soil classification, greater than 5.5 indicates a Eutric Brunisol and <5.5 is and Dystric Brunisol (SCWG 1987). Dystric Brunisol is the dominant great group within the LSA as seen in Table 11. The pH for the topsoil is the limiting factor for reclamation suitability (Table 12) according to the *Soil Quality Criteria Relative to Disturbance and Reclamation* (Alberta

Agriculture 1982); however, the 2019 reference sites indicate that the acidic pH levels are natural to the area and therefore would not be considered a limiting factor for reclamation success. For the subsoil the pH values ranged from Good to Unsuitable (Table 13).

The electrical conductivity (EC) results for the collected 2018 and 2019 samples ranged from less than 0.10 to 0.29 decisiemens per metre (dS/m), and from 0.15 to 0.35 dS/m, respectively. As EC is a measurement of soil salinity, the results indicate that the representative samples are non-saline. Soils analyzed with EC values less than 1 dS/m are considered to be non-saline soils, where EC values greater than 1 dS/m are considered to be saline soils. The EC values for topsoil and subsoil are Good for reclamation suitability (Table 12, Table 13).

The majority (63%) of the 2018 soil sample horizons analyzed had sodium adsorption ratios (SAR) that were incalculable due to undetectable sodium values and/or calcium and magnesium values that were below the detection limit (i.e., <0.30). The horizons from the 2018 soil sampling that had detectable limits had SAR values ranging from 0.30 to 2.6. The 2019 soil sample horizons analyzed had SAR ranging from 0.1 to 0.7. The reported SAR values represented in Appendix B indicate the maximum detected limit. The actual SAR values may be lower if both calcium and magnesium were detectable for all of the horizons analyzed. The SAR values indicate that the soils within the LSA are non-saline and non-sodic and the topsoil and subsoil (where applicable) are considered Good for reclamation suitability (Table 12, Table 13).

The 2018 CEC values for all samples ranged from less than 0.80 to 7.68 mEq/100g, where the majority (75%) of the horizons from the collected samples from 2018 were below detectable limits. The incalculable or low CEC results indicate that soils in the maximum disturbance area and LSA may have low available nutrients for plants and low buffering capacity against soil acidification. Due to the high percentage (75%) of the sites below detection limits, the CEC results for topsoil and subsoil were not evaluated for reclamation suitability.

The majority (67%) of the 2018 mineral soil sample horizons had coarse-textured (sand to loamy sand), hand texturing from the remaining inspection sites not submitted or sampled in 2018 had comparable coarse-textures (sand, sandy loam, loamy sand) throughout the profiles. The 2019 soil horizons were hand-textured with comparable coarse-textures (sand, sandy loam, loamy sand) throughout the profiles. The topsoil textures were determined to have Poor reclamation suitability with only one site classified as Good for reclamation suitability (Table 12). Subsoil reclamation suitability for texture was classified as Poor with only one site ranging from Poor to Good (Table 13).

Soil chemistry results from the 2018 and 2019 field programs detected leachable metals such as arsenic, barium, cadmium, chromium, copper, lead, nickel, vanadium, and zinc. The complete list of metals detected from the 2018 and 2019 samples is located in Appendix B. Concentrations of leachable metals listed in Appendix B were compared with the lower limits of the *Soil Quality Guidelines for the Protection of Environmental and Human Heath* defined for industrial, agricultural or residential/parkland land uses, whichever is lower (CCME 2014).

Soil concentrations of three metals exceeded the *Soil Quality Guidelines for the Protection of Environmental and Human Heath* defined for agricultural or residential/parkland land uses (CCME 2014). Boron met or exceeded the Soil Quality Guideline for agricultural land use (2 mg/kg dry weight) in all 2019 samples, except for the EXP03 C sample (Table B-4, Appendix B). Boron concentrations were below the Soil Quality Guideline for agriculture land use in all 2018 samples. Sulphur exceeded the Soil Quality Guideline for agriculture land use (500 mg/kg dry weight) at the NR18MS 77 sample location (both soil horizon samples) in 2018 (Table B-4, Appendix B). Uranium exceeded the Soil Quality Guideline for agriculture land use and residential/parkland land use (both 23 mg/kg dry weight) in the 2018 NR18MS 77 sample location of horizon sample. Several (11%) of the metals that were analyzed (e.g., aluminum, iron, strontium, and zirconium) are not listed in the Soil Quality Guidelines (CCME 2014).

Radionuclide analysis of soils samples collected at the 2019 exposure and reference sites identified no detectable levels of lead-210, thorium-228, thorium-230, or thorium-232. Polonium-210 levels ranged between 0.01 and 0.02 becquerels per gram (Bq/g), and radium-226 levels ranged between 0.02 and 0.03 Bq/g (Appendix B). There was a higher concentration of polonium-210 and radium-226 in soils sampled at the reference sites compared to the exposure sites. Compared to the *Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials (NORM)* (Canadian NORM Working Group 2013), none of the radionuclide values that were analyzed in 2019 exceed the derived release limits.

Based on field investigations and laboratory analysis, the mineral SMUs in the maximum disturbance area and LSA are considered to have Poor reclamation suitability ratings in the topsoil (i.e., upper lift) and subsoil (i.e., lower lift). The Poor ratings are due to texture being the primary limiting factor.

Table 12: Topsoil Reclamation Suitability Ratings for the Local Study Area

Site	Reaction (pH)[(b)]	Salinity (EC) (dS/m)	Sodicity (SAR)	Texture[(a)]	Limiting Factor[(b)]
NR18MS 77	Unsuitable	Good	Good	n/a	None
NR18MS 96	Unsuitable	Good	Good	n/a	None
NR18MS 108	Unsuitable	Good	Good	Poor	Texture – Poor
EXP01	Unsuitable	Good	Good	Poor	Texture – Poor
EXP02	Unsuitable	Good	Good	Poor	Texture – Poor
EXP03	Unsuitable	Good	Good	Poor	Texture – Poor
REF04	Unsuitable	Good	Good	Poor	Texture – Poor
REF05	Unsuitable	Good	Good	Good to Poor	Texture – Poor
REF06	Unsuitable	Good	Good	Poor	Texture – Poor

Suitability ratings have been determined for each site, the most limiting factor for each site was displayed when multiple horizons were sampled with different ratings.
a) For sites with mineral and organic horizons sampled, the mineral ratings were used for Texture suitability ratings. For sites where only organic topsoil horizons were sampled no ratings were determined for texture.
b) The pH suitability was not considered when determining limiting factors for the site as the pH ranges identified were within the range of the natural background reference sites.
EC = electrical conductivity; dS/m = decisiemens per metre; n/a = not applicable; SAR = sodium adsorption ratio

Table 13: Subsoil Reclamation Suitability Ratings for the Local Study Area

Site	Reaction (pH)	Salinity (EC) (dS/m)	Sodicity (SAR)	Texture[(a)]	Limiting Factor[(b)]
NR18MS 58	Poor to Good	Good	n/a	Poor	Texture & pH – Poor
NR18MS 82	Poor to Fair	Good	Good	Poor	Texture & pH – Poor
NR18MS 96	Unsuitable to Poor	Good	Good	Good to Poor	pH – Unsuitable to Poor Texture - Poor
NR18MS 108	Poor	Good	n/a	Poor	Texture & pH – Poor

Suitability ratings have been determined for each site, the most limiting factor for each site was displayed when multiple horizons were sampled with different ratings.
a) For sites with mineral and organic horizons sampled, the mineral ratings were used for Texture suitability ratings. For sites where only organic topsoil horizons were sampled no ratings were determined for texture.
b) The pH suitability was not considered when determining limiting factors for the site as the pH ranges identified were within the range of the natural background reference sites.
EC = electrical conductivity; dS/m = decisiemens per metre; n/a = not applicable; SAR = sodium adsorption ratio

5.3 Soil Sensitivities

5.3.1 Water and Wind Erosion Sensitivities

5.3.1.1 Water Erosion Sensitivity

Water erosion potentials were assigned to the SMUs within the LSA (Table 14 and Table 15). Water erosion potential for dominant soil subgroups in the majority of the SMUs was Low to Medium, based on the dominantly sandy and loamy sand texture associated with upper mineral soil horizons, gentle slope gradient (<10%), and a dominant slope length greater than 70 m. Soils with Low water erosion potential were associated with smaller slope percentages (Table 14 and Table 15).

In the maximum disturbance area and LSA, the sandy to loamy sand Brunisolic soils at upland landscape positions generally have a Low to Medium sensitivity to water erosion. At transitional and depressional landscape positions, poorly drained Gleysolic soils also have Low to Medium sensitivity to water erosion. In areas with Organic soils that have the shallow organic surface horizons removed and the subsoil materials exposed, the water erosion potential of the underlying material is Low. Deep Organic soils are not rated for water erosion as bare mineral soil will not likely be exposed. Within all SMUs, as slope percentage or slope length increases, the water erosion potential for soils would also increase.

Table 14: Water Erosion Potential Rating for Mineral Soil Map Units within the Local Study Area

Soil Map Unit Name (Map Unit Symbol)	Soil Subgroups in the Soil Map Unit[a]	Dominant Topsoil Horizon Texture	Water Erosion Rating	Dominant Slope Class	Dominant Slope Length (m)	Water Erosion Potential Rating
Mineral-1 (M1)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	Low	3-6 (>2%-30%)	>70	Low to Medium
Mineral-2 (M2)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	Low	3-5 (>2%-15%)	>70	Low to Medium
	Inclusions of Gleyed Eluviated Dystric Brunisols					
Mineral-3 (M3)	**Dominantly** Eluviated Dystric Brunisols	Sand	Low	4-7 (>5%-45%)	>70	Low to Medium
	Inclusions of Gleyed Eluviated Dystric Brunisols					
Mineral-4 (M4)	**Dominantly** Eluviated Dystric Brunisols	Sand, loamy sand	Low	1-3 (0%-5%)	>70	Low to Medium
	Sub-dominantly Gleyed Eluviated Dystric Brunisols	Loamy sand, sandy loam	Low to Medium			
	Inclusions of Gleysolic soils	Loamy sand	Low			
Mineral-5 (M5)	**Dominantly** Gleyed Eluviated Dystric Brunisols	Sand, loamy sand	Low	2-3 (>0.5%-5%)	>70	Low
	Sub-dominantly Eluviated Dystric Brunisols					
	Inclusions of Gleysolic soils and Terric Mesisols	Loamy sand / n/a	Low/ n/a			
Mineral-6 (M6)	**Dominantly** Orthic Gleysols	Loamy sand	Low	1-2 (0%-2%)	>70	Low
	Sub-dominantly Terric Mesisols	n/a	n/a			
	Inclusions of Gleyed Eluviated Dystric Brunisols	Sand, loamy sand	Low			

Table 14: Water Erosion Potential Rating for Mineral Soil Map Units within the Local Study Area

Soil Map Unit Name (Map Unit Symbol)	Soil Subgroups in the Soil Map Unit[(a)]	Dominant Topsoil Horizon Texture	Water Erosion Rating	Dominant Slope Class	Dominant Slope Length (m)	Water Erosion Potential Rating
Mineral-7 (M7)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	Low	2-4 (>0.5%-10%)	>70	Low
	Inclusions of Gleyed Eluviated Dystric Brunisols					
Mineral-8 (M8)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	Low	4-7 (>5%-45%)	>70	Low to Medium
	Inclusions of Gleyed Eluviated Dystric Brunisols					
Mineral-9 (M9)	**Dominantly** Eluviated Dystric Brunisols	Sand, loamy sand	Low	2-4 (>0.5%-10%)	>70	Low
	Sub-dominantly Gleyed Eluviated Dystric Brunisols	Loamy sand				
Mineral-10 (M10)	**Dominantly** Eluviated Dystric Brunisols	Sandy loam	Medium	2-5 (>0.5%-15%)	>70	Medium to High
	Inclusions of Gleyed Eluviated Dystric Brunisols					
Mineral-11 (M11)	**Dominantly** Gleyed Eluviated Dystric Brunisols	Sand, loamy sand	Low	2-3 (>0.5%-5%)	>70	Low
	Sub-dominantly Eluviated Dystric Brunisols and Gleysolic soils					
	Inclusions of Terric Mesisols	n/a	n/a			
Mineral-12 (M12)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand, sandy loam	Low to Medium	2-4 (>0.5%-10%)	>70	Low to Medium
	Inclusions of Gleyed Eluviated Dystric Brunisols and Gleysolic soils	Loamy sand	Low			

a) Dominant soil subgroup(s) = cover 60% to 100% of the soil map unit area; co-dominant soil subgroup(s) = cover 40% to 60% of the soil map unit area; sub-dominant soil subgroup(s) = cover 20% to 40% of the soil map unit area; inclusion = cover 15% to 20% of the soil map unit area. The LSA includes the maximum disturbance area and is based on a 1 km buffer around the maximum disturbance area.
< = less than; n/a = not applicable; LSA = local study area.

Table 15: Water Erosion Potential Rating for Organic Soil Map Units within Local Study Area

Soil Map Unit Name (Map Unit Symbol)	Soil Subgroups in Soil Map Unit[(a)]	Dominant Topsoil Horizon Texture	Water Erosion Rating	Dominant Slope Class	Dominant Slope Length (m)	Water Erosion Potential Rating
Organic-1 (O1)	**Dominantly** Terric Mesisols	n/a	n/a	1 (0%-0.5%)	<70	n/a
	Inclusions of Gleysolic soils	Sand, loamy sand	Low			Low
Organic-2 (O2)	**Dominantly** Typic Mesisols	n/a	n/a	1 (0%-0.5%)	<70	n/a
	Inclusions of Terric Mesisols	n/a	n/a			
Organic-3 (O3)	**Dominantly** Typic Mesisols	n/a	n/a	1 (0%-0.5%)	<70	n/a
	Inclusions of Gleysolic soils and Gleyed Eluviated Dystric Brunisols	Loamy sand	Low			Low

a) Dominant soil subgroup(s) = cover 60% to 100% of the soil map unit area; co-dominant soil subgroup(s) = cover 40% to 60% of the soil map unit area; sub-dominant soil subgroup(s) = cover 20% to 40% of the soil map unit area; inclusion = cover 15% to 20% of the soil map unit area. The LSA includes the maximum disturbance area and is based on a 1 km buffer around the maximum disturbance area.

< = less than; n/a = not applicable; LSA = local study area.

5.3.1.2 Wind Erosion Sensitivity

Wind erosion ratings were assigned to SMUs within the maximum disturbance area and LSA (Table 16 and Table 17). Wind erosion ratings of mineral soils are based on disturbed, bare soils, and wind erosion ratings of Organic soils are based on degree of peat decomposition under dry and disturbed conditions.

Wind erosion ratings for dominant soil subgroups in the majority of the SMUs was High, based on the sandy and loamy sand textured mineral upper soil horizons. Soils with Moderate wind erosion ratings were associated with sandy loam textured mineral upper soil horizons. Organic horizons were identified to have Low wind erosion ratings due to decomposition of the uppermost organic horizon (Table 17).

Soils most sensitive to wind erosion include sandy and loamy sand textured Brunisolic soils. In the event Organic surface materials are removed and underlying mineral soil horizons are exposed, the wind erosion ratings remain High due to the sandy textures. Areas containing Organic Mesisols and peaty phase Gleysolic soils with silt or silt loam topsoil mineral horizons have a Low sensitivity to wind erosion.

Table 16: Wind Erosion Potential Rating for Mineral Soil Map Units within the Maximum Disturbance Area and Local Study Area

Soil Map Unit Name (Map Unit Symbol)	Soil Subgroups in the Soil Map Unit[a]	Dominant Topsoil Horizon Texture	Wind Erosion Potential Rating
Mineral-1 (M1)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	High
Mineral-2 (M2)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	High
	Inclusions of Gleyed Eluviated Dystric Brunisols		
Mineral-3 (M3)	**Dominantly** Eluviated Dystric Brunisols	Sand	High
	Inclusions of Gleyed Eluviated Dystric Brunisols		
Mineral-4 (M4)	**Dominantly** Eluviated Dystric Brunisols	Sand, loamy sand	High
	Sub-dominantly Gleyed Eluviated Dystric Brunisols	Loamy sand, sandy loam	Moderate to High
	Inclusions of Gleysolic soils	Loamy sand	High
Mineral-5 (M5)	**Dominantly** Gleyed Eluviated Dystric Brunisols	Sand, loamy sand	High
	Sub-dominantly Eluviated Dystric Brunisols		
	Inclusions of Gleysolic soils and Terric Mesisols	Loamy sand / n/a	High/Low
Mineral-6 (M6)	**Dominantly** Orthic Gleysols	Loamy sand	High
	Sub-dominantly Terric Mesisols	n/a	Low
	Inclusions of Gleyed Eluviated Dystric Brunisols	Sand, loamy sand	High
Mineral-7 (M7)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	High
	Inclusions of Gleyed Eluviated Dystric Brunisols		

Table 16: Wind Erosion Potential Rating for Mineral Soil Map Units within the Maximum Disturbance Area and Local Study Area

Soil Map Unit Name (Map Unit Symbol)	Soil Subgroups in the Soil Map Unit[(a)]	Dominant Topsoil Horizon Texture	Wind Erosion Potential Rating
Mineral-8 (M8)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	High
	Inclusions of Gleyed Eluviated Dystric Brunisols		
Mineral-9 (M9)	**Dominantly** Eluviated Dystric Brunisols	Sand, loamy sand	High
	Sub-dominantly Gleyed Eluviated Dystric Brunisols	Loamy sand	
Mineral-10 (M10)	**Dominantly** Eluviated Dystric Brunisols	Sandy loam	Moderate
	Inclusions of Gleyed Eluviated Dystric Brunisols		
Mineral-11 (M11)	**Dominantly** Gleyed Eluviated Dystric Brunisols	Sand, loamy sand	High
	Sub-dominantly Eluviated Dystric Brunisols and Gleysolic soils		
	Inclusions of Terric Mesisols	n/a	Low
Mineral-12 (M12)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand, sandy loam	Moderate to High
	Inclusions of Gleyed Eluviated Dystric Brunisols and Gleysolic soils	Loamy sand	High

a) Dominant soil subgroup(s) = cover 60% to 100% of the soil map unit area; co-dominant soil subgroup(s) = cover 40% to 60% of the soil map unit area; sub-dominant soil subgroup(s) = cover 20% to 40% of the soil map unit area; inclusion = cover 15% to 20% of the soil map unit area. The LSA includes the maximum disturbance area and is based on a 1 km buffer around the maximum disturbance area.
n/a = not applicable; LSA = local study area.

Table 17: Wind Erosion Potential Rating for Organic Soil Map Units within the Maximum Disturbance Area and Local Study Area

Soil Map Unit Name (Map Unit Symbol)	Soil Subgroups in Soil Map Unit[(a)]	Dominant Topsoil Horizon Texture	Wind Erosion Potential Rating
Organic-1 (O1)	**Dominantly** Terric Mesisols	n/a	Low
	Inclusions of Gleysolic soils	Sand, loamy sand	High
Organic-2 (O2)	**Dominantly** Typic Mesisols	n/a	Low
	Inclusions of Terric Mesisols	n/a	Low
Organic-3 (O3)	**Dominantly** Typic Mesisols	n/a	Low
	Inclusions of Gleysolic soils and Gleyed Eluviated Dystric Brunisols	Loamy sand	High

a) Dominant soil subgroup(s) = cover 60% to 100% of the soil map unit area; co-dominant soil subgroup(s) = cover 40% to 60% of the soil map unit area; sub-dominant soil subgroup(s) = cover 20% to 40% of the soil map unit area; inclusion = cover 15% to 20% of the soil map unit area. The LSA includes the maximum disturbance area and is based on a 1 km buffer around the maximum disturbance area.
n/a = not applicable; LSA = local study area.

5.3.2 Sensitivity to Acidification

Acidification sensitivity ratings were assigned to the SMUs within the maximum disturbance area and LSA Table 18 and Table 19). Brunisolic soils had a sand or loamy sand topsoil texture, and these textures are generally associated with a low CEC. Brunisolic B horizon pH values ranged from 3.83 to 4.56 from the soil samples collected; therefore, topsoil horizons would also be considered as acidic. As all soil samples from Brunisols in the maximum disturbance area and LSA had a pH less than 5.5, all Brunisolic soils in the maximum disturbance area and LSA have been assumed to have a pH less than 5.5. Due to the low CEC and low pH values in the samples, these Brunisolic soils have a High sensitivity to acidification.

Organic soils within all SMUs have Low to Moderate sensitivity to acidification depending on the associated wetland type. Moderate, rich, and extreme rich fens have a Low sensitivity to acidification. Bogs and poor fens are rated as having a Moderate sensitivity to acidification.

Gleysolic soils generally had sandy loam textures, which are associated with low to high CEC (Table 18). These soils occur in transitional areas adjacent to wetlands; therefore, the pH values would be influenced by water associated with the adjacent wetland type. Even in areas that are considered to be in the peaty phase, the overlying shallow organic layer would be influenced by underlying materials. In general, these soils are considered to have a Low to Moderate sensitivity to acidification; this rating would increase to Moderate to High where soils occur adjacent to acidic bogs or where textures are sandy.

Overall, in the maximum disturbance area and LSA, upland landscape positions containing well-drained, sandy-textured soils are most sensitive to acidification, whereas wetlands containing Organic soils (i.e., within bogs, fens, and swamps) have a Low to Moderate sensitivity to acidification (Table 19). Gleysolic soils generally have a Low to Moderate sensitivity; the exception occurs when these soils have sandy textures and are subsequently rated as a High sensitivity to acidification.

Table 18: Acidification Potential Rating for Mineral Soil Map Units within the Maximum Disturbance Area and Local Study Area

Soil Map Unit Name (Map Unit Symbol)	Soil Subgroups in the Soil Map Unit[a]	Dominant Topsoil Horizon Texture	Expected Range of CEC (mEq/100 g) Based on Soil Texture[b]	Acidification Sensitivity Potential Rating
Mineral-1 (M1)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	<6	High
Mineral-2 (M2)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	<6	High
	Inclusions of Gleyed Eluviated Dystric Brunisols			
Mineral-3 (M3)	**Dominantly** Eluviated Dystric Brunisols	Sand	<6	High
	Inclusions of Gleyed Eluviated Dystric Brunisols			
Mineral-4 (M4)	**Dominantly** Eluviated Dystric Brunisols	Sand, loamy sand	<6	Moderate to High
	Sub-dominantly Gleyed Eluviated Dystric Brunisols	Loamy sand, sandy loam	<6-15	
	Inclusions of Gleysolic soils	Loamy sand	<6	

Table 18: Acidification Potential Rating for Mineral Soil Map Units within the Maximum Disturbance Area and Local Study Area

Soil Map Unit Name (Map Unit Symbol)	Soil Subgroups in the Soil Map Unit[a]	Dominant Topsoil Horizon Texture	Expected Range of CEC (mEq/100 g) Based on Soil Texture[b]	Acidification Sensitivity Potential Rating
Mineral-5 (M5)	**Dominantly** Gleyed Eluviated Dystric Brunisols	Sand, loamy sand	<6	Moderate to High
	Sub-dominantly Eluviated Dystric Brunisols			
	Inclusions of Gleysolic soils and Terric Mesisols	Loamy sand / n/a	<6 / n/a	
Mineral-6 (M6)	**Dominantly** Orthic Gleysols	Loamy sand	<6	Moderate to High
	Sub-dominantly Terric Mesisols	n/a	n/a	
	Inclusions of Gleyed Eluviated Dystric Brunisols	Sand, loamy sand	<6	
Mineral-7 (M7)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	<6	High
	Inclusions of Gleyed Eluviated Dystric Brunisols			
Mineral-8 (M8)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	<6	High
	Inclusions of Gleyed Eluviated Dystric Brunisols			
Mineral-9 (M9)	**Dominantly** Eluviated Dystric Brunisols	Sand, loamy sand	<6	High
	Sub-dominantly Gleyed Eluviated Dystric Brunisols	Loamy sand		
Mineral-10 (M10)	**Dominantly** Eluviated Dystric Brunisols	Sandy loam	6-15	Moderate to High
	Inclusions of Gleyed Eluviated Dystric Brunisols			
Mineral-11 (M11)	**Dominantly** Gleyed Eluviated Dystric Brunisols	Sand, loamy sand	<6	Moderate to High
	Sub-dominantly Eluviated Dystric Brunisols and Gleysolic soils			
	Inclusions of Terric Mesisols	n/a	n/a	
Mineral-12 (M12)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand, sandy loam	<6-15	Moderate to High
	Inclusions of Gleyed Eluviated Dystric Brunisols and Gleysolic soils			

a) Dominant soil subgroup(s) = cover 60% to 100% of the soil map unit area; co-dominant soil subgroup(s) = cover 40% to 60% of the soil map unit area; sub-dominant soil subgroup(s) = cover 20% to 40% of the soil map unit area; inclusion = cover 15% to 20% of the soil map unit area. The LSA includes the maximum disturbance area and is based on a 1 km buffer around the maximum disturbance area.

n/a = not applicable; LSA = local study area.

Table 19: Acidification Rating for Organic Soil Map Units Within the Maximum Disturbance Area and Local Study Area

Soil Map Unit Name (Map Unit Symbol)	Soil Subgroups in the Soil Map Unit[(a)]	Dominant Topsoil Horizon Texture	Expected Range of CEC (mEq/100 g) Based on Soil Texture[(b)]	Acidification Sensitivity Potential Rating
Organic-1 (O1)	**Dominantly** Terric Mesisols	n/a	n/a	Low to Moderate
	Inclusions of Gleysolic soils	Sand, loamy sand	<6	High
Organic-2 (O2)	**Dominantly** Typic Mesisols	n/a	n/a	Low to Moderate
	Inclusions of Terric Mesisols	n/a	n/a	Low to Moderate
Organic-3 (O3)	**Dominantly** Typic Mesisols	n/a	n/a	Low to Moderate
	Inclusions of Gleysolic soils and Gleyed Eluviated Dystric Brunisols	Loamy sand	<6	High

a) Dominant soil subgroup(s) = cover 60% to 100% of the soil map unit area; co-dominant soil subgroup(s) = cover 40% to 60% of the soil map unit area; sub-dominant soil subgroup(s) = cover 20% to 40% of the soil map unit area; inclusion = cover 15% to 20% of the soil map unit area. The LSA includes the maximum disturbance area and is based on a 1 km buffer around the maximum disturbance area.
b) Derived from soil data presented in Holowaychuk and Fessenden (1987).
< = less than; > = greater than; n/a = not applicable; CEC = cation exchange capacity; LSA = local study area.

5.3.3 Permafrost Potential

The maximum disturbance area and LSA are within the sporadic scattered discontinuous permafrost zone where permafrost may occupy approximately 10% to 50% of the area (Natural Resources Canada 1995). The distribution and occurrence of permafrost is highly variable in the scattered discontinuous permafrost zone. The permafrost in this area is characterized by having low ice content, indicating the ground ice content in the upper 10 to 20 m of the ground has less than 10% ice content by volume of visible ice (Natural Resources Canada 1995). Though most treed bogs have a higher potential to contain permafrost, many fens are free of permafrost (Zoltai 1995). Within the maximum disturbance area and LSA, permafrost, if present, likely occurs in treed bogs with poorly drained Organic soils. No observations of permafrost were recorded during the 2018 and 2019 soil surveys.

In general, imperfectly to poorly drained soils have Low to Moderate permafrost potential, whereas moderately to rapidly drained soils have Very Low potential for permafrost (Table 20). Sandy textured Brunisolic soils in the maximum disturbance area and LSA have Very Low permafrost potential. Gleysolic soils and soils with poor to moderately well drainage have Low permafrost potential. Overall, Organic soils have Low to Moderate potential to contain permafrost (Table 21).

Table 20: Permafrost Potential Rating for Soil Map Units within the Local Study Area

Soil Map Unit Name (Map Unit Symbol)	Soil Subgroups in the Soil Map Unit[(a)]	Dominant Topsoil Horizon Texture	Soil Drainage Class	Permafrost Potential Rating
Mineral-1 (M1)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	Rapid to Well	Very Low
Mineral-2 (M2)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	Rapid to Moderately Well	Very Low
	Inclusions of Gleyed Eluviated Dystric Brunisols			
Mineral-3 (M3)	**Dominantly** Eluviated Dystric Brunisols	Sand	Rapid	Very Low
	Inclusions of Gleyed Eluviated Dystric Brunisols			

Table 20: Permafrost Potential Rating for Soil Map Units within the Local Study Area

Soil Map Unit Name (Map Unit Symbol)	Soil Subgroups in the Soil Map Unit[(a)]	Dominant Topsoil Horizon Texture	Soil Drainage Class	Permafrost Potential Rating
Mineral-4 (M4)	**Dominantly** Eluviated Dystric Brunisols	Sand, loamy sand	Well to Imperfect	Low
	Sub-dominantly Gleyed Eluviated Dystric Brunisols	Loamy sand, sandy loam		
	Inclusions of Gleysolic soils	Loamy sand		
Mineral-5 (M5)	**Dominantly** Gleyed Eluviated Dystric Brunisols	Sand, loamy sand	Moderately Well	Low
	Sub-dominantly Eluviated Dystric Brunisols			
	Inclusions of Gleysolic soils and Terric Mesisols	Loamy sand / n/a		
Mineral-6 (M6)	**Dominantly** Orthic Gleysols	Loamy sand	Imperfect to Very Poor	Low to Moderate
	Sub-dominantly Terric Mesisols	n/a		
	Inclusions of Gleyed Eluviated Dystric Brunisols	Sand, loamy sand		
Mineral-7 (M7)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	Rapid to Well	Very Low
	Inclusions of Gleyed Eluviated Dystric Brunisols			
Mineral-8 (M8)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	Rapid	Very Low
	Inclusions of Gleyed Eluviated Dystric Brunisols			
Mineral-9 (M9)	**Dominantly** Eluviated Dystric Brunisols	Sand, loamy sand	Well to Moderately Well	Low
	Sub-dominantly Gleyed Eluviated Dystric Brunisols	Loamy sand		
Mineral-10 (M10)	**Dominantly** Eluviated Dystric Brunisols	Sandy loam	Rapid to Well	Very Low
	Inclusions of Gleyed Eluviated Dystric Brunisols			
Mineral-11 (M11)	**Dominantly** Gleyed Eluviated Dystric Brunisols	Sand, loamy sand	Moderately Well to Very Poor	Low to Moderate
	Sub-dominantly Eluviated Dystric Brunisols and Gleysolic soils			
	Inclusions of Terric Mesisols	n/a		
Mineral-12 (M12)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand, sandy loam	Rapid to Moderately Well	Low to Moderate
	Inclusions of Gleyed Eluviated Dystric Brunisols and Gleysolic soils			

a) Dominant soil subgroup(s) = cover 60% to 100% of the soil map unit area; co-dominant soil subgroup(s) = near equal proportion of the soil map unit area covered; sub-dominant soil subgroup(s) = cover 15% to 40% of the soil map unit area. The LSA includes the maximum disturbance area and is based on a 1 km buffer around the maximum disturbance area.

n/a = not applicable; LSA = local study area.

Table 21: Permafrost Potential Rating for Organic Soil Map Units within the Local Study Area

Soil Map Unit Name (Map Unit Symbol)	Soil Subgroups in the Soil Map Unit[(a)]	Dominant Topsoil Horizon Texture	Soil Drainage Class	Permafrost Potential
Organic-1 (O1)	**Dominantly** Terric Mesisols	n/a	Very Poor	Low to Moderate
	Inclusions of Gleysolic soils	Sand, loamy sand		
Organic-2 (O2)	**Dominantly** Typic Mesisols	n/a	Very Poor	Low to Moderate
	Inclusions of Terric Mesisols	n/a		
Organic-3 (O3)	**Dominantly** Typic Mesisols	n/a	Imperfect to Very Poor	Low to Moderate
	Inclusions of Gleysolic soils and Gleyed Eluviated Dystric Brunisols	Loamy sand		

a) Dominant soil subgroup(s) = cover 60% to 100% of the soil map unit area; co-dominant soil subgroup(s) = near equal proportion of the soil map unit area covered; sub-dominant soil subgroup(s) = cover 15% to 40% of the soil map unit area. The LSA includes the maximum disturbance area and is based on a 1 km buffer around the maximum disturbance area.
n/a = not applicable; LSA = local study area.

5.3.4 Sensitivity to Compaction

Compaction ratings for SMUs in the LSA are listed in Table 22 and Table 23. Sandy and loamy sand textured Brunisols have a Low sensitivity to compaction under moist soil conditions. Gleysolic soils, including peaty phase Gleysolic soils, generally had sandy, sandy loam, silt, and silt loam textures in the upper and lower mineral soil horizons, indicating Moderate to Very High sensitivity to compaction under wet soil conditions.

Table 22: Compaction Potential Ratings for Mineral Soil Map Units within the Local Study Area

Soil Map Unit Name (Map Unit Symbol)	Soil Subgroups in the Soil Map Unit[(a)]	Dominant Topsoil Horizon Texture	Mineral Soil Compaction Rating
Mineral-1 (M1)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	Low
Mineral-2 (M2)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	Low
	Inclusions of Gleyed Eluviated Dystric Brunisols		
Mineral-3 (M3)	**Dominantly** Eluviated Dystric Brunisols	Sand	Low
	Inclusions of Gleyed Eluviated Dystric Brunisols		
Mineral-4 (M4)	**Dominantly** Eluviated Dystric Brunisols	Sand, loamy sand	Low
	Sub-dominantly Gleyed Eluviated Dystric Brunisols	Loamy sand, sandy loam	
	Inclusions of Gleysolic soils	Loamy sand	
Mineral-5 (M5)	**Dominantly** Gleyed Eluviated Dystric Brunisols	Sand, loamy sand	Low to Moderate
	Sub-dominantly Eluviated Dystric Brunisols		
	Inclusions of Gleysolic soils and Terric Mesisols	Loamy sand / n/a	Low / n/a
Mineral-6 (M6)	**Dominantly** Orthic Gleysols	Loamy sand	Moderate to High
	Sub-dominantly Terric Mesisols	n/a	n/a
	Inclusions of Gleyed Eluviated Dystric Brunisols	Sand, loamy sand	Low
Mineral-7 (M7)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	Low
	Inclusions of Gleyed Eluviated Dystric Brunisols		

Table 22: Compaction Potential Ratings for Mineral Soil Map Units within the Local Study Area

Soil Map Unit Name (Map Unit Symbol)	Soil Subgroups in the Soil Map Unit[a]	Dominant Topsoil Horizon Texture	Mineral Soil Compaction Rating
Mineral-8 (M8)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand	Low
	Inclusions of Gleyed Eluviated Dystric Brunisols		
Mineral-9 (M9)	**Dominantly** Eluviated Dystric Brunisols	Sand, loamy sand	Low
	Sub-dominantly Gleyed Eluviated Dystric Brunisols	Loamy sand	
Mineral-10 (M10)	**Dominantly** Eluviated Dystric Brunisols	Sandy loam	Moderate
	Inclusions of Gleyed Eluviated Dystric Brunisols		
Mineral-11 (M11)	**Dominantly** Gleyed Eluviated Dystric Brunisols	Sand, loamy sand	Low to Moderate
	Sub-dominantly Eluviated Dystric Brunisols and Gleysolic soils		
	Inclusions of Terric Mesisols	n/a	n/a
Mineral-12 (M12)	**Dominantly** Eluviated Dystric Brunisols	Loamy sand, sandy loam	Low
	Inclusions of Gleyed Eluviated Dystric Brunisols and Gleysolic soils		

a) Dominant soil subgroup(s) = cover 60% to 100% of the soil map unit area; co-dominant soil subgroup(s) = near equal proportion of the soil map unit area covered; sub-dominant soil subgroup(s) = cover 15% to 40% of the soil map unit area. The LSA includes the maximum disturbance area and is based on a 1 km buffer around the maximum disturbance area.

n/a = not applicable; LSA = local study area.

Table 23: Compaction Potential Rating for Organic Soil Map Units within the Local Study Area

Soil Map Unit Name (Map Unit Symbol)	Soil Subgroups in Map Unit[a]	Dominant Mineral Soil Texture	Mineral Soil Compaction Rating
Organic-1 (O1)	**Dominantly** Terric Mesisols	n/a	n/a
	Inclusions of Gleysolic soils	Sand, loamy sand	Low
Organic-2 (O2)	**Dominantly** Typic Mesisols	n/a	n/a
	Inclusions of Terric Mesisols	n/a	n/a
Organic-3 (O3)	**Dominantly** Typic Mesisols	n/a	n/a
	Inclusions of Gleysolic soils and Gleyed Eluviated Dystric Brunisols	Loamy sand	Low

a) Dominant soil subgroup(s) = cover 60% to 100% of the soil map unit area; co-dominant soil subgroup(s) = near equal proportion of the soil map unit area covered; sub-dominant soil subgroup(s) = cover 15% to 40% of the soil map unit area. The LSA includes the maximum disturbance area and is based on a 1 km buffer around the maximum disturbance area.

n/a = not applicable; LSA = local study area.

6.0 SUMMARY

The 2018 and 2019 field program results indicate the terrain in most (65%) of the maximum disturbance area and local study area (LSA) comprises undulating to hummocky upland landscape with high relief and dominant surface stoniness class of Very Stony (3% to 15% of ground surface covered). Soil inspections during the field programs indicate that the maximum disturbance area and LSA predominantly consists of loamy sand textured soils formed from glaciofluvial parent material and outwash depositional settings.

The maximum disturbance area and LSA was predominantly classified within the Brunisolic order, with some instances of Gleysolic and Organic orders. The Brunisolic order included subgroup classifications of Eluviated Dystric Brunisol and Gleyed Eluviated Dystric Brunisol. The great group classification (i.e., Eutric and Dystric) was confirmed using the B horizon pH. The soil inspection site within the Gleysolic order was classified as an Orthic Gleysol. Soils classified within the Organic order included Mesic Fibrisol, Fibric Mesisol, Terric Mesisol, and Terric Humisol.

Soil chemistry results from the 2018 and 2019 field programs indicate that concentrations of all metals that were analyzed did not exceed the upper limits of the listed metals in the *Soil Quality Guidelines for the Protection of Environmental and Human Heath* (CCME 2014). Radionuclide analysis of soils samples collected at the 2019 exposure and reference sites identified no detectable levels of lead-210, thorium-228, thorium-230, and thorium-232. Polonium-210 levels ranged between 0.01 and 0.02 becquerels per gram (Bq/g), and radium-226 levels ranged between 0.02 and 0.03 Bq/g. There was a higher concentration of polonium-210 and radium-226 in soils sampled at the reference sites compared to the exposure sites. When compared to the *Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials* (Canadian NORM Working Group 2013), none of the radionuclide values that were analyzed in 2019 exceed the upper limits.

Reclamation suitability of the upper lift mineral soils is rated as Poor due to the general soil profile texture of each mineral soil map unit (SMU) within the maximum disturbance area and LSA. The upper and lower lift ratings for the Organic SMUs within the maximum disturbance area and LSA were deemed not applicable for reclamation purposes, except for mineral soil inclusions that are considered to have a Poor reclamation suitability.

Wind erosion ratings for dominant mineral soil subgroups in all SMUs were generally High in the maximum disturbance area and LSA, based on either sandy-textured mineral upper soil horizons or disturbed upper soil horizons. Sandy Brunisolic soils were deemed to be most sensitive to wind erosion. Surface horizons of Organic soils were deemed to have Low wind erosion ratings. In the event Organic soils are removed and underlying mineral soil horizons are exposed, the wind erosion ratings would be deemed to be High because of the sandy textures contained within the underlying material.

Overall, the uplands in the maximum disturbance area and LSA contain moderately well to rapidly drained sandy soils and are predicted to be most sensitive to acidification (i.e., High sensitivity). Wetlands containing Organic soils (i.e., within bogs, fens, and swamps) have a Low to Moderate sensitivity to acidification.

Brunisolic soils within the maximum disturbance area and LSA generally have Very Low permafrost potential rating. Gleysolic soils and soils with poor to moderately well drainage have Low permafrost potential. Areas of treed bogs containing Organic soils would be the most likely to contain permafrost; however, no permafrost soils were observed during the field programs. Overall, Organic soils have Low to Moderate potential to contain permafrost where permafrost potential within the maximum disturbance area and LSA is Low.

Sandy and loamy sand textured Brunisols have a Low sensitivity to compaction under moist soil conditions. Gleysolic soils with sandy and sandy loam textures in the upper and lower mineral soil horizons also generally have a Low sensitivity to compaction under moist conditions. Overall, compaction sensitivity in the maximum disturbance area and LSA is Low.

The objectives of the terrain and baseline study, to obtain information on terrain and sensitive terrain, characterize existing soil quality and distribution and determine baseline soil chemistry and evaluate soil sensitivities within the maximum disturbance area and LSA, have been met.

CLOSING

Golder is pleased to submit this report to NexGen in support of the environmental assessment for the Rook I Project. For details on the limitations and use of information presented in this report, please refer to the Study Limitations section following this page. If you have any questions or require additional details related to this study, please contact the undersigned.

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KH/JV/rd

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APPENDIX A

Joint Working Group Feedback Applicable to Terrain and Soils Baseline

Table A-1 presents the comments and feedback NexGen has received from members of local Indigenous communities through established Joint Working Group meetings. NexGen continues to engage with communities, and the feedback presented in Table A-1 reflects comments and feedback received through March 2020 that were related to baseline terrain and soils or the comprehensive baseline program generally.

Table A-1: Joint Working Group Feedback – Terrain and Soils

Community	Comment
Birch Narrows Dene Nation (BNDN)	Are you aware of any huge adverse environmental impacts in any of the current mine sites?
	Important topics for the Joint Working Group moving forward are Indigenous knowledge, traditional land use, the species discussion, water quality, environmental monitoring, employment and business opportunities.
	Could we ask that you take samples here? That way we can see changes into the future. Even if it isn't affected by the mine. Respectfully, I request that samples are taken here.
	What's the elevation on the shore?
Buffalo River Dene Nation (BRDN)	Have you gone to communities to show what you are doing? If so, what was the feedback?
	It's important to explain the Project to elders in a way that they can then explain it to other elders in the communities.
	I met an old guy in Lac Brochet; I was standing there and he came up to me. Lac Brochet is landscaped by rocks. He's from Brochet and he goes back and forth to Lac Brochet. He said, see that rock there? I said yes. It's alive, he said. There's one spot on the lake where everyone stops to have tea. One trip a few years ago he stopped at that island and started a fire to make tea. He heard rumbling; it was a clear sky. He thought it was maybe jets flying over, but it got louder and he could feel the ground shaking. He could see the water rippling where the boat launch was. Suddenly he saw the top of a rock come out through the top of the lake. He got scared. He left and went to Lac Brochet. On the way home he didn't want to stop there but he went around the island looking, and that rock was up on the shore. He said it crawled right up there. That's why he said those rocks are alive. That story is from not even 30 years ago.
Clearwater River Dene Nation (CRDN)	Remember, we're trying to implement a plain speak document because of visual concepts of understanding. That is what the Chief is talking about.
	In terms of baseline studies, are there any opportunities for community involvement with any of your residual baseline work, from fish, terrestrial, etc.?
	We will eventually throw in our environmental monitors. I don't know if you knew that. We want to train our own people because of lack of trust of government and industry.
	The interim CRDN Rights and Knowledge study will come out of the CRDN-defined initial list of valued components that we want to talk to you about. As we go through there may be additional ones. We know there's a certain window, but we'll try to be as comprehensive as possible. It may not be as linear as moose; it might be having undisturbed places on waterbodies. They might be more complex.
	How far away from the mine to the lake?
	Not on the old or existing mines that are sitting there?
	Golder does the same thing – hires three or four band members to do the interviews, then takes the notes and puts the document together. When you find the stuff it's not always based on the relationship to the stuff. It's based on what the government's qualifications are on the Environmental Assessment's impacts, and not the actual concerns of it. I'm trying to reach what [CRDN member] is saying between traditional and modern ways.

Table A-1: Joint Working Group Feedback – Terrain and Soils

Community	Comment
Clearwater River Dene Nation (CRDN)	When we started looking at the strategy process, there is that interpretation of cumulative effects. Then we define and introduce an interpretation for that. It's not just one side, western science, we're doing the traditional side as well. That's what the Chief's referring to.
	Both traditional and western science are very important.
	Will we see the results of those studies?
	How many other projects are in that square box (referring to map)?
	Do other companies have mineral holdings in that box on the map – like for oil and gas?
	I think it's really important to compare Cluff Lake to what's happening in the baseline studies. It's a good question.
	What's the purpose of trying to gather all this information?
Métis Nation – Saskatchewan (MN-S)	We have to understand all living and non-living things.
	Are any community members involved in the establishment of the baseline for environmental monitoring, so can they verify their accuracy? Would the results be released and reviewed by the community? From a trust point of view, our people will want to know that those numbers are accurate now, not later. Just a comment to think about.
	How would this group know – is there a way for the people involved in the studies to inform the group of what they saw and if they are confident, they are accurate? Once the stuff hits the Environmental Impact Statement (EIS), how do we know that it is good? If community folks that were involved in that process and they can validate the results, that brings comfort to community members.
	How often are you monitoring?
	It's that validation we're looking for. When I had to involve community members in monitoring, I would get them to write a report if they couldn't speak to the broader community in general. If they didn't feel like writing it, they could talk so someone who would transcribe it. That report could give a summary of how things went, what they saw, were the readings accurate; that could come back to this group, if they couldn't present themselves. The point [MN-S member's] trying to make is, we need some connection to that community resource that's out there doing the monitoring and seeing this stuff. We know who they are, and we're confident in the results. That builds trust.
	Do you have instruments or people taking samples? What does an instrument look like?
	The studies we did a few years back, these guys don't want to use them. That's what I heard.
	I had feedback on community engagement, and I'm trying to figure out how we can move forward in a responsible way where people have their input without being offended. We're working towards a bigger goal than what is currently perceived. We need a discussion on how we can approach it. I can offer some high-level thinking to help bring my community around.
	We should have more of these meetings with other companies like this. I'd like to get a Métis community member to work side by side with you guys and report the environmental side to the community instead of you guys doing it, so we know where we are and how much damage is being done to the land.
	This is general – the same information will come back to all the Joint Working Groups??

BNDN = Birch Narrows Dene Nation; BRDN = Buffalo River Dene Nation; CRDN = Clearwater River Dene Nation; EIS = Environmental Impact Statement; MNS = Métis Nation – Saskatchewan.

APPENDIX B

Chemical Analysis Results

Table B-1: Soil pH Results

Sampling Program	Sample	Horizon	Depth	pH
			cm	1:2 $CaCl_2$
2018 soil survey baseline	NR18MS 58	AC	0-13	4.13
	NR18MS 58	Bm	13-34	4.56
	NR18MS 58	Cg	34-100	5.20
	NR18MS 77	Of	0-40	3.41
	NR18MS 77	Om	40-95	3.17
	NR18MS 82	AC	0-7	4.09
	NR18MS 82	Bj	7-35	4.54
	NR18MS 96	LFH	9-0	2.86
	NR18MS 96	AhC	0-5	3.20
	NR18MS 96	Bmgj	5-24	4.24
	NR18MS 96	BC	24-55	3.91
	NR18MS 96	C	55-100	4.33
	NR18MS 108	LFH	4-0	3.22
	NR18MS 108	Aegj	0-14	3.18
	NR18MS 108	Bg	14-40	3.83
	NR18MS 108	Cg	40-100	4.30
	Lowest Detection Limit			**2.86**
	Highest Detection Limit			**5.20**
2019 soil survey baseline	EXP01 A	Ahe/Ae	0-19	3.39
	EXP01 B	Ahe/Ae	0-19	3.17
	EXP01 C	Ahe/Ae	0-17	3.53
	EXP02 A	Ae	0-13	3.17
	EXP02 B	Ahe/Ae	0-29	3.18
	EXP02 C	Ahe/Ae	0-24	3.08
	EXP03 A	Ahe/Ae	0-28	4.27
	EXP03 B	Ahe/Ae	0-25	3.75
	EXP03 C	Ahe/Ae	0-22	3.57
	REF04 A	Ahe/Ae	0-12	3.75
	REF04 B	Ae	0-12	3.93
	REF04 C	Ae	0-5	3.78
	REF05 A	Ahe/Ae	0-9	4.06
	REF05 B	Ae	0-5	3.80
	REF05 C	Ahe/Ae	0-10	3.76
	REF06 A	Ahe/Ae	0-23	3.42
	REF06 B	Ahe/Ae	0-59	3.59
	REF06 C	Ae	0-10	3.85
	Lowest Detection Limit			**3.08**
	Highest Detection Limit			**4.27**

cm = centimetre; CaCl2 = calcium chloride.

Table B-2: Soil Analytical Results (Saturated Paste Extractables)

Sampling Program	Sample	Horizon	Depth	pH	SAR[a]	Sodium	Calcium	Magnesium	Potassium	Conductivity Sat. Paste	Saturation
			cm	1:2 $CaCl_2$		mg/L	mg/L	mg/L	mg/L	dS/m	%
2018 soil survey baseline	NR18MS 58	AC	0-13	4.13	Incalculable	<5.0	<5.0	<5.0	5.6	<0.10	25.9
	NR18MS 58	Bm	13-34	4.56	Incalculable	14.5	<5.0	<5.0	<5.0	0.10	28.0
	NR18MS 58	Cg	34-100	5.20	Incalculable	<5.0	<5.0	<5.0	<5.0	<0.10	25.3
	NR18MS 77	Of	0-40	3.41	2.6	22.3	5.6	<5.0	9.4	0.18	941
	NR18MS 77	Om	40-95	3.17	0.83	9.7	10.3	<5.0	<5.0	0.15	601
	NR18MS 82	AC	0-7	4.09	<0.50	<5.0	7.3	<5.0	<5.0	<0.10	24.8
	NR18MS 82	Bj	7-35	4.54	Incalculable	<5.0	<5.0	<5.0	<5.0	<0.10	29.6
	NR18MS 96	LFH	9-0	2.86	<0.40	<5.0	10.2	<5.0	12.2	0.20	428
	NR18MS 96	AhC	0-5	3.20	0.64	5.6	5.9	<5.0	8.1	0.17	56.7
	NR18MS 96	Bmgj	5-24	4.24	Incalculable	<5.0	<5.0	<5.0	<5.0	<0.10	41.2
	NR18MS 96	BC	24-55	3.91	Incalculable	6.0	<5.0	<5.0	<5.0	<0.10	34.2
	NR18MS 96	C	55-100	4.33	Incalculable	<5.0	<5.0	<5.0	<5.0	<0.10	23.5
	NR18MS 108	LFH	4-0	3.22	<0.30	<5.0	17.4	6.7	35.6	0.29	247
	NR18MS 108	Aegj	0-14	3.18	Incalculable	<5.0	<5.0	<5.0	<5.0	<0.10	32.9
	NR18MS 108	Bg	14-40	3.83	Incalculable	<5.0	<5.0	<5.0	<5.0	<0.10	35.0
	NR18MS 108	Cg	40-100	4.30	Incalculable	<5.0	<5.0	<5.0	<5.0	<0.10	32.4
	Lowest Detection Limit			**2.86**	**0.30**	**5.0**	**5.0**	**5.0**	**5.0**	**0.10**	**1.0**
	Highest Detection Limit			**5.20**	**2.60**	**22.30**	**17.40**	**6.70**	**35.60**	**0.29**	**941.00**
2019 soil survey	EXP01 A	Ahe/Ae	0-19	3.39	0.2	2	10	3	8	0.19	29.2
	EXP01 B	Ahe/Ae	0-19	3.17	0.2	3	8	2	12	0.24	32.8
	EXP01 C	Ahe/Ae	0-17	3.53	2	22	5	2	11	0.25	31.2
	EXP02 A	Ae	0-13	3.17	0.2	2	6	3	7	0.23	27.9
	EXP02 B	Ahe/Ae	0-29	3.18	0.3	5	13	4	10	0.30	36.5
	EXP02 C	Ahe/Ae	0-24	3.08	0.7	6	5	2	11	0.35	37.0
	EXP03 A	Ahe/Ae	0-28	4.27	0.2	2	10	3	6	0.15	32.1
	EXP03 B	Ahe/Ae	0-25	3.75	0.5	6	10	2	10	0.17	23.2
	EXP03 C	Ahe/Ae	0-22	3.57	0.2	3	10	2	7	0.18	24.5
	REF04 A	Ahe/Ae	0-12	3.75	0.3	5	13	2	5	0.19	27.4
	REF04 B	Ae	0-12	3.93	0.1	3	20	3	6	0.22	31.2
	REF04 C	Ae	0-5	3.78	0.2	3	13	3	9	0.23	33.4
	REF05 A	Ahe/Ae	0-9	4.06	0.1	3	20	4	4	0.20	29.2
	REF05 B	Ae	0-5	3.80	0.2	4	18	6	7	0.24	34.5
	REF05 C	Ahe/Ae	0-10	3.76	0.3	5	14	5	6	0.24	38.7
	REF06 A	Ahe/Ae	0-23	3.42	0.2	2	10	2	6	0.16	29.0
	REF06 B	Ahe/Ae	0-59	3.59	0.1	3	24	5	22	0.32	36.6
	REF06 C	Ae	0-10	3.85	0.2	3	11	4	8	0.18	25.7
	Lowest Detection Limit			**3.08**	**0.1**	**2**	**5**	**2**	**4**	**0.15**	**23.20**
	Highest Detection Limit			**4.27**	**0.70**	**22**	**24**	**6**	**22**	**0.35**	**38.70**

a) Incalculable due to undetecable sodium, calcium, or magnesium. Detection limit represents maximum possible SAR value. Actual SAR values may be lower if both calcium and magnesium were detectable.

cm = centimetre; SAR = sodium adsorption ratio; $CaCl_2$ = calcium chloride; mg/L = miligrams per litre; dS/m^{-1} = deciSiemens per metre; % = percent; < = less than; - = not measured or incalculable.

Table B-3: Soil Cation Exchange Capacity Results

Sample	Horizon	Depth	Cation Exchange Capacity
		cm	mEq/100 g
NR18MS 58	AC	0-13	<0.80
NR18MS 58	Bm	13-34	-
NR18MS 58	Cg	34-100	-
NR18MS 77	Of	0-40	-
NR18MS 77	Om	40-95	-
NR18MS 82	AC	0-7	<0.80
NR18MS 82	Bj	7-35	-
NR18MS 96	LFH	9-0	-
NR18MS 96	AhC	0-5	7.68
NR18MS 96	Bmgj	5-24	-
NR18MS 96	BC	24-55	-
NR18MS 96	C	55-100	-
NR18MS 108	LFH	4-0	-
NR18MS 108	Aegj	0-14	<0.80
NR18MS 108	Bg	14-40	-
NR18MS 108	Cg	40-100	-
Lowest Detection Limit			**0.80**
Highest Detection Limit			**7.68**

cm = centimetre; mEq/100 g = milliequivalents per 100 grams; < = less than; - = not applicable.

Table B-4: Soil Analytical Results for Acid Base Accounting, Trace Metals, Short Term Leach Design, Mineralogical Testing (Leachable Metals)

Sampling Program	Sample	Horizon	Depth	Aluminum (Al)	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Bismuth (Bi)	Boron (B)	Cadmium (Cd)	Calcium (Ca)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Lithium (Li)	Magnesium (Mg)	Manganese (Mn)	Mercury (Hg)
			cm	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
2018 soil survey baseline	NR18MS 58	AC	0-13	187	<0.10	0.20	6.98	<0.10	<0.20	<5.0	<0.020	<50	<0.50	<0.10	<0.50	250	<0.50	<2.0	54	3.7	<0.0050
	NR18MS 58	Bm	13-34	4560	<0.10	0.64	10.2	<0.10	<0.20	<5.0	<0.020	64	3.62	0.38	2.98	3830	1.97	3.2	179	10.5	0.0232
	NR18MS 58	Cg	34-100	782	<0.10	0.41	3.82	<0.10	<0.20	<5.0	<0.020	<50	1.02	0.30	<0.50	1020	0.59	<2.0	98	7.1	<0.0050
	NR18MS 77	Of	0-40	3210	0.17	1.46	200	0.18	0.28	<5.0	0.339	7210	7.32	2.03	10.2	3210	3.87	3.3	1980	71.2	0.0763
	NR18MS 77	Om	40-95	2810	<0.10	0.61	266	0.18	<0.20	<5.0	0.275	5910	4.50	0.79	3.95	1490	0.66	<2.0	955	20.2	0.0716
	NR18MS 82	AC	0-7	354	<0.10	0.22	3.75	<0.10	<0.20	<5.0	<0.020	58	0.51	<0.10	<0.50	491	0.67	<2.0	31	14.7	<0.0050
	NR18MS 82	Bj	7-35	4760	<0.10	0.82	12.0	0.11	<0.20	<5.0	<0.020	92	3.95	0.57	1.91	4140	1.88	4.3	266	14.5	0.0211
	NR18MS 96	LFH	9-0	4140	<0.10	1.08	235	0.31	<0.20	<5.0	0.257	2870	3.40	0.70	6.82	2420	6.43	<2.0	324	33.6	0.0853
	NR18MS 96	AhC	0-5	1980	<0.10	0.52	17.3	<0.10	<0.20	<5.0	<0.020	83	2.93	0.16	0.91	1750	2.14	<2.0	136	6.2	0.0126
	NR18MS 96	Bmgj	5-24	7180	<0.10	0.97	22.3	0.16	<0.20	<5.0	<0.020	161	7.60	1.00	0.85	6350	2.44	4.6	688	20.3	0.0124
	NR18MS 96	BC	24-55	5460	<0.10	1.06	22.6	0.15	<0.20	<5.0	<0.020	136	8.47	1.25	0.89	5160	1.85	4.6	1010	24.8	0.0119
	NR18MS 96	C	55-100	1870	<0.10	0.59	8.46	<0.10	<0.20	<5.0	<0.020	104	2.81	0.58	0.57	1860	0.94	<2.0	324	19.7	<0.0050
	NR18MS 108	LFH	4-0	816	<0.10	0.51	69.9	<0.10	<0.20	<5.0	0.156	2090	1.63	0.24	3.29	854	3.37	<2.0	279	234	0.0642
	NR18MS 108	Aegj	0-14	130	<0.10	0.16	1.64	<0.10	<0.20	<5.0	<0.020	<50	<0.50	<0.10	<0.50	95	<0.50	<2.0	<20	<1.0	<0.0050
	NR18MS 108	Bg	14-40	1300	<0.10	0.83	3.62	<0.10	<0.20	<5.0	<0.020	63	1.72	0.13	<0.50	5090	<0.50	<2.0	55	1.6	<0.0050
	NR18MS 108	Cg	40-100	592	<0.10	0.27	2.85	<0.10	<0.20	<5.0	<0.020	55	0.93	<0.10	<0.50	353	<0.50	<2.0	47	1.2	<0.0050
	Lowest Detection Limit			**50**	**0.10**	**0.10**	**0.50**	**0.10**	**0.20**	**5.0**	**0.020**	**50**	**0.50**	**0.10**	**0.50**	**50**	**0.50**	**2.0**	**20**	**1.0**	**0.0050**
	Highest Detection Limit			**7180**	**0.17**	**1.46**	**266**	**0.31**	**0.28**	**5.0**	**0.34**	**7210**	**8.47**	**2.03**	**10.20**	**6350**	**6.43**	**4.60**	**1980**	**234**	**0.0853**
2019 soil survey	EXP01 A	Ahe/Ae	0-19	2030	<0.2	0.5	24	<0.1	<0.2	3	<0.1	140	3.0	0.2	<0.5	910	1.4	1.3	130	24	<0.05
	EXP01 B	Ahe/Ae	0-19	1680	<0.2	0.4	27	<0.1	<0.2	2	<0.1	170	2.9	0.2	<0.5	890	1.4	1.2	120	19	<0.05
	EXP01 C	Ahe/Ae	0-17	1190	<0.2	0.5	28	<0.1	<0.2	2	<0.1	160	1.7	<0.2	<0.5	630	1.5	0.7	70	18	<0.05
	EXP02 A	Ae	0-13	2220	<0.2	0.8	22	<0.1	<0.2	4	<0.1	150	5.3	2.5	<0.5	6200	1.6	3.5	110	74	<0.05
	EXP02 B	Ahe/Ae	0-29	2580	<0.2	0.8	27	<0.1	<0.2	4	<0.1	130	5.0	0.3	0.5	2940	1.6	1.8	130	40	<0.05
	EXP02 C	Ahe/Ae	0-24	2820	<0.2	0.7	30	<0.1	<0.2	5	<0.1	180	4.3	0.4	0.7	7300	1.8	1.9	160	110	<0.05
	EXP03 A	Ahe/Ae	0-28	1700	<0.2	0.5	17	<0.1	<0.2	3	<0.1	130	4.7	<0.2	<0.5	840	1.4	1.4	110	16	<0.05
	EXP03 B	Ahe/Ae	0-25	1060	<0.2	0.4	16	<0.1	<0.2	2	<0.1	130	2.1	0.4	<0.5	600	1.3	0.8	70	12	<0.05
	EXP03 C	Ahe/Ae	0-22	940	<0.2	0.4	14	<0.1	<0.2	<1	<0.1	160	1.5	<0.2	<0.5	570	1.2	0.6	80	22	<0.05
	REF04 A	Ahe/Ae	0-12	3650	<0.2	0.9	28	<0.1	<0.2	3	<0.1	330	4.2	0.5	0.8	2870	2.4	3.9	360	35	<0.05
	REF04 B	Ae	0-12	2440	<0.2	0.5	31	<0.1	<0.2	2	<0.1	290	3.6	0.2	<0.5	1590	1.8	1.8	180	34	<0.05
	REF04 C	Ae	0-5	2530	<0.2	0.7	24	<0.1	<0.2	2	<0.1	280	2.8	0.5	<0.5	1420	1.7	2.3	200	43	<0.05
	REF05 A	Ahe/Ae	0-9	4750	<0.2	0.8	41	<0.1	<0.2	2	<0.1	550	5.8	0.9	1.0	4770	2.3	3.6	490	70	<0.05
	REF05 B	Ae	0-5	5200	<0.2	0.8	33	<0.1	<0.2	3	<0.1	540	7.2	0.8	1.0	4900	2.4	4.2	570	60	<0.05
	REF05 C	Ahe/Ae	0-10	5400	<0.2	0.9	30	<0.1	<0.2	2	<0.1	510	8.1	1.1	0.9	5400	2.6	4.1	540	56	<0.05
	REF06 A	Ahe/Ae	0-23	850	<0.2	0.4	15	<0.1	<0.2	2	<0.1	150	16	0.4	0.6	480	1.3	0.6	60	18	<0.05
	REF06 B	Ahe/Ae	0-59	840	<0.2	0.4	17	<0.1	<0.2	3	<0.1	200	4.6	0.9	<0.5	330	1.4	0.6	60	21	<0.05
	REF06 C	Ae	0-10	3690	<0.2	0.7	28	<0.1	<0.2	4	<0.1	310	3.9	0.5	0.7	2150	2.1	2.6	240	26	<0.05
	Lowest Detection Limit			**0.5**	**0.2**	**0.1**	**0.5**	**0.1**	**0.2**	**1.0**	**0.1**	**10.0**	**0.5**	**0.2**	**0.5**	**0.5**	**0.1**	**0.1**	**10.0**	**0.5**	**0.1**
	Highest Detection Limit			**5400**	**0.2**	**0.9**	**41**	**0.1**	**0.2**	**5.0**	**0.1**	**550**	**16**	**2.5**	**1.00**	**7300**	**2.6**	**4.2**	**570**	**110**	**0.05**

mg/kg = milligram per kilogram; < = less than

Table B-4: Soil Analytical Results for Acid Base Accounting, Trace Metals, Short Term Leach Design, Mineralogical Testing (Leachable Metals)

Sampling Program	Sample	Horizon	Depth	Molybdenum (Mo)	Nickel (Ni)	Phosphorus (P)	Potassium (K)	Selenium (Se)	Silver (Ag)	Sodium (Na)	Strontium (Sr)	Sulfate (SO_4)	Sulfur (S)	Thallium (Tl)	Tin (Sn)	Titanium (Ti)	Tungsten (W)	Uranium (U)	Vanadium (V)	Zinc (Zn)	Zirconium (Zr)
			cm	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
2018 soil survey baseline	NR18MS 58	AC	0-13	<0.10	<0.50	<50	<100	<0.20	<0.10	<50	1.75	-	<1000	<0.050	<1.0	25.5	0.62	<0.050	0.68	<2.0	<1.0
	NR18MS 58	Bm	13-34	0.15	1.06	373	<100	<0.20	<0.10	<50	4.10	-	<1000	<0.050	<1.0	78.0	<0.50	0.158	8.52	16.8	1.7
	NR18MS 58	Cg	34-100	<0.10	0.62	<50	<100	<0.20	<0.10	<50	3.88	-	<1000	<0.050	<1.0	29.5	<0.50	0.086	1.92	2.1	1.0
	NR18MS 77	Of	0-40	4.09	9.10	545	660	0.29	0.78	567	71.5	-	1900	<0.050	<1.0	11.4	13.3	30.9	5.86	28.1	2.5
	NR18MS 77	Om	40-95	0.56	5.90	504	160	0.33	0.12	154	52.6	-	2400	<0.050	<1.0	20.9	<0.50	0.794	4.37	20.9	<1.0
	NR18MS 82	AC	0-7	<0.10	<0.50	<50	<100	<0.20	<0.10	<50	1.78	-	<1000	<0.050	<1.0	25.9	<0.50	<0.050	1.28	<2.0	<1.0
	NR18MS 82	Bj	7-35	0.12	1.41	242	<100	<0.20	<0.10	<50	3.89	-	<1000	<0.050	<1.0	99.4	<0.50	0.214	8.42	8.1	1.8
	NR18MS 96	LFH	9-0	0.34	4.39	814	400	0.38	<0.10	<50	33.2	-	<1000	<0.050	<1.0	18.0	<0.50	0.181	4.32	10.6	<1.0
	NR18MS 96	AhC	0-5	<0.10	0.61	109	<100	<0.20	<0.10	<50	2.84	-	<1000	<0.050	<1.0	13.8	<0.50	0.180	4.31	2.6	<1.0
	NR18MS 96	Bmgj	5-24	0.13	2.18	145	120	<0.20	<0.10	<50	5.40	-	<1000	<0.050	<1.0	161	<0.50	0.348	11.9	5.6	<1.0
	NR18MS 96	BC	24-55	0.16	3.11	68	160	<0.20	<0.10	<50	7.95	-	<1000	<0.050	<1.0	197	<0.50	0.397	11.9	6.5	3.2
	NR18MS 96	C	55-100	<0.10	1.28	55	130	<0.20	<0.10	<50	6.47	-	<1000	<0.050	<1.0	60.9	<0.50	0.157	4.45	2.7	1.3
	NR18MS 108	LFH	4-0	0.24	1.53	410	450	<0.20	<0.10	<50	9.07	-	<1000	<0.050	<1.0	15.9	<0.50	0.060	1.90	17.4	<1.0
	NR18MS 108	Aegj	0-14	<0.10	<0.50	<50	<100	<0.20	<0.10	<50	2.09	-	<1000	<0.050	<1.0	7.7	<0.50	<0.050	0.27	<2.0	<1.0
	NR18MS 108	Bg	14-40	0.11	<0.50	57	<100	<0.20	<0.10	<50	2.84	-	<1000	<0.050	<1.0	24.5	<0.50	0.103	7.69	<2.0	<1.0
	NR18MS 108	Cg	40-100	<0.10	<0.50	51	<100	<0.20	<0.10	<50	3.53	-	<1000	<0.050	<1.0	18.2	<0.50	0.078	1.21	<2.0	<1.0
	Lowest Detection Limit			**0.10**	**0.50**	**50**	**100**	**0.20**	**0.10**	**50**	**0.50**	**-**	**1000**	**0.050**	**1.0**	**1.0**	**0.50**	**0.050**	**0.20**	**2.0**	**1.0**
	Highest Detection Limit			**4.09**	**9.10**	**814**	**660**	**0.38**	**0.78**	**567**	**71.50**	**-**	**2400**	**0.050**	**1.0**	**197**	**13.3**	**30.90**	**11.90**	**28.10**	**3.2**
2019 soil survey	EXP01 A	Ahe/Ae	0-19	<0.1	0.5	40	620	<0.1	<0.1	110	15	18	-	<0.2	<0.1	210	<0.5	0.2	3.1	1.7	13
	EXP01 B	Ahe/Ae	0-19	<0.1	0.4	40	560	<0.1	<0.1	120	16	20	-	<0.2	<0.1	220	<0.5	0.3	3.4	1.8	17
	EXP01 C	Ahe/Ae	0-17	<0.1	0.3	40	460	<0.1	<0.1	130	16	20	-	<0.2	<0.1	130	<0.5	0.2	2.0	2.2	13
	EXP02 A	Ae	0-13	0.1	2.0	130	560	<0.1	<0.1	80	24	23	-	<0.2	<0.1	160	<0.5	0.3	4.4	2.4	13
	EXP02 B	Ahe/Ae	0-29	0.1	0.7	70	580	<0.1	<0.1	80	17	32	-	<0.2	0.1	280	<0.5	0.3	5.2	2.5	16
	EXP02 C	Ahe/Ae	0-24	0.2	1.2	110	710	<0.1	<0.1	140	20	31	-	<0.2	0.1	240	<0.5	0.3	5.4	3.2	16
	EXP03 A	Ahe/Ae	0-28	0.2	1.4	40	450	<0.1	<0.1	120	18	10	-	<0.2	<0.1	140	<0.5	0.2	2.3	0.9	16
	EXP03 B	Ahe/Ae	0-25	<0.1	0.4	40	360	<0.1	<0.1	100	18	12	-	<0.2	<0.1	120	<0.5	0.2	1.8	1.0	14
	EXP03 C	Ahe/Ae	0-22	<0.1	0.3	30	320	<0.1	<0.1	120	14	12	-	<0.2	<0.1	130	<0.5	0.2	1.7	1.9	9.2
	REF04 A	Ahe/Ae	0-12	<0.1	1.2	70	630	<0.1	<0.1	100	32	10	-	<0.2	0.2	280	<0.5	0.3	8.3	5.4	18
	REF04 B	Ae	0-12	0.1	0.9	80	630	<0.1	<0.1	110	17	13	-	<0.2	0.1	200	<0.5	0.2	4.9	3.8	14
	REF04 C	Ae	0-5	<0.1	0.9	50	600	<0.1	<0.1	150	20	11	-	<0.2	<0.1	130	<0.5	0.2	3.5	3.3	10
	REF05 A	Ahe/Ae	0-9	0.1	1.7	90	770	<0.1	<0.1	150	18	12	-	<0.2	0.2	360	<0.5	0.3	10	7.1	17
	REF05 B	Ae	0-5	0.2	2.1	80	610	<0.1	<0.1	110	17	10	-	<0.2	4.2	420	<0.5	0.4	13	5.5	17
	REF05 C	Ahe/Ae	0-10	0.2	2.2	120	500	<0.1	<0.1	120	16	14	-	<0.2	0.3	460	<0.5	0.4	14	7.4	17
	REF06 A	Ahe/Ae	0-23	1.8	7.4	40	330	<0.1	<0.1	120	13	14	-	<0.2	<0.1	75	<0.5	0.2	1.3	1.4	8.6
	REF06 B	Ahe/Ae	0-59	0.2	2.0	40	250	<0.1	<0.1	80	15	27	-	<0.2	<0.1	61	<0.5	0.2	1.1	2.8	8.7
	REF06 C	Ae	0-10	<0.1	0.9	160	1600	<0.1	<0.1	870	18	6	-	<0.2	0.1	150	<0.5	0.2	5.5	3.9	14
	Lowest Detection Limit			**0.1**	**0.1**	**10**	**10**	**0.1**	**0.1**	**10**	**0.50**	**2**	**-**	**0.2**	**0.1**	**0.5**	**0.5**	**0.1**	**0.1**	**0.5**	**0.1**
	Highest Detection Limit			**1.80**	**7.4**	**160**	**1600**	**0.1**	**0.1**	**870**	**32**	**32**	**-**	**0.2**	**4.2**	**460**	**0.5**	**0.40**	**14**	**7.40**	**18.0**

cm = centimetre; mg/kg = milligram per kilogram; < = less than; - not measured.

Source: CCME (2014); Based on soil chemistry results from the 2018 and 2019 field programs, concentrations of samples are considered to be below Canadian Council of Ministers of the Environment Soil Quality Guidelines for the Protection of Environmental and Human Heath.

Table B-5: Soil Analytical Results for Particle Size

Sample	Horizon	Depth	% Sand	% Silt	% Clay	Texture
		cm	(2.0 mm - 0.05 mm)	(0.05 mm - 2 µm)	<2 µm	
NR18MS 58	AC	0-13	94.0	5.8	<1.0	Sand
NR18MS 58	Bm	13-34	83.7	15.9	<1.0	Loamy sand
NR18MS 58	Cg	34-100	96.3	3.6	<1.0	Sand
NR18MS 77	Of	0-40	-	-	-	-
NR18MS 77	Om	40-95	-	-	-	-
NR18MS 82	AC	0-7	91.0	8.9	<1.0	Sand
NR18MS 82	Bj	7-35	74.3	24.8	<1.0	Loamy sand
NR18MS 96	LFH	9-0	-	-	-	-
NR18MS 96	AhC	0-5	27.9	69.6	2.5	Silt loam
NR18MS 96	Bmgj	5-24	26.3	71.6	2.1	Silt loam
NR18MS 96	BC	24-55	28.5	67.7	3.8	Silt loam
NR18MS 96	C	55-100	81.3	17.9	<1.0	Loamy sand
NR18MS 108	LFH	4-0	-	-	-	-
NR18MS 108	Aegj	0-14	94.8	5.1	<1.0	Sand
NR18MS 108	Bg	14-40	93.4	5.6	1.0	Sand
NR18MS 108	Cg	40-100	98.9	<1.0	<1.0	Sand
Lowest Detection Limit		-	1.0	1.0	1.0	-

cm = centimetre; % = percent; mm = millimetre; µm = micrometre; < = less than; - = not applicable.

Table B-6: Baseline Total Radionuclides in Soil at the 2019 Soil Monitoring Program Reference and Exposure Locations

Sampling Program	Sample	Horizon	Depth	Lead-210	Polonium-210	Radium-226	Thorium-228	Thorium-230	Thorium-232
			cm	Bq/g	Bq/g	Bq/g	Bq/g	Bq/g	Bq/g
2019 soil survey	EXP01 A	Ahe/Ae	0-19	< 0.04	0.01	0.02	<0.02	<0.02	<0.02
	EXP01 B	Ahe/Ae	0-19	< 0.04	< 0.01	0.02	<0.02	<0.02	<0.02
	EXP01 C	Ahe/Ae	0-17	< 0.04	< 0.01	0.01	<0.02	<0.02	<0.02
	EXP02 A	Ae	0-13	< 0.04	0.01	< 0.01	<0.02	<0.02	<0.02
	EXP02 B	Ahe/Ae	0-29	< 0.04	< 0.01	0.02	<0.02	<0.02	<0.02
	EXP02 C	Ahe/Ae	0-24	< 0.04	< 0.01	0.02	<0.02	<0.02	<0.02
	EXP03 A	Ahe/Ae	0-28	< 0.04	< 0.01	0.02	<0.02	<0.02	<0.02
	EXP03 B	Ahe/Ae	0-25	< 0.04	< 0.01	< 0.01	<0.02	<0.02	<0.02
	EXP03 C	Ahe/Ae	0-22	< 0.04	< 0.01	< 0.01	<0.02	<0.02	<0.02
	REF04 A	Ahe/Ae	0-12	< 0.04	< 0.01	0.02	<0.02	<0.02	<0.02
	REF04 B	Ae	0-12	< 0.04	0.01	0.02	<0.02	<0.02	<0.02
	REF04 C	Ae	0-5	< 0.04	0.01	0.02	<0.02	<0.02	<0.02
	REF05 A	Ahe/Ae	0-9	< 0.04	0.02	0.02	<0.02	<0.02	<0.02
	REF05 B	Ae	0-5	< 0.04	0.01	0.02	<0.02	<0.02	<0.02
	REF05 C	Ahe/Ae	0-10	< 0.04	< 0.01	0.02	<0.02	<0.02	<0.02
	REF06 A	Ahe/Ae	0-23	< 0.04	< 0.01	0.03	<0.02	<0.02	<0.02
	REF06 B	Ahe/Ae	0-59	< 0.04	0.02	0.03	<0.02	<0.02	<0.02
	REF06 C	Ae	0-10	< 0.04	0.02	0.02	<0.02	<0.02	<0.02
	Lowest Detection Limit			0.04	0.01	0.01	0.02	0.02	0.02

cm = centimentre; Bq/g = becquerels per gram; < = less than.

Golder Associates Ltd.
ATTN: KYLE HODGSON
1721 8th Street East
Saskatoon SK S7H 0T4

Date Received: 19-OCT-18
Report Date: 14-NOV-18 14:58 (MT)
Version: FINAL

Client Phone: 306-665-7989

Certificate of Analysis

Lab Work Order #: L2183989
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

Brian Morgan, B.Sc. Hons.
Client Services Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-1 NR18MS 108 LFH (4-0)							
Sampled By: CLIENT on 16-OCT-18 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
Mercury (Hg)	0.0642		0.0050	mg/kg	06-NOV-18	06-NOV-18	R4322916
% Saturation	247		1.0	%	05-NOV-18	06-NOV-18	R4322487
Metals in Soil by CRC ICPMS							
Aluminum (Al)	816		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Antimony (Sb)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Arsenic (As)	0.51		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Barium (Ba)	69.9		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Beryllium (Be)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Boron (B)	<5.0		5.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Bismuth (Bi)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cadmium (Cd)	0.156		0.020	mg/kg	06-NOV-18	14-NOV-18	R4333729
Calcium (Ca)	2090		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Chromium (Cr)	1.63		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cobalt (Co)	0.24		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Copper (Cu)	3.29		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Iron (Fe)	854		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lead (Pb)	3.37		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lithium (Li)	<2.0		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Magnesium (Mg)	279		20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Manganese (Mn)	234		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Molybdenum (Mo)	0.24		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Nickel (Ni)	1.53		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Phosphorus (P)	410		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Potassium (K)	450		100	mg/kg	06-NOV-18	14-NOV-18	R4333729
Selenium (Se)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Silver (Ag)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sodium (Na)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Strontium (Sr)	9.07		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sulfur (S)	<1000		1000	mg/kg	06-NOV-18	14-NOV-18	R4333729
Thallium (Tl)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tin (Sn)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Titanium (Ti)	15.9		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tungsten (W)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Uranium (U)	0.060		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Vanadium (V)	1.90		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zinc (Zn)	17.4		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zirconium (Zr)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Basic Salinity							
EC (Saturated Paste)							
Conductivity Sat. Paste	0.29		0.10	dS m-1	05-NOV-18	06-NOV-18	R4322487
SAR and Cations in saturated soil							
Calcium (Ca)	17.4		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Potassium (K)	35.6		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Magnesium (Mg)	6.7		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Sodium (Na)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
SAR	<0.30	SAR:DL	0.30	SAR	06-NOV-18	06-NOV-18	R4322910
pH (1:2 Soil:CaCl2 Extraction)							
pH (1:2 CaCl2)	3.22		0.10	pH	06-NOV-18	06-NOV-18	R4321628
L2183989-2 NR18MS 108 AEGJ (0-14)							
Sampled By: CLIENT on 16-OCT-18 @ 12:00							
Matrix: SOIL							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-2 NR18MS 108 AEGJ (0-14)							
Sampled By: CLIENT on 16-OCT-18 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
Cation Exchange Capacity	<0.80		0.80	meq/100g	08-NOV-18	08-NOV-18	R4326328
Mercury (Hg)	<0.0050		0.0050	mg/kg	06-NOV-18	06-NOV-18	R4322916
% Saturation	32.9		1.0	%	05-NOV-18	06-NOV-18	R4322487
Particle Size Analysis:Mini-Pipet Method							
% Sand (2.0mm - 0.05mm)	94.8		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Silt (0.05mm - 2um)	5.1		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Clay (<2um)	<1.0		1.0	%	05-NOV-18	06-NOV-18	R4322698
Texture	Sand				05-NOV-18	06-NOV-18	R4322698
Metals in Soil by CRC ICPMS							
Aluminum (Al)	130		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Antimony (Sb)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Arsenic (As)	0.16		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Barium (Ba)	1.64		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Beryllium (Be)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Boron (B)	<5.0		5.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Bismuth (Bi)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cadmium (Cd)	<0.020		0.020	mg/kg	06-NOV-18	14-NOV-18	R4333729
Calcium (Ca)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Chromium (Cr)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cobalt (Co)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Copper (Cu)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Iron (Fe)	95		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lead (Pb)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lithium (Li)	<2.0		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Magnesium (Mg)	<20		20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Manganese (Mn)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Molybdenum (Mo)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Nickel (Ni)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Phosphorus (P)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Potassium (K)	<100		100	mg/kg	06-NOV-18	14-NOV-18	R4333729
Selenium (Se)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Silver (Ag)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sodium (Na)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Strontium (Sr)	2.09		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sulfur (S)	<1000		1000	mg/kg	06-NOV-18	14-NOV-18	R4333729
Thallium (Tl)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tin (Sn)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Titanium (Ti)	7.7		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tungsten (W)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Uranium (U)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Vanadium (V)	0.27		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zinc (Zn)	<2.0		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zirconium (Zr)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Basic Salinity							
EC (Saturated Paste)							
Conductivity Sat. Paste	<0.10		0.10	dS m-1	05-NOV-18	06-NOV-18	R4322487
SAR and Cations in saturated soil							
Calcium (Ca)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Potassium (K)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Magnesium (Mg)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Sodium (Na)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-2 NR18MS 108 AEGJ (0-14)							
Sampled By: CLIENT on 16-OCT-18 @ 12:00							
Matrix: SOIL							
SAR and Cations in saturated soil							
SAR	Incalculable	SAR:INC	0.10	SAR	06-NOV-18	06-NOV-18	R4322910
pH (1:2 Soil:CaCl2 Extraction)							
pH (1:2 CaCl2)	3.18		0.10	pH	06-NOV-18	06-NOV-18	R4321628
L2183989-3 NR18MS 108 BG (14-40)							
Sampled By: CLIENT on 16-OCT-18 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
Mercury (Hg)	<0.0050		0.0050	mg/kg	06-NOV-18	06-NOV-18	R4322916
% Saturation	35.0		1.0	%	05-NOV-18	06-NOV-18	R4322487
Particle Size Analysis:Mini-Pipet Method							
% Sand (2.0mm - 0.05mm)	93.4		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Silt (0.05mm - 2um)	5.6		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Clay (<2um)	1.0		1.0	%	05-NOV-18	06-NOV-18	R4322698
Texture	Sand				05-NOV-18	06-NOV-18	R4322698
Metals in Soil by CRC ICPMS							
Aluminum (Al)	1300		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Antimony (Sb)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Arsenic (As)	0.83		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Barium (Ba)	3.62		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Beryllium (Be)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Boron (B)	<5.0		5.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Bismuth (Bi)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cadmium (Cd)	<0.020		0.020	mg/kg	06-NOV-18	14-NOV-18	R4333729
Calcium (Ca)	63		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Chromium (Cr)	1.72		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cobalt (Co)	0.13		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Copper (Cu)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Iron (Fe)	5090		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lead (Pb)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lithium (Li)	<2.0		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Magnesium (Mg)	55		20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Manganese (Mn)	1.6		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Molybdenum (Mo)	0.11		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Nickel (Ni)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Phosphorus (P)	57		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Potassium (K)	<100		100	mg/kg	06-NOV-18	14-NOV-18	R4333729
Selenium (Se)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Silver (Ag)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sodium (Na)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Strontium (Sr)	2.84		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sulfur (S)	<1000		1000	mg/kg	06-NOV-18	14-NOV-18	R4333729
Thallium (Tl)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tin (Sn)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Titanium (Ti)	24.5		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tungsten (W)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Uranium (U)	0.103		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Vanadium (V)	7.69		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zinc (Zn)	<2.0		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zirconium (Zr)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Basic Salinity							
EC (Saturated Paste)							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-3 NR18MS 108 BG (14-40)							
Sampled By: CLIENT on 16-OCT-18 @ 12:00							
Matrix: SOIL							
EC (Saturated Paste)							
Conductivity Sat. Paste	<0.10		0.10	dS m-1	05-NOV-18	06-NOV-18	R4322487
SAR and Cations in saturated soil							
Calcium (Ca)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Potassium (K)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Magnesium (Mg)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Sodium (Na)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
SAR	Incalculable	SAR:INC	0.10	SAR	06-NOV-18	06-NOV-18	R4322910
pH (1:2 Soil:CaCl2 Extraction)							
pH (1:2 CaCl2)	3.83		0.10	pH	06-NOV-18	06-NOV-18	R4321628
L2183989-4 NR18MS 108 CG (40-100)							
Sampled By: CLIENT on 16-OCT-18 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
Mercury (Hg)	<0.0050		0.0050	mg/kg	06-NOV-18	06-NOV-18	R4322916
% Saturation	32.4		1.0	%	05-NOV-18	06-NOV-18	R4322487
Particle Size Analysis:Mini-Pipet Method							
% Sand (2.0mm - 0.05mm)	98.9		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Silt (0.05mm - 2um)	<1.0		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Clay (<2um)	<1.0		1.0	%	05-NOV-18	06-NOV-18	R4322698
Texture	Sand				05-NOV-18	06-NOV-18	R4322698
Metals in Soil by CRC ICPMS							
Aluminum (Al)	592		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Antimony (Sb)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Arsenic (As)	0.27		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Barium (Ba)	2.85		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Beryllium (Be)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Boron (B)	<5.0		5.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Bismuth (Bi)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cadmium (Cd)	<0.020		0.020	mg/kg	06-NOV-18	14-NOV-18	R4333729
Calcium (Ca)	55		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Chromium (Cr)	0.93		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cobalt (Co)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Copper (Cu)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Iron (Fe)	353		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lead (Pb)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lithium (Li)	<2.0		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Magnesium (Mg)	47		20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Manganese (Mn)	1.2		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Molybdenum (Mo)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Nickel (Ni)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Phosphorus (P)	51		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Potassium (K)	<100		100	mg/kg	06-NOV-18	14-NOV-18	R4333729
Selenium (Se)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Silver (Ag)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sodium (Na)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Strontium (Sr)	3.53		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sulfur (S)	<1000		1000	mg/kg	06-NOV-18	14-NOV-18	R4333729
Thallium (Tl)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tin (Sn)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Titanium (Ti)	18.2		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tungsten (W)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-4 NR18MS 108 CG (40-100)							
Sampled By: CLIENT on 16-OCT-18 @ 12:00							
Matrix: SOIL							
Metals in Soil by CRC ICPMS							
Uranium (U)	0.078		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Vanadium (V)	1.21		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zinc (Zn)	<2.0		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zirconium (Zr)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Basic Salinity							
EC (Saturated Paste)							
Conductivity Sat. Paste	<0.10		0.10	dS m-1	05-NOV-18	06-NOV-18	R4322487
SAR and Cations in saturated soil							
Calcium (Ca)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Potassium (K)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Magnesium (Mg)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Sodium (Na)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
SAR	Incalculable	SAR:INC	0.10	SAR	06-NOV-18	06-NOV-18	R4322910
pH (1:2 Soil:CaCl2 Extraction)							
pH (1:2 CaCl2)	4.30		0.10	pH	06-NOV-18	06-NOV-18	R4321628
L2183989-5 NR18MS 77 OF (0-40)							
Sampled By: CLIENT on 14-OCT-18 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
Mercury (Hg)	0.0763		0.0050	mg/kg	06-NOV-18	06-NOV-18	R4322916
% Saturation	941		1.0	%	05-NOV-18	06-NOV-18	R4322487
Metals in Soil by CRC ICPMS							
Aluminum (Al)	3210		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Antimony (Sb)	0.17		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Arsenic (As)	1.46		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Barium (Ba)	200		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Beryllium (Be)	0.18		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Boron (B)	<5.0		5.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Bismuth (Bi)	0.28		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cadmium (Cd)	0.339		0.020	mg/kg	06-NOV-18	14-NOV-18	R4333729
Calcium (Ca)	7210		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Chromium (Cr)	7.32		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cobalt (Co)	2.03		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Copper (Cu)	10.2		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Iron (Fe)	3210		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lead (Pb)	3.87		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lithium (Li)	3.3		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Magnesium (Mg)	1980		20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Manganese (Mn)	71.2		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Molybdenum (Mo)	4.09		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Nickel (Ni)	9.10		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Phosphorus (P)	545		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Potassium (K)	660		100	mg/kg	06-NOV-18	14-NOV-18	R4333729
Selenium (Se)	0.29		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Silver (Ag)	0.78		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sodium (Na)	567		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Strontium (Sr)	71.5		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sulfur (S)	1900		1000	mg/kg	06-NOV-18	14-NOV-18	R4333729
Thallium (Tl)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tin (Sn)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Titanium (Ti)	11.4		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-5 NR18MS 77 OF (0-40)							
Sampled By: CLIENT on 14-OCT-18 @ 12:00							
Matrix: SOIL							
Metals in Soil by CRC ICPMS							
Tungsten (W)	13.3		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Uranium (U)	30.9		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Vanadium (V)	5.86		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zinc (Zn)	28.1		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zirconium (Zr)	2.5		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Basic Salinity							
EC (Saturated Paste)							
Conductivity Sat. Paste	0.18		0.10	dS m-1	05-NOV-18	06-NOV-18	R4322487
SAR and Cations in saturated soil							
Calcium (Ca)	5.6		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Potassium (K)	9.4		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Magnesium (Mg)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Sodium (Na)	22.3		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
SAR	2.60	SAR:M	0.10	SAR	06-NOV-18	06-NOV-18	R4322910
pH (1:2 Soil:CaCl2 Extraction)							
pH (1:2 CaCl2)	3.41		0.10	pH	06-NOV-18	06-NOV-18	R4321628
L2183989-6 NR18MS 77 OM (40-95)							
Sampled By: CLIENT on 14-OCT-18 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
Mercury (Hg)	0.0716		0.0050	mg/kg	06-NOV-18	06-NOV-18	R4322916
% Saturation	601		1.0	%	05-NOV-18	06-NOV-18	R4322487
Metals in Soil by CRC ICPMS							
Aluminum (Al)	2810		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Antimony (Sb)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Arsenic (As)	0.61		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Barium (Ba)	266		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Beryllium (Be)	0.18		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Boron (B)	<5.0		5.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Bismuth (Bi)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cadmium (Cd)	0.275		0.020	mg/kg	06-NOV-18	14-NOV-18	R4333729
Calcium (Ca)	5910		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Chromium (Cr)	4.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cobalt (Co)	0.79		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Copper (Cu)	3.95		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Iron (Fe)	1490		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lead (Pb)	0.66		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lithium (Li)	<2.0		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Magnesium (Mg)	955		20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Manganese (Mn)	20.2		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Molybdenum (Mo)	0.56		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Nickel (Ni)	5.90		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Phosphorus (P)	504		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Potassium (K)	160		100	mg/kg	06-NOV-18	14-NOV-18	R4333729
Selenium (Se)	0.33		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Silver (Ag)	0.12		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sodium (Na)	154		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Strontium (Sr)	52.6		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sulfur (S)	2400		1000	mg/kg	06-NOV-18	14-NOV-18	R4333729
Thallium (Tl)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tin (Sn)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-6 NR18MS 77 OM (40-95)							
Sampled By: CLIENT on 14-OCT-18 @ 12:00							
Matrix: SOIL							
Metals in Soil by CRC ICPMS							
Titanium (Ti)	20.9		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tungsten (W)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Uranium (U)	0.794		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Vanadium (V)	4.37		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zinc (Zn)	20.9		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zirconium (Zr)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Basic Salinity							
EC (Saturated Paste)							
Conductivity Sat. Paste	0.15		0.10	dS m-1	05-NOV-18	06-NOV-18	R4322487
SAR and Cations in saturated soil							
Calcium (Ca)	10.3		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Potassium (K)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Magnesium (Mg)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Sodium (Na)	9.7		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
SAR	0.83	SAR:M	0.10	SAR	06-NOV-18	06-NOV-18	R4322910
pH (1:2 Soil:CaCl2 Extraction)							
pH (1:2 CaCl2)	3.17		0.10	pH	06-NOV-18	06-NOV-18	R4321628
L2183989-7 NR18MS 58 AC (0-13)							
Sampled By: CLIENT on 13-OCT-18 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
Cation Exchange Capacity	<0.80		0.80	meq/100g	08-NOV-18	08-NOV-18	R4326328
Mercury (Hg)	<0.0050		0.0050	mg/kg	06-NOV-18	06-NOV-18	R4322916
% Saturation	25.9		1.0	%	05-NOV-18	06-NOV-18	R4322487
Particle Size Analysis:Mini-Pipet Method							
% Sand (2.0mm - 0.05mm)	94.0		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Silt (0.05mm - 2um)	5.8		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Clay (<2um)	<1.0		1.0	%	05-NOV-18	06-NOV-18	R4322698
Texture	Sand				05-NOV-18	06-NOV-18	R4322698
Metals in Soil by CRC ICPMS							
Aluminum (Al)	187		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Antimony (Sb)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Arsenic (As)	0.20		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Barium (Ba)	6.98		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Beryllium (Be)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Boron (B)	<5.0		5.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Bismuth (Bi)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cadmium (Cd)	<0.020		0.020	mg/kg	06-NOV-18	14-NOV-18	R4333729
Calcium (Ca)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Chromium (Cr)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cobalt (Co)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Copper (Cu)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Iron (Fe)	250		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lead (Pb)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lithium (Li)	<2.0		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Magnesium (Mg)	54		20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Manganese (Mn)	3.7		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Molybdenum (Mo)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Nickel (Ni)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Phosphorus (P)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Potassium (K)	<100		100	mg/kg	06-NOV-18	14-NOV-18	R4333729

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-7 NR18MS 58 AC (0-13)							
Sampled By: CLIENT on 13-OCT-18 @ 12:00							
Matrix: SOIL							
Metals in Soil by CRC ICPMS							
Selenium (Se)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Silver (Ag)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sodium (Na)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Strontium (Sr)	1.75		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sulfur (S)	<1000		1000	mg/kg	06-NOV-18	14-NOV-18	R4333729
Thallium (Tl)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tin (Sn)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Titanium (Ti)	25.5		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tungsten (W)	0.62		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Uranium (U)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Vanadium (V)	0.68		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zinc (Zn)	<2.0		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zirconium (Zr)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Basic Salinity							
EC (Saturated Paste)							
Conductivity Sat. Paste	<0.10		0.10	dS m-1	05-NOV-18	06-NOV-18	R4322487
SAR and Cations in saturated soil							
Calcium (Ca)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Potassium (K)	5.6		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Magnesium (Mg)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Sodium (Na)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
SAR	Incalculable	SAR:INC	0.10	SAR	06-NOV-18	06-NOV-18	R4322910
pH (1:2 Soil:CaCl2 Extraction)							
pH (1:2 CaCl2)	4.13		0.10	pH	06-NOV-18	06-NOV-18	R4321628
L2183989-8 NR18MS 58 BM (13-34)							
Sampled By: CLIENT on 13-OCT-18 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
Mercury (Hg)	0.0232		0.0050	mg/kg	06-NOV-18	06-NOV-18	R4322916
% Saturation	28.0		1.0	%	05-NOV-18	06-NOV-18	R4322487
Particle Size Analysis:Mini-Pipet Method							
% Sand (2.0mm - 0.05mm)	83.7		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Silt (0.05mm - 2um)	15.9		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Clay (<2um)	<1.0		1.0	%	05-NOV-18	06-NOV-18	R4322698
Texture	Loamy sand				05-NOV-18	06-NOV-18	R4322698
Metals in Soil by CRC ICPMS							
Aluminum (Al)	4560		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Antimony (Sb)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Arsenic (As)	0.64		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Barium (Ba)	10.2		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Beryllium (Be)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Boron (B)	<5.0		5.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Bismuth (Bi)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cadmium (Cd)	<0.020		0.020	mg/kg	06-NOV-18	14-NOV-18	R4333729
Calcium (Ca)	64		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Chromium (Cr)	3.62		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cobalt (Co)	0.38		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Copper (Cu)	2.98		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Iron (Fe)	3830		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lead (Pb)	1.97		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lithium (Li)	3.2		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-8 NR18MS 58 BM (13-34)							
Sampled By: CLIENT on 13-OCT-18 @ 12:00							
Matrix: SOIL							
Metals in Soil by CRC ICPMS							
Magnesium (Mg)	179		20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Manganese (Mn)	10.5		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Molybdenum (Mo)	0.15		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Nickel (Ni)	1.06		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Phosphorus (P)	373		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Potassium (K)	<100		100	mg/kg	06-NOV-18	14-NOV-18	R4333729
Selenium (Se)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Silver (Ag)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sodium (Na)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Strontium (Sr)	4.10		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sulfur (S)	<1000		1000	mg/kg	06-NOV-18	14-NOV-18	R4333729
Thallium (Tl)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tin (Sn)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Titanium (Ti)	78.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tungsten (W)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Uranium (U)	0.158		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Vanadium (V)	8.52		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zinc (Zn)	16.8		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zirconium (Zr)	1.7		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Basic Salinity							
EC (Saturated Paste)							
Conductivity Sat. Paste	0.10		0.10	dS m-1	05-NOV-18	06-NOV-18	R4322487
SAR and Cations in saturated soil							
Calcium (Ca)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Potassium (K)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Magnesium (Mg)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Sodium (Na)	14.5		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
SAR	Incalculable	SAR:INC	0.10	SAR	06-NOV-18	06-NOV-18	R4322910
pH (1:2 Soil:CaCl2 Extraction)							
pH (1:2 CaCl2)	4.56		0.10	pH	06-NOV-18	06-NOV-18	R4321628
L2183989-9 NR18MS 58 C (34-100)							
Sampled By: CLIENT on 13-OCT-18 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
Mercury (Hg)	<0.0050		0.0050	mg/kg	06-NOV-18	06-NOV-18	R4322916
% Saturation	25.3		1.0	%	05-NOV-18	06-NOV-18	R4322487
Particle Size Analysis:Mini-Pipet Method							
% Sand (2.0mm - 0.05mm)	96.3		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Silt (0.05mm - 2um)	3.6		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Clay (<2um)	<1.0		1.0	%	05-NOV-18	06-NOV-18	R4322698
Texture	Sand				05-NOV-18	06-NOV-18	R4322698
Metals in Soil by CRC ICPMS							
Aluminum (Al)	782		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Antimony (Sb)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Arsenic (As)	0.41		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Barium (Ba)	3.82		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Beryllium (Be)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Boron (B)	<5.0		5.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Bismuth (Bi)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cadmium (Cd)	<0.020		0.020	mg/kg	06-NOV-18	14-NOV-18	R4333729
Calcium (Ca)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-9 NR18MS 58 C (34-100)							
Sampled By: CLIENT on 13-OCT-18 @ 12:00							
Matrix: SOIL							
Metals in Soil by CRC ICPMS							
Chromium (Cr)	1.02		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cobalt (Co)	0.30		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Copper (Cu)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Iron (Fe)	1020		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lead (Pb)	0.59		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lithium (Li)	<2.0		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Magnesium (Mg)	98		20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Manganese (Mn)	7.1		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Molybdenum (Mo)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Nickel (Ni)	0.62		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Phosphorus (P)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Potassium (K)	<100		100	mg/kg	06-NOV-18	14-NOV-18	R4333729
Selenium (Se)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Silver (Ag)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sodium (Na)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Strontium (Sr)	3.88		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sulfur (S)	<1000		1000	mg/kg	06-NOV-18	14-NOV-18	R4333729
Thallium (Tl)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tin (Sn)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Titanium (Ti)	29.5		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tungsten (W)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Uranium (U)	0.086		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Vanadium (V)	1.92		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zinc (Zn)	2.1		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zirconium (Zr)	1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Basic Salinity							
EC (Saturated Paste)							
Conductivity Sat. Paste	<0.10		0.10	dS m-1	05-NOV-18	06-NOV-18	R4322487
SAR and Cations in saturated soil							
Calcium (Ca)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Potassium (K)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Magnesium (Mg)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Sodium (Na)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
SAR	Incalculable	SAR:INC	0.10	SAR	06-NOV-18	06-NOV-18	R4322910
pH (1:2 Soil:CaCl2 Extraction)							
pH (1:2 CaCl2)	5.20		0.10	pH	06-NOV-18	06-NOV-18	R4321628
L2183989-10 NR18MS 82 AC (0-7)							
Sampled By: CLIENT on 14-OCT-18 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
Cation Exchange Capacity	<0.80		0.80	meq/100g	08-NOV-18	08-NOV-18	R4326328
Mercury (Hg)	<0.0050		0.0050	mg/kg	06-NOV-18	06-NOV-18	R4322916
% Saturation	24.8		1.0	%	05-NOV-18	06-NOV-18	R4322487
Particle Size Analysis:Mini-Pipet Method							
% Sand (2.0mm - 0.05mm)	91.0		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Silt (0.05mm - 2um)	8.9		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Clay (<2um)	<1.0		1.0	%	05-NOV-18	06-NOV-18	R4322698
Texture	Sand				05-NOV-18	06-NOV-18	R4322698
Metals in Soil by CRC ICPMS							
Aluminum (Al)	354		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Antimony (Sb)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-10 NR18MS 82 AC (0-7)							
Sampled By: CLIENT on 14-OCT-18 @ 12:00							
Matrix: SOIL							
Metals in Soil by CRC ICPMS							
Arsenic (As)	0.22		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Barium (Ba)	3.75		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Beryllium (Be)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Boron (B)	<5.0		5.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Bismuth (Bi)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cadmium (Cd)	<0.020		0.020	mg/kg	06-NOV-18	14-NOV-18	R4333729
Calcium (Ca)	58		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Chromium (Cr)	0.51		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cobalt (Co)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Copper (Cu)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Iron (Fe)	491		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lead (Pb)	0.67		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lithium (Li)	<2.0		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Magnesium (Mg)	31		20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Manganese (Mn)	14.7		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Molybdenum (Mo)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Nickel (Ni)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Phosphorus (P)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Potassium (K)	<100		100	mg/kg	06-NOV-18	14-NOV-18	R4333729
Selenium (Se)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Silver (Ag)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sodium (Na)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Strontium (Sr)	1.78		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sulfur (S)	<1000		1000	mg/kg	06-NOV-18	14-NOV-18	R4333729
Thallium (Tl)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tin (Sn)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Titanium (Ti)	25.9		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tungsten (W)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Uranium (U)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Vanadium (V)	1.28		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zinc (Zn)	<2.0		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zirconium (Zr)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Basic Salinity							
EC (Saturated Paste)							
Conductivity Sat. Paste	<0.10		0.10	dS m-1	05-NOV-18	06-NOV-18	R4322487
SAR and Cations in saturated soil							
Calcium (Ca)	7.3		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Potassium (K)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Magnesium (Mg)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Sodium (Na)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
SAR	<0.50	SAR:DL	0.50	SAR	06-NOV-18	06-NOV-18	R4322910
pH (1:2 Soil:CaCl2 Extraction)							
pH (1:2 CaCl2)	4.09		0.10	pH	06-NOV-18	06-NOV-18	R4321628
L2183989-11 NR18MS 82 B+J (7-35)							
Sampled By: CLIENT on 14-OCT-18 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
Mercury (Hg)	0.0211		0.0050	mg/kg	06-NOV-18	06-NOV-18	R4322916
% Saturation	29.6		1.0	%	05-NOV-18	06-NOV-18	R4322487
Particle Size Analysis:Mini-Pipet Method							
% Sand (2.0mm - 0.05mm)	74.3		1.0	%	05-NOV-18	06-NOV-18	R4322698

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-11 NR18MS 82 B+J (7-35)							
Sampled By: CLIENT on 14-OCT-18 @ 12:00							
Matrix: SOIL							
Particle Size Analysis:Mini-Pipet Method							
% Silt (0.05mm - 2um)	24.8		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Clay (<2um)	<1.0		1.0	%	05-NOV-18	06-NOV-18	R4322698
Texture	Loamy sand				05-NOV-18	06-NOV-18	R4322698
Metals in Soil by CRC ICPMS							
Aluminum (Al)	4760		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Antimony (Sb)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Arsenic (As)	0.82		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Barium (Ba)	12.0		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Beryllium (Be)	0.11		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Boron (B)	<5.0		5.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Bismuth (Bi)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cadmium (Cd)	<0.020		0.020	mg/kg	06-NOV-18	14-NOV-18	R4333729
Calcium (Ca)	92		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Chromium (Cr)	3.95		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cobalt (Co)	0.57		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Copper (Cu)	1.91		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Iron (Fe)	4140		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lead (Pb)	1.88		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lithium (Li)	4.3		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Magnesium (Mg)	266		20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Manganese (Mn)	14.5		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Molybdenum (Mo)	0.12		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Nickel (Ni)	1.41		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Phosphorus (P)	242		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Potassium (K)	<100		100	mg/kg	06-NOV-18	14-NOV-18	R4333729
Selenium (Se)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Silver (Ag)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sodium (Na)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Strontium (Sr)	3.89		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sulfur (S)	<1000		1000	mg/kg	06-NOV-18	14-NOV-18	R4333729
Thallium (Tl)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tin (Sn)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Titanium (Ti)	99.4		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tungsten (W)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Uranium (U)	0.214		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Vanadium (V)	8.42		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zinc (Zn)	8.1		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zirconium (Zr)	1.8		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Basic Salinity							
EC (Saturated Paste)							
Conductivity Sat. Paste	<0.10		0.10	dS m-1	05-NOV-18	06-NOV-18	R4322487
SAR and Cations in saturated soil							
Calcium (Ca)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Potassium (K)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Magnesium (Mg)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Sodium (Na)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
SAR	Incalculable	SAR:INC	0.10	SAR	06-NOV-18	06-NOV-18	R4322910
pH (1:2 Soil:CaCl2 Extraction)							
pH (1:2 CaCl2)	4.54		0.10	pH	06-NOV-18	06-NOV-18	R4321628

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-12 NR18MS 96 LFH (9-0)							
Sampled By: CLIENT on 15-OCT-18 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
Mercury (Hg)	0.0853		0.0050	mg/kg	06-NOV-18	06-NOV-18	R4322916
% Saturation	428		1.0	%	05-NOV-18	06-NOV-18	R4322487
Metals in Soil by CRC ICPMS							
Aluminum (Al)	4140		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Antimony (Sb)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Arsenic (As)	1.08		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Barium (Ba)	235		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Beryllium (Be)	0.31		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Boron (B)	<5.0		5.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Bismuth (Bi)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cadmium (Cd)	0.257		0.020	mg/kg	06-NOV-18	14-NOV-18	R4333729
Calcium (Ca)	2870		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Chromium (Cr)	3.40		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cobalt (Co)	0.70		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Copper (Cu)	6.82		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Iron (Fe)	2420		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lead (Pb)	6.43		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lithium (Li)	<2.0		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Magnesium (Mg)	324		20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Manganese (Mn)	33.6		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Molybdenum (Mo)	0.34		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Nickel (Ni)	4.39		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Phosphorus (P)	814		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Potassium (K)	400		100	mg/kg	06-NOV-18	14-NOV-18	R4333729
Selenium (Se)	0.38		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Silver (Ag)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sodium (Na)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Strontium (Sr)	33.2		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sulfur (S)	<1000		1000	mg/kg	06-NOV-18	14-NOV-18	R4333729
Thallium (Tl)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tin (Sn)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Titanium (Ti)	18.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tungsten (W)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Uranium (U)	0.181		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Vanadium (V)	4.32		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zinc (Zn)	10.6		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zirconium (Zr)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Basic Salinity							
EC (Saturated Paste)							
Conductivity Sat. Paste	0.20		0.10	dS m-1	05-NOV-18	06-NOV-18	R4322487
SAR and Cations in saturated soil							
Calcium (Ca)	10.2		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Potassium (K)	12.2		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Magnesium (Mg)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Sodium (Na)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
SAR	<0.40	SAR:DL	0.40	SAR	06-NOV-18	06-NOV-18	R4322910
pH (1:2 Soil:CaCl2 Extraction)							
pH (1:2 CaCl2)	2.86		0.10	pH	06-NOV-18	06-NOV-18	R4321628
L2183989-13 NR18MS 96 AHC (0-5)							
Sampled By: CLIENT on 15-OCT-18 @ 12:00							
Matrix: SOIL							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-13 NR18MS 96 AHC (0-5)							
Sampled By: CLIENT on 15-OCT-18 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
Cation Exchange Capacity	7.68		0.80	meq/100g	08-NOV-18	08-NOV-18	R4326328
Mercury (Hg)	0.0126		0.0050	mg/kg	06-NOV-18	06-NOV-18	R4322916
% Saturation	56.7		1.0	%	05-NOV-18	06-NOV-18	R4322487
Particle Size Analysis:Mini-Pipet Method							
% Sand (2.0mm - 0.05mm)	27.9		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Silt (0.05mm - 2um)	69.6		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Clay (<2um)	2.5		1.0	%	05-NOV-18	06-NOV-18	R4322698
Texture	Silt loam				05-NOV-18	06-NOV-18	R4322698
Metals in Soil by CRC ICPMS							
Aluminum (Al)	1980		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Antimony (Sb)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Arsenic (As)	0.52		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Barium (Ba)	17.3		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Beryllium (Be)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Boron (B)	<5.0		5.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Bismuth (Bi)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cadmium (Cd)	<0.020		0.020	mg/kg	06-NOV-18	14-NOV-18	R4333729
Calcium (Ca)	83		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Chromium (Cr)	2.93		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cobalt (Co)	0.16		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Copper (Cu)	0.91		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Iron (Fe)	1750		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lead (Pb)	2.14		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lithium (Li)	<2.0		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Magnesium (Mg)	136		20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Manganese (Mn)	6.2		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Molybdenum (Mo)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Nickel (Ni)	0.61		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Phosphorus (P)	109		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Potassium (K)	<100		100	mg/kg	06-NOV-18	14-NOV-18	R4333729
Selenium (Se)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Silver (Ag)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sodium (Na)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Strontium (Sr)	2.84		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sulfur (S)	<1000		1000	mg/kg	06-NOV-18	14-NOV-18	R4333729
Thallium (Tl)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tin (Sn)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Titanium (Ti)	13.8		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tungsten (W)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Uranium (U)	0.180		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Vanadium (V)	4.31		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zinc (Zn)	2.6		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zirconium (Zr)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Basic Salinity							
EC (Saturated Paste)							
Conductivity Sat. Paste	0.17		0.10	dS m-1	05-NOV-18	06-NOV-18	R4322487
SAR and Cations in saturated soil							
Calcium (Ca)	5.9		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Potassium (K)	8.1		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Magnesium (Mg)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Sodium (Na)	5.6		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-13 NR18MS 96 AHC (0-5)							
Sampled By: CLIENT on 15-OCT-18 @ 12:00							
Matrix: SOIL							
SAR and Cations in saturated soil							
SAR	0.64	SAR:M	0.10	SAR	06-NOV-18	06-NOV-18	R4322910
pH (1:2 Soil:CaCl2 Extraction)							
pH (1:2 CaCl2)	3.20		0.10	pH	06-NOV-18	06-NOV-18	R4321628
L2183989-14 NR18MS 96 BMGJ (5-24)							
Sampled By: CLIENT on 15-OCT-18 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
Mercury (Hg)	0.0124		0.0050	mg/kg	06-NOV-18	06-NOV-18	R4322916
% Saturation	41.2		1.0	%	05-NOV-18	06-NOV-18	R4322487
Particle Size Analysis:Mini-Pipet Method							
% Sand (2.0mm - 0.05mm)	26.3		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Silt (0.05mm - 2um)	71.6		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Clay (<2um)	2.1		1.0	%	05-NOV-18	06-NOV-18	R4322698
Texture	Silt loam				05-NOV-18	06-NOV-18	R4322698
Metals in Soil by CRC ICPMS							
Aluminum (Al)	7180		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Antimony (Sb)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Arsenic (As)	0.97		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Barium (Ba)	22.3		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Beryllium (Be)	0.16		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Boron (B)	<5.0		5.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Bismuth (Bi)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cadmium (Cd)	<0.020		0.020	mg/kg	06-NOV-18	14-NOV-18	R4333729
Calcium (Ca)	161		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Chromium (Cr)	7.60		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cobalt (Co)	1.00		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Copper (Cu)	0.85		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Iron (Fe)	6350		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lead (Pb)	2.44		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lithium (Li)	4.6		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Magnesium (Mg)	688		20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Manganese (Mn)	20.3		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Molybdenum (Mo)	0.13		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Nickel (Ni)	2.18		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Phosphorus (P)	145		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Potassium (K)	120		100	mg/kg	06-NOV-18	14-NOV-18	R4333729
Selenium (Se)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Silver (Ag)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sodium (Na)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Strontium (Sr)	5.40		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sulfur (S)	<1000		1000	mg/kg	06-NOV-18	14-NOV-18	R4333729
Thallium (Tl)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tin (Sn)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Titanium (Ti)	161		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tungsten (W)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Uranium (U)	0.348		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Vanadium (V)	11.9		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zinc (Zn)	5.6		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zirconium (Zr)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Basic Salinity							
EC (Saturated Paste)							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-14 NR18MS 96 BMGJ (5-24)							
Sampled By: CLIENT on 15-OCT-18 @ 12:00							
Matrix: SOIL							
EC (Saturated Paste)							
Conductivity Sat. Paste	<0.10		0.10	dS m-1	05-NOV-18	06-NOV-18	R4322487
SAR and Cations in saturated soil							
Calcium (Ca)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Potassium (K)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Magnesium (Mg)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Sodium (Na)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
SAR	Incalculable	SAR:INC	0.10	SAR	06-NOV-18	06-NOV-18	R4322910
pH (1:2 Soil:CaCl2 Extraction)							
pH (1:2 CaCl2)	4.24		0.10	pH	06-NOV-18	06-NOV-18	R4321628
L2183989-15 NR18MS 96 BC (24-55)							
Sampled By: CLIENT on 15-OCT-18 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
Mercury (Hg)	0.0119		0.0050	mg/kg	06-NOV-18	06-NOV-18	R4322916
% Saturation	34.2		1.0	%	05-NOV-18	06-NOV-18	R4322487
Particle Size Analysis:Mini-Pipet Method							
% Sand (2.0mm - 0.05mm)	28.5		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Silt (0.05mm - 2um)	67.7		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Clay (<2um)	3.8		1.0	%	05-NOV-18	06-NOV-18	R4322698
Texture	Silt loam				05-NOV-18	06-NOV-18	R4322698
Metals in Soil by CRC ICPMS							
Aluminum (Al)	5460		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Antimony (Sb)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Arsenic (As)	1.06		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Barium (Ba)	22.6		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Beryllium (Be)	0.15		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Boron (B)	<5.0		5.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Bismuth (Bi)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cadmium (Cd)	<0.020		0.020	mg/kg	06-NOV-18	14-NOV-18	R4333729
Calcium (Ca)	136		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Chromium (Cr)	8.47		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cobalt (Co)	1.25		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Copper (Cu)	0.89		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Iron (Fe)	5160		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lead (Pb)	1.85		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lithium (Li)	4.6		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Magnesium (Mg)	1010		20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Manganese (Mn)	24.8		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Molybdenum (Mo)	0.16		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Nickel (Ni)	3.11		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Phosphorus (P)	68		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Potassium (K)	160		100	mg/kg	06-NOV-18	14-NOV-18	R4333729
Selenium (Se)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Silver (Ag)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sodium (Na)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Strontium (Sr)	7.95		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sulfur (S)	<1000		1000	mg/kg	06-NOV-18	14-NOV-18	R4333729
Thallium (Tl)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tin (Sn)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Titanium (Ti)	197		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tungsten (W)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-15 NR18MS 96 BC (24-55)							
Sampled By: CLIENT on 15-OCT-18 @ 12:00							
Matrix: SOIL							
Metals in Soil by CRC ICPMS							
Uranium (U)	0.397		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Vanadium (V)	11.9		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zinc (Zn)	6.5		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zirconium (Zr)	3.2		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Basic Salinity							
EC (Saturated Paste)							
Conductivity Sat. Paste	<0.10		0.10	dS m-1	05-NOV-18	06-NOV-18	R4322487
SAR and Cations in saturated soil							
Calcium (Ca)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Potassium (K)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Magnesium (Mg)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Sodium (Na)	6.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
SAR	Incalculable	SAR:INC	0.10	SAR	06-NOV-18	06-NOV-18	R4322910
pH (1:2 Soil:CaCl2 Extraction)							
pH (1:2 CaCl2)	3.91		0.10	pH	06-NOV-18	06-NOV-18	R4321628
L2183989-16 NR18MS 96 C (55-100)							
Sampled By: CLIENT on 15-OCT-18 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
Mercury (Hg)	<0.0050		0.0050	mg/kg	06-NOV-18	06-NOV-18	R4322916
% Saturation	23.5		1.0	%	05-NOV-18	06-NOV-18	R4322487
Particle Size Analysis:Mini-Pipet Method							
% Sand (2.0mm - 0.05mm)	81.3		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Silt (0.05mm - 2um)	17.9		1.0	%	05-NOV-18	06-NOV-18	R4322698
% Clay (<2um)	<1.0		1.0	%	05-NOV-18	06-NOV-18	R4322698
Texture	Loamy sand				05-NOV-18	06-NOV-18	R4322698
Metals in Soil by CRC ICPMS							
Aluminum (Al)	1870		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Antimony (Sb)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Arsenic (As)	0.59		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Barium (Ba)	8.46		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Beryllium (Be)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Boron (B)	<5.0		5.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Bismuth (Bi)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cadmium (Cd)	<0.020		0.020	mg/kg	06-NOV-18	14-NOV-18	R4333729
Calcium (Ca)	104		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Chromium (Cr)	2.81		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Cobalt (Co)	0.58		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Copper (Cu)	0.57		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Iron (Fe)	1860		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lead (Pb)	0.94		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Lithium (Li)	<2.0		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Magnesium (Mg)	324		20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Manganese (Mn)	19.7		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Molybdenum (Mo)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Nickel (Ni)	1.28		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Phosphorus (P)	55		50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Potassium (K)	130		100	mg/kg	06-NOV-18	14-NOV-18	R4333729
Selenium (Se)	<0.20		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Silver (Ag)	<0.10		0.10	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sodium (Na)	<50		50	mg/kg	06-NOV-18	14-NOV-18	R4333729

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2183989-16 NR18MS 96 C (55-100)							
Sampled By: CLIENT on 15-OCT-18 @ 12:00							
Matrix: SOIL							
Metals in Soil by CRC ICPMS							
Strontium (Sr)	6.47		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Sulfur (S)	<1000		1000	mg/kg	06-NOV-18	14-NOV-18	R4333729
Thallium (Tl)	<0.050		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tin (Sn)	<1.0		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Titanium (Ti)	60.9		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Tungsten (W)	<0.50		0.50	mg/kg	06-NOV-18	14-NOV-18	R4333729
Uranium (U)	0.157		0.050	mg/kg	06-NOV-18	14-NOV-18	R4333729
Vanadium (V)	4.45		0.20	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zinc (Zn)	2.7		2.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Zirconium (Zr)	1.3		1.0	mg/kg	06-NOV-18	14-NOV-18	R4333729
Basic Salinity							
EC (Saturated Paste)							
Conductivity Sat. Paste	<0.10		0.10	dS m-1	05-NOV-18	06-NOV-18	R4322487
SAR and Cations in saturated soil							
Calcium (Ca)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Potassium (K)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Magnesium (Mg)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
Sodium (Na)	<5.0		5.0	mg/L	06-NOV-18	06-NOV-18	R4322910
SAR	Incalculable	SAR:INC	0.10	SAR	06-NOV-18	06-NOV-18	R4322910
pH (1:2 Soil:CaCl2 Extraction)							
pH (1:2 CaCl2)	4.33		0.10	pH	06-NOV-18	06-NOV-18	R4321628

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Sample Parameter Qualifier Key:

Qualifier	Description
SAR:DL	SAR is incalculable due to undetectable Na. Detection Limit represents maximum possible SAR value.
SAR:INC	SAR is incalculable due to Ca, Mg below detection limit.
SAR:M	Reported SAR represents a maximum value. Actual SAR may be lower if both Ca and Mg were detectable.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CEC-SK	Soil	Cation Exchange Capacity (NH4OAC Extn)	CSSS(2008) 18(4)

Soil exchange sites are saturated with ammonium, then displaced with sodium. Ammonium in the extract is determined colorimetrically.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SAR-SK	Soil	EC (Saturated Paste)	CSSS 18.2.2/CSSS 18.3.1

After saturated soil paste equilibrium, an extract is obtained by vacuum filtration with conductivity of the extract measured by a conductivity meter.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-200.2-CVAA-SK	Soil	Mercury in Soil by CVAAS	EPA 200.2/1631E (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

ALS Test Code	Matrix	Test Description	Method Reference**
MET-200.2-CCMS-SK	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)

Soil/sediment is dried, disaggregated, and sieved (2 mm). Strong Acid Leachable Metals in the <2mm fraction are solubilized by heated digestion with nitric and hydrochloric acids. Instrumental analysis is by Collision / Reaction Cell ICPMS.

Limitations: This method is intended to liberate environmentally available metals. Silicate minerals are not solubilized. Some metals may be only partially recovered (matrix dependent), including Al, Ba, Be, Cr, S, Sr, Ti, Tl, V, W, and Zr. Elemental Sulfur may be poorly recovered by this method. Volatile forms of sulfur (e.g. sulfide, H2S) may be excluded if lost during sampling, storage, or digestion.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-1:2CACL2-SK	Soil	pH (1:2 Soil:CaCl2 Extraction)	CSSS 2008 16.3

1 part dry soil and 2 parts de-ionized 0.01M CaCl2 (by volume) is mixed. The slurry is allowed to stand with occasional stirring for 30 - 60 minutes. pH of the soil slurry is then measured using a pH meter.

ALS Test Code	Matrix	Test Description	Method Reference**
PSA-1-SK	Soil	Particle Size Analysis:Mini-Pipet Method	SSIR-51 Method 3.2.1

Dry, < 2 mm soil is treated with sodium hexametaphosphate to ensure complete dispersion of primary soil particles. The homogenized suspension is allowed to settle in accordance with Stoke's Law so that only clay particles remain in suspension.To determine the clay fraction, an aliquot of the clay suspension is removed, then dried and weighed. The sand fraction is determined by wet sieving the remaining suspension, then drying and weighing the sand retained on the sieve. The silt fraction is determined by calculation where % Silt = 100 - (%Sand+%Clay)

ALS Test Code	Matrix	Test Description	Method Reference**
SAL-MG/KG-CALC-SK	Soil	Detail Salinity in mg/kg	Manual Calculation
SAR-CALC-SK	Soil	SAR and Cations in saturated soil	CSSS 18.4-Calculation

Ca, Mg, Na and K in a saturated soil extract are determined by ICP-OES.

ALS Test Code	Matrix	Test Description	Method Reference**
SAT-PCNT-SK	Soil	Saturated Paste	CSSS (1993) 18.2.2

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA

Chain of Custody Numbers:

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: Golder Associates Ltd.
1721 8th Street East
Saskatoon SK S7H 0T4

Contact: KYLE HODGSON

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CEC-SK	**Soil**							
Batch R4326328								
WG2922907-1 DUP		**L2183989-10**						
Cation Exchange Capacity		<0.80	<0.80	RPD-NA	meq/100g	N/A	20	08-NOV-18
WG2922907-3 IRM		**SAL814**						
Cation Exchange Capacity			101.9		%		70-130	08-NOV-18
WG2922907-2 MB								
Cation Exchange Capacity			<0.80		meq/100g		0.8	08-NOV-18
EC-SAR-SK	**Soil**							
Batch R4322487								
WG2922855-1 DUP		**L2183989-9**						
Conductivity Sat. Paste		<0.10	<0.10	RPD-NA	dS m-1	N/A	20	06-NOV-18
WG2922855-3 IRM		**SK-SAL-17**						
Conductivity Sat. Paste			92.9		%		80-120	06-NOV-18
WG2922855-5 LCS								
Conductivity Sat. Paste			99.0		%		80-120	06-NOV-18
WG2922855-2 MB								
Conductivity Sat. Paste			<0.10		dS m-1		0.1	06-NOV-18
HG-200.2-CVAA-SK	**Soil**							
Batch R4322916								
WG2922042-3 CRM		**TILL-1**						
Mercury (Hg)			98.6		%		70-130	06-NOV-18
WG2922042-4 LCS								
Mercury (Hg)			95.0		%		80-120	06-NOV-18
WG2922042-1 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	06-NOV-18
MET-200.2-CCMS-SK	**Soil**							
Batch R4333729								
WG2922042-3 CRM		**TILL-1**						
Aluminum (Al)			103.6		%		70-130	14-NOV-18
Antimony (Sb)			102.2		%		70-130	14-NOV-18
Arsenic (As)			103.8		%		70-130	14-NOV-18
Barium (Ba)			100.4		%		70-130	14-NOV-18
Beryllium (Be)			106.0		%		70-130	14-NOV-18
Boron (B)			3.0		mg/kg		0-8.2	14-NOV-18
Bismuth (Bi)			92.3		%		70-130	14-NOV-18
Cadmium (Cd)			102.9		%		70-130	14-NOV-18
Calcium (Ca)			103.3		%		70-130	14-NOV-18
Chromium (Cr)			101.7		%		70-130	14-NOV-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-SK	**Soil**							
Batch R4333729								
WG2922042-3 CRM		**TILL-1**						
Cobalt (Co)			101.8		%		70-130	14-NOV-18
Copper (Cu)			104.1		%		70-130	14-NOV-18
Iron (Fe)			98.4		%		70-130	14-NOV-18
Lead (Pb)			98.3		%		70-130	14-NOV-18
Lithium (Li)			108.4		%		70-130	14-NOV-18
Magnesium (Mg)			99.0		%		70-130	14-NOV-18
Manganese (Mn)			100.5		%		70-130	14-NOV-18
Molybdenum (Mo)			102.6		%		70-130	14-NOV-18
Nickel (Ni)			102.3		%		70-130	14-NOV-18
Phosphorus (P)			108.8		%		70-130	14-NOV-18
Potassium (K)			91.9		%		70-130	14-NOV-18
Selenium (Se)			0.32		mg/kg		0.11-0.51	14-NOV-18
Silver (Ag)			0.24		mg/kg		0.13-0.33	14-NOV-18
Sodium (Na)			93.8		%		70-130	14-NOV-18
Strontium (Sr)			96.5		%		70-130	14-NOV-18
Thallium (Tl)			0.123		mg/kg		0.077-0.18	14-NOV-18
Tin (Sn)			1.3		mg/kg		0-3.1	14-NOV-18
Titanium (Ti)			94.8		%		70-130	14-NOV-18
Tungsten (W)			0.14		mg/kg		0-0.66	14-NOV-18
Uranium (U)			96.2		%		70-130	14-NOV-18
Vanadium (V)			100.1		%		70-130	14-NOV-18
Zinc (Zn)			104.3		%		70-130	14-NOV-18
Zirconium (Zr)			1.0		mg/kg		0-1.8	14-NOV-18
WG2922042-4 LCS								
Aluminum (Al)			105.9		%		80-120	14-NOV-18
Antimony (Sb)			109.6		%		80-120	14-NOV-18
Arsenic (As)			104.2		%		80-120	14-NOV-18
Barium (Ba)			106.3		%		80-120	14-NOV-18
Beryllium (Be)			101.7		%		80-120	14-NOV-18
Boron (B)			102.4		%		80-120	14-NOV-18
Bismuth (Bi)			93.9		%		80-120	14-NOV-18
Cadmium (Cd)			106.8		%		80-120	14-NOV-18
Calcium (Ca)			100.8		%		80-120	14-NOV-18
Chromium (Cr)			105.0		%		80-120	14-NOV-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-SK	**Soil**							
Batch R4333729								
WG2922042-4 LCS								
Cobalt (Co)			102.6		%		80-120	14-NOV-18
Copper (Cu)			102.6		%		80-120	14-NOV-18
Iron (Fe)			113.3		%		80-120	14-NOV-18
Lead (Pb)			100.6		%		80-120	14-NOV-18
Lithium (Li)			97.0		%		80-120	14-NOV-18
Magnesium (Mg)			105.9		%		80-120	14-NOV-18
Manganese (Mn)			106.0		%		80-120	14-NOV-18
Molybdenum (Mo)			101.5		%		80-120	14-NOV-18
Nickel (Ni)			104.4		%		80-120	14-NOV-18
Phosphorus (P)			111.0		%		80-120	14-NOV-18
Potassium (K)			105.2		%		80-120	14-NOV-18
Selenium (Se)			105.3		%		80-120	14-NOV-18
Silver (Ag)			104.8		%		80-120	14-NOV-18
Sodium (Na)			104.8		%		80-120	14-NOV-18
Strontium (Sr)			93.4		%		80-120	14-NOV-18
Sulfur (S)			107.5		%		80-120	14-NOV-18
Thallium (Tl)			94.3		%		80-120	14-NOV-18
Tin (Sn)			105.0		%		80-120	14-NOV-18
Titanium (Ti)			96.1		%		80-120	14-NOV-18
Tungsten (W)			97.0		%		80-120	14-NOV-18
Uranium (U)			93.1		%		80-120	14-NOV-18
Vanadium (V)			104.2		%		80-120	14-NOV-18
Zinc (Zn)			104.7		%		80-120	14-NOV-18
Zirconium (Zr)			105.9		%		80-120	14-NOV-18
WG2922042-1 MB								
Aluminum (Al)			<50		mg/kg		50	14-NOV-18
Antimony (Sb)			<0.10		mg/kg		0.1	14-NOV-18
Arsenic (As)			<0.10		mg/kg		0.1	14-NOV-18
Barium (Ba)			<0.50		mg/kg		0.5	14-NOV-18
Beryllium (Be)			<0.10		mg/kg		0.1	14-NOV-18
Boron (B)			<5.0		mg/kg		5	14-NOV-18
Bismuth (Bi)			<0.20		mg/kg		0.2	14-NOV-18
Cadmium (Cd)			<0.020		mg/kg		0.02	14-NOV-18
Calcium (Ca)			<50		mg/kg		50	14-NOV-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-SK	**Soil**							
Batch R4333729								
WG2922042-1 MB								
Chromium (Cr)			<0.50		mg/kg		0.5	14-NOV-18
Cobalt (Co)			<0.10		mg/kg		0.1	14-NOV-18
Copper (Cu)			<0.50		mg/kg		0.5	14-NOV-18
Iron (Fe)			<50		mg/kg		50	14-NOV-18
Lead (Pb)			<0.50		mg/kg		0.5	14-NOV-18
Lithium (Li)			<2.0		mg/kg		2	14-NOV-18
Magnesium (Mg)			<20		mg/kg		20	14-NOV-18
Manganese (Mn)			<1.0		mg/kg		1	14-NOV-18
Molybdenum (Mo)			<0.10		mg/kg		0.1	14-NOV-18
Nickel (Ni)			<0.50		mg/kg		0.5	14-NOV-18
Phosphorus (P)			<50		mg/kg		50	14-NOV-18
Potassium (K)			<100		mg/kg		100	14-NOV-18
Selenium (Se)			<0.20		mg/kg		0.2	14-NOV-18
Silver (Ag)			<0.10		mg/kg		0.1	14-NOV-18
Sodium (Na)			<50		mg/kg		50	14-NOV-18
Strontium (Sr)			<0.50		mg/kg		0.5	14-NOV-18
Sulfur (S)			<1000		mg/kg		1000	14-NOV-18
Thallium (Tl)			<0.050		mg/kg		0.05	14-NOV-18
Tin (Sn)			<1.0		mg/kg		1	14-NOV-18
Titanium (Ti)			<1.0		mg/kg		1	14-NOV-18
Tungsten (W)			<0.50		mg/kg		0.5	14-NOV-18
Uranium (U)			<0.050		mg/kg		0.05	14-NOV-18
Vanadium (V)			<0.20		mg/kg		0.2	14-NOV-18
Zinc (Zn)			<2.0		mg/kg		2	14-NOV-18
Zirconium (Zr)			<1.0		mg/kg		1	14-NOV-18
PH-1:2CACL2-SK	**Soil**							
Batch R4321628								
WG2922803-1 DUP		**L2183989-2**						
pH (1:2 CaCl2)		3.18	3.24	J	pH	0.06	0.3	06-NOV-18
WG2922803-2 IRM		**SAL814**						
pH (1:2 CaCl2)			7.66		pH		7.55-8.15	06-NOV-18
WG2922803-3 LCS								
pH (1:2 CaCl2)			6.96		pH		6.66-7.06	06-NOV-18
PSA-1-SK	**Soil**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PSA-1-SK	**Soil**							
Batch R4322698								
WG2921509-2 IRM		**2017-PSA**						
% Sand (2.0mm - 0.05mm)			51.7		%		45.8-55.8	06-NOV-18
% Silt (0.05mm - 2um)			34.3		%		28.6-38.6	06-NOV-18
% Clay (<2um)			14.0		%		10.6-20.6	06-NOV-18
WG2921509-3 MB								
% Sand (2.0mm - 0.05mm)			100		%		105	06-NOV-18
% Silt (0.05mm - 2um)			<1.0		%		1	06-NOV-18
% Clay (<2um)			<1.0		%		1	06-NOV-18
SAR-CALC-SK	**Soil**							
Batch R4322910								
WG2922855-1 DUP		**L2183989-9**						
Calcium (Ca)		<5.0	<5.0	RPD-NA	mg/L	N/A	30	06-NOV-18
Potassium (K)		<5.0	<5.0	RPD-NA	mg/L	N/A	30	06-NOV-18
Magnesium (Mg)		<5.0	<5.0	RPD-NA	mg/L	N/A	30	06-NOV-18
Sodium (Na)		<5.0	<5.0	RPD-NA	mg/L	N/A	30	06-NOV-18
WG2922855-3 IRM		**SK-SAL-17**						
Calcium (Ca)			93.1		%		70-130	06-NOV-18
Potassium (K)			90.7		%		70-130	06-NOV-18
Magnesium (Mg)			93.2		%		70-130	06-NOV-18
Sodium (Na)			94.0		%		70-130	06-NOV-18
WG2922855-2 MB								
Calcium (Ca)			<5.0		mg/L		5	06-NOV-18
Potassium (K)			<5.0		mg/L		5	06-NOV-18
Magnesium (Mg)			<5.0		mg/L		5	06-NOV-18
Sodium (Na)			<5.0		mg/L		5	06-NOV-18
SAT-PCNT-SK	**Soil**							
Batch R4322487								
WG2922855-1 DUP		**L2183989-9**						
% Saturation		25.3	28.0		%	10	20	06-NOV-18
WG2922855-3 IRM		**SK-SAL-17**						
% Saturation			105.9		%		80-120	06-NOV-18
WG2922855-5 LCS								
% Saturation			102.0		%		80-120	06-NOV-18
WG2922855-2 MB								
% Saturation			<1.0		%		1	06-NOV-18

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L2183989-COFC

COC Number: 14 -

Report To	Marcin Stanislawski
Company:	Golder Associates
Contact:	Marcin Stanislawski
Address:	2535 3rd ave SE Calgary, AB T2A 7W5
Phone:	403 880 6786 (cell) 403 509 1858 (work)
Invoice To	Same as Report To ☐ Yes ☑ No
	Copy of Invoice with Report ☐ Yes ☑ No
Company:	Golder Associates
Contact:	Kyle Hodgson

Project Information

ALS Quote #:	
Job #:	1899581
PO / AFE:	
LSD:	

ALS Lab Work Order # (lab use only)

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ Yes ☐ No

☐ Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax Marcin_Stanislawski@golder.com

Email 2 Kyle_Hodgson@golder.com

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax Kyle_Hodgson@golder.com

Email 2

Oil and Gas Required Fields (client use)

Approver ID:	Cost Center:
GL Account:	Routing Code:
Activity Code:	
Location:	
ALS Contact:	Sampler:

Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)

- R ☑ Regular (Standard TAT if received by 3 pm - business days)
- P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
- E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
- E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge

Specify Date Required for E2,E or P:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	SAL-BASIC-ABT1-ED	PSA-1-SK	MET-200.2-CCMS-SK	HG-200.2-CVAA-SK	CEC								Number of Containers
	NR18MS108 LFH (4-0)	16-Oct-18		soil	R		R	R									
	NR18MS108 Aegj (0-14)	16-Oct-18		soil	R	R	R	R	R								
	NR18MS108 Bg (14-40)	16-Oct-18		soil	R	R	R	R									
	NR18MS108 Cg (40-100)	16-Oct-18		soil	R	R	R	R									
	NR18MS77 Of (0-40)	14-Oct-18		soil	R		R	R									
	NR18MS77 Om (40-95)	14-Oct-18		soil	R		R	R									
	NR18MS58 Ae (0-13)	13-Oct-18		soil	R	R	R	R	R								
	NR18MS58 Bm (13-34)	13-Oct-18		soil	R	R	R	R									
	NR18MS58 C (34-100)	13-Oct-18		soil	R	R	R	R									
	NR18MS82 Ae (0-7)	14-Oct-18		soil	R	R	R	R	R								
	NR18MS82 Btj (7-35)	14-Oct-18		soil	R	R	R	R									
	NR18MS96 LFH (9-0)	15-Oct-18		soil	R		R	R									

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ Yes ☑ No

Are samples for human drinking water use?
☐ Yes ☑ No

Special Instructions / Specify Criteria to add on report (client Use)

SHIPMENT RELEASE (client use)

Released by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION   WHITE - LABORATORY COPY   YELLOW - CLIENT COPY

NA-FM-0326a v09 Front/04 January 2014

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2183989-COFC

COC Number: 14 -

Report To	Marcin Stanislawski
Company:	Golder Associates
Contact:	Marcin Stanislawski
Address:	2535 3rd ave SE Calgary, AB T2A 7W5
Phone:	403 880 6786 (cell) 403 509 1858 (work)
Invoice To	Same as Report To ☐ Yes ☑ No
	Copy of Invoice with Report ☐ Yes ☑ No
Company:	Golder Associates
Contact:	Kyle Hodgson

Project Information

ALS Quote #:	
Job #:	1774160
PO / AFE:	
LSD:	
ALS Lab Work Order # (lab use only)	

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ Yes ☐ No
☐ Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax Marcin_Stanislawski@golder.com
Email 2 Kyle_Hodgson@golder.com

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax Kyle_Hodgson@golder.com
Email 2

Oil and Gas Required Fields (client use)

Approver ID:	Cost Center:
GL Account:	Routing Code:
Activity Code:	
Location:	
ALS Contact:	Sampler:

Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)

- R ☑ Regular (Standard TAT if received by 3 pm - business days)
- P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
- E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
- E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge

Specify Date Required for E2,E or P:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	SAL-BASIC-ABT1-ED	PSA-1-SK	MET-200.2-CCMS-SK	HG-200.2-CVAA-SK	CEC	Number of Containers
	NR18MS96 Ahe (0-5)	15-Oct-18		soil	R	R	R	R	R	
	NR18MS96 Bmgj (5-24)	15-Oct-18		soil	R	R	R	R		
	NR18MS96 BC (24-55)	15-Oct-18		soil	R	R	R	R		
	NR18MS96 C (55-100)	15-Oct-18		soil	R	R	R	R		
				soil						
				soil						
				soil						
				soil						
				soil						
				soil						
				soil						
				soil						

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ Yes ☑ No

Are samples for human drinking water use? ☐ Yes ☑ No

Special Instructions / Specify Criteria to add on report (client Use)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice packs Yes ☐ No ☐ Custody seal intact Yes ☐ No ☐

SHIPMENT RELEASE (client use)

Released by:	Date:	Time:

FINAL SHIPMENT RECEPTION (lab use only)

Received by: Date: Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

SRC SASKATCHEWAN RESEARCH COUNCIL
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Sep 04, 2019

This report was generated for samples included in SRC Group # 2019-11322

Quality Control Report

Kyle Hodgson
Golder
1721 8th Street East
Saskatoon, SK S7H 0T4

Reference Materials and Standards:

A reference material of known concentration is used whenever possible as either a control sample or control standard and analyzed with each batch of samples. These "QC" results are used to assess the performance of the method and must be within clearly defined limits; otherwise corrective action is required.

QC Analysis	Units	Target Value	Obtained Value
Aluminum	ug/g	23600	23400
Arsenic	ug/g	17.0	16.8
Barium	ug/g	99.0	102
Beryllium	ug/g	0.634	0.569
Bismuth	ug/g	1.89	1.88
Cadmium	ug/g	0.244	0.242
Calcium	mg/L	63.4	63.0
Calcium	ug/g	6400	6770
Chloride	mg/L	49.8	50.5
Chloride	mg/L	308	325
Chromium	ug/g	41.4	40.4
Cobalt	ug/g	13.7	12.7
Copper	ug/g	43.6	43.3
Iron	ug/g	37600	35200
Lead	ug/g	13.3	14.1
Lead-210	Bq/L	21.6	18.4
Lead-210	Bq	7.70	6.65
Magnesium	mg/L	16.5	16.4
Magnesium	ug/g	7400	7540
Manganese	ug/g	1230	1220
Mercury	ug/g	0.412	0.349
Mercury	ug/g	0.412	0.346
Molybdenum	ug/g	0.766	0.474
Nickel	ug/g	20.5	20.8
Phosphorus	ug/g	830	769
Polonium-210	Bq/L	18.8	19.9
Polonium-210	Bq	0.077	0.096
Potassium	mg/L	163	164
Potassium	ug/g	1700	1680
Radium-226	Bq/L	18.4	14.8
Radium-226	Bq	2.13	1.87
Radium-226	Bq/L	18.4	18.6

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QC Analysis	Units	Target Value	Obtained Value
Radium-226	Bq	0.043	0.037
Selenium	ug/g	0.420	0.393
Silver	ug/g	0.200	0.219
Sodium	mg/L	100	98.3
Sodium	ug/g	893	873
Strontium	ug/g	27.3	26.8
Sulfate	mg/L	150	147
Thorium-230	Bq/L	19.9	20.6
Thorium-232	Bq	0.203	0.189
Tin	ug/g	1.52	1.46
Titanium	ug/g	1990	2250
Uranium	ug/g	1.20	1.29
Vanadium	ug/g	71.2	69.2
Zinc	ug/g	74.8	80.4

Duplicates:

Duplicates are used to assess problems with precision and help ensure that samples within a given batch were processed appropriately. The difference between duplicates must be within strict limits, otherwise corrective action is required. Please note, the duplicate(s) in this report are duplicates analyzed within a given batch of test samples and may not be from this specific group of samples.

Duplicate Analysis	Units	Sample ID	First Result	Second Result
Silver	ug/g	45051	<0.1	<0.1
Silver	ug/g	45061	<0.1	<0.1
Aluminum	ug/g	45051	3650	3640
Aluminum	ug/g	45061	2580	2680
Arsenic	ug/g	45051	0.9	0.8
Arsenic	ug/g	45061	0.8	0.7
Boron	ug/g	45051	3	4
Boron	ug/g	45061	4	3
Barium	ug/g	45051	28	29
Barium	ug/g	45061	27	29
Beryllium	ug/g	45051	<0.1	<0.1
Beryllium	ug/g	45061	<0.1	<0.1
Bismuth	ug/g	45051	<0.2	<0.2
Bismuth	ug/g	45061	<0.2	<0.2
Calcium	ug/g	45051	330	370
Calcium	ug/g	45061	130	120
Calcium	mg/L	45068	10	9
Cadmium	ug/g	45051	<0.1	<0.1
Cadmium	ug/g	45061	<0.1	<0.1
Chloride	mg/L	45068	4	5
Chloride	mg/L	45847	<1	<1
Cobalt	ug/g	45051	0.5	1.3
Cobalt	ug/g	45061	0.3	0.3

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Duplicate Analysis	Units	Sample ID	First Result	Second Result
Chromium	ug/g	45051	4.2	4.2
Chromium	ug/g	45061	5.0	5.0
Cesium	ug/g	45051	0.1	0.1
Cesium	ug/g	45061	<0.1	<0.1
Copper	ug/g	45051	0.8	1.0
Copper	ug/g	45061	0.5	0.5
Iron	ug/g	45051	2870	2840
Iron	ug/g	45061	2940	2920
Mercury	ug/g	45051	<0.05	<0.05
Mercury	ug/g	45061	<0.05	<0.05
Potassium	ug/g	45051	630	650
Potassium	ug/g	45061	580	630
Potassium	mg/L	45068	7	7
Lithium	ug/g	45051	3.9	3.8
Lithium	ug/g	45061	1.8	1.8
Magnesium	ug/g	45051	360	360
Magnesium	ug/g	45061	130	130
Magnesium	mg/L	45068	2	2
Manganese	ug/g	45051	35	33
Manganese	ug/g	45061	40	43
Molybdenum	ug/g	45051	<0.1	0.7
Molybdenum	ug/g	45061	0.1	0.1
Moisture	%	45068	4.60	4.51
Sodium	ug/g	45051	100	110
Sodium	ug/g	45061	80	80
Sodium	mg/L	45068	3	3
Nickel	ug/g	45051	1.2	1.1
Nickel	ug/g	45061	0.7	0.6
Phosphorus	ug/g	45051	70	70
Phosphorus	ug/g	45061	70	70
Lead	ug/g	45051	2.4	2.4
Lead	ug/g	45061	1.6	1.6
Lead-210	Bq/g	45051	<0.04	<0.04
pH	pH units	45068	3.57	3.61
Polonium-210	Bq/g	45051	<0.01	<0.01
Radium-226	Bq/g	45057	0.02	0.02
Radium-226	Bq/g	45067	<0.01	0.02
Radium-226	Bq/g	45729	0.02	<0.01
Rubidium	ug/g	45051	2.6	2.6
Rubidium	ug/g	45061	2.4	2.6
Antimony	ug/g	45051	<0.2	<0.2
Antimony	ug/g	45061	<0.2	<0.2
Selenium	ug/g	45051	<0.1	<0.1
Selenium	ug/g	45061	<0.1	<0.1
Tin	ug/g	45051	0.2	0.2
Tin	ug/g	45061	0.1	0.1

Sep 04, 2019

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Duplicate Analysis	Units	Sample ID	First Result	Second Result
Sulfate	mg/L	45068	12	13
Specific conductivity	uS/cm	45068	176	174
Strontium	ug/g	45051	32	32
Strontium	ug/g	45061	17	18
Tellurium	ug/g	45051	<0.5	<0.5
Tellurium	ug/g	45061	<0.5	<0.5
Thorium-228	Bq/g	45051	<0.02	<0.02
Thorium-230	Bq/g	45051	<0.02	<0.02
Thorium-232	Bq/g	45051	<0.02	<0.02
Titanium	ug/g	45051	280	270
Titanium	ug/g	45061	280	270
Thallium	ug/g	45051	<0.2	<0.2
Thallium	ug/g	45061	<0.2	<0.2
Uranium	ug/g	45051	0.3	0.3
Uranium	ug/g	45061	0.3	0.3
Vanadium	ug/g	45051	8.3	8.2
Vanadium	ug/g	45061	5.2	5.1
Tungsten	ug/g	45051	<0.5	<0.5
Tungsten	ug/g	45061	<0.5	<0.5
Zinc	ug/g	45051	5.4	5.0
Zinc	ug/g	45061	2.5	3.8
Zirconium	ug/g	45051	18	18
Zirconium	ug/g	45061	16	16

Spikes and/or Surrogates:

Samples spiked with a known quantity of the analyte of interest or a surrogate which is a known quantity of a compound which behaves in a similar manner to the analyte of interest, are used to assess problems with the sample processing or sample matrix. The recovery must be within clearly defined limits when the quantity of spike is comparable to the sample concentration.

Spike Analysis	Percent Recovery
Calcium	106
Chloride	100
Magnesium	107
Potassium	105
Sodium	107
Sulfate	101

All quality control results were within the specified limits and considered acceptable.

Roxane Ortmann - Quality Assurance Supervisor

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SRC Group # 2019-11322

Aug 20, 2019

Salinity Package Summary Report

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45051
Description: 08/08/2019 19-REF04-A-SO *SOIL*

% Saturation:	27.4
pH:	3.75
EC (µS/cm):	188
SAR:	0.3
TGR *:	0

	mg/L	meq/L	ug/g
Calcium:	13	0.65	3.6
Magnesium:	2	0.2	0.5
Sodium:	5	0.2	1
Potassium:	5	0.1	1
Chloride:	5	0.1	1
Sulfate:	10	0.21	2.7

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^+]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: $TGR = 0.335 \times a^2 \{(1/b^2) - (1/c^2)\} \times (\% \text{ sat.}/100)$

Where: a = Na
b = 7
c = SAR

This report is a summary containing the salinity package analytes.
For all the results requested for this sample, please refer to the complete report.

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Aug 20, 2019

Salinity Package Summary Report

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45052
Description: 08/11/2019 19-REF04-B-SO *SOIL*

% Saturation:	31.2		
pH:	3.93		
EC (µS/cm):	216		
SAR:	0.1		
TGR *:	0		
	mg/L	meq/L	ug/g
Calcium:	20	1.0	6.2
Magnesium:	3	0.2	0.9
Sodium:	3	0.1	0.9
Potassium:	6	0.2	2
Chloride:	6	0.2	2
Sulfate:	13	0.27	4.1

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^{+}]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: TGR = 0.335 × a^2 {($1/b^2$) – ($1/c^2$)} × (% sat./100)
Where: a = Na
b = 7
c = SAR

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Aug 20, 2019

Salinity Package Summary Report

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45053
Description: 08/11/2019 19-REF04-C-SO *SOIL*

% Saturation:	33.4		
pH:	3.78		
EC (µS/cm):	231		
SAR:	0.2		
TGR *:	0		
	mg/L	meq/L	ug/g
Calcium:	13	0.65	4.3
Magnesium:	3	0.2	1
Sodium:	3	0.1	1
Potassium:	9	0.2	3
Chloride:	6	0.2	2
Sulfate:	11	0.23	3.7

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^+]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: TGR = 0.335 × a^2 {(1/b^2) – (1 /c^2)} × (% sat./100)
Where: a = Na
b = 7
c = SAR

This report is a summary containing the salinity package analytes.
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Salinity Package Summary Report

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45054
Description: 08/09/2019 19-REF05-A-SO *SOIL*

% Saturation:	29.2		
pH:	4.06		
EC (µS/cm):	201		
SAR:	0.1		
TGR *:	0		
	mg/L	meq/L	ug/g
Calcium:	20	1.0	5.8
Magnesium:	4	0.3	1
Sodium:	3	0.1	0.9
Potassium:	4	0.1	1
Chloride:	4	0.1	1
Sulfate:	12	0.25	3.5

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^+]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: TGR = 0.335 × a^2 {(1/b^2) – (1 /c^2)} × (% sat./100)
Where: a = Na
b = 7
c = SAR

This report is a summary containing the salinity package analytes.
For all the results requested for this sample, please refer to the complete report.

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Aug 20, 2019

Salinity Package Summary Report

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45055
Description: 08/09/2019 19-REF05-B-SO *SOIL*

% Saturation:	34.5		
pH:	3.80		
EC (µS/cm):	238		
SAR:	0.2		
TGR *:	0		
	mg/L	meq/L	ug/g
Calcium:	18	0.90	6.2
Magnesium:	6	0.5	2
Sodium:	4	0.2	1
Potassium:	7	0.2	2
Chloride:	6	0.2	2
Sulfate:	10	0.21	3.4

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^{+}]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: $TGR = 0.335 \times a^2 \{(1/b^2) - (1/c^2)\} \times (\%\ sat./100)$

Where: a = Na
b = 7
c = SAR

This report is a summary containing the salinity package analytes.
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Aug 20, 2019

Salinity Package Summary Report

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45056
Description: 08/09/2019 19-REF05-C-SO *SOIL*

% Saturation:	38.7		
pH:	3.76		
EC (µS/cm):	241		
SAR:	0.3		
TGR *:	0		
	mg/L	meq/L	ug/g
Calcium:	14	0.70	5.4
Magnesium:	5	0.4	2
Sodium:	5	0.2	2
Potassium:	6	0.2	2
Chloride:	6	0.2	2
Sulfate:	14	0.29	5.4

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^+]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: TGR = 0.335 × a^2 {(1/b^2) – (1 /c^2)} × (% sat./100)
Where: a = Na
b = 7
c = SAR

This report is a summary containing the salinity package analytes.
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Aug 20, 2019

Salinity Package Summary Report

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45057
Description: 08/07/2019 19-EXP01-A-SO *SOIL*

% Saturation:	29.2		
pH:	3.39		
EC (µS/cm):	193		
SAR:	0.2		
TGR *:	0		
	mg/L	meq/L	ug/g
Calcium:	10	0.50	2.9
Magnesium:	3	0.2	0.9
Sodium:	2	0.09	0.6
Potassium:	8	0.2	2
Chloride:	4	0.1	1
Sulfate:	18	0.37	5.3

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^+]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: $TGR = 0.335 \times a^2 \{(1/b^2) - (1/c^2)\} \times (\%\ sat./100)$

Where: a = Na
b = 7
c = SAR

This report is a summary containing the salinity package analytes.
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SRC Group # 2019-11322

Aug 20, 2019

Salinity Package Summary Report

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45058
Description: 08/07/2019 19-EXP01-B-SO *SOIL*

% Saturation:	32.8		
pH:	3.17		
EC (µS/cm):	240		
SAR:	0.2		
TGR *:	0		
	mg/L	meq/L	ug/g
Calcium:	8	0.4	3
Magnesium:	2	0.2	0.6
Sodium:	3	0.1	1
Potassium:	12	0.31	3.9
Chloride:	4	0.1	1
Sulfate:	20	0.42	6.6

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^+]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: TGR = 0.335 × a^2 {(1/b^2) – (1 /c^2)} × (% sat./100)
Where: a = Na
b = 7
c = SAR

This report is a summary containing the salinity package analytes.
For all the results requested for this sample, please refer to the complete report.

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E: analytical@src.sk.ca
www.src.sk.ca/analytical

SRC Group # 2019-11322

Aug 20, 2019

Salinity Package Summary Report

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45059
Description: 08/07/2019 19-EXP01-C-SO *SOIL*

% Saturation:	31.2
pH:	3.53
EC (µS/cm):	247
SAR:	2
TGR *:	0

	mg/L	meq/L	ug/g
Calcium:	5	0.2	2
Magnesium:	2	0.2	0.6
Sodium:	22	0.96	6.8
Potassium:	11	0.28	3.4
Chloride:	7	0.2	2
Sulfate:	20	0.42	6.2

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^+]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: $TGR = 0.335 \times a^2 \{(1/b^2) - (1/c^2)\} \times (\%\ sat./100)$
Where: a = Na
b = 7
c = SAR

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SRC Group # 2019-11322

Aug 20, 2019

Salinity Package Summary Report

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45060
Description: 08/07/2019 19-EXP02-A-SO *SOIL*

% Saturation:	27.9		
pH:	3.17		
EC (µS/cm):	233		
SAR:	0.2		
TGR *:	0		
	mg/L	meq/L	ug/g
Calcium:	6	0.3	2
Magnesium:	3	0.2	0.8
Sodium:	2	0.09	0.6
Potassium:	7	0.2	2
Chloride:	4	0.1	1
Sulfate:	23	0.48	6.4

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^+]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: $TGR = 0.335 \times a^2 \{(1/b^2) - (1/c^2)\} \times (\% \text{ sat.}/100)$
Where: a = Na
b = 7
c = SAR

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SRC Group # 2019-11322

Aug 20, 2019

Salinity Package Summary Report

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45061
Description: 08/07/2019 19-EXP02-B-SO *SOIL*

% Saturation:	36.5		
pH:	3.18		
EC (µS/cm):	295		
SAR:	0.3		
TGR *:	0		
	mg/L	meq/L	ug/g
Calcium:	13	0.65	4.8
Magnesium:	4	0.3	1
Sodium:	5	0.2	2
Potassium:	10	0.26	3.6
Chloride:	9	0.2	3
Sulfate:	32	0.67	12

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^+]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: $TGR = 0.335 \times a^2 \{(1/b^2) - (1/c^2)\} \times (\% \text{ sat.}/100)$
Where: a = Na
b = 7
c = SAR

This report is a summary containing the salinity package analytes.
For all the results requested for this sample, please refer to the complete report.

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SRC Group # 2019-11322

Aug 20, 2019

Salinity Package Summary Report

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45062
Description: 08/07/2019 19-EXP02-C-SO *SOIL*

% Saturation:	37.0
pH:	3.08
EC (µS/cm):	345
SAR:	0.7
TGR *:	0

	mg/L	meq/L	ug/g
Calcium:	5	0.2	2
Magnesium:	2	0.2	0.7
Sodium:	6	0.3	2
Potassium:	11	0.28	4.1
Chloride:	9	0.2	3
Sulfate:	31	0.64	11

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^+]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: $TGR = 0.335 \times a^2 \{(1/b^2) - (1/c^2)\} \times (\% \text{ sat.}/100)$

Where: a = Na
b = 7
c = SAR

This report is a summary containing the salinity package analytes.
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SRC Group # 2019-11322

Aug 20, 2019

Salinity Package Summary Report

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45063
Description: 08/10/2019 19-REF06-A-SO *SOIL*

% Saturation:	29.0		
pH:	3.42		
EC (µS/cm):	163		
SAR:	0.2		
TGR *:	0		
	mg/L	meq/L	ug/g
Calcium:	10	0.50	2.9
Magnesium:	2	0.2	0.6
Sodium:	2	0.09	0.6
Potassium:	6	0.2	2
Chloride:	4	0.1	1
Sulfate:	14	0.29	4.0

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^+]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: $TGR = 0.335 \times a^2 \{(1/b^2) - (1/c^2)\} \times (\% \text{ sat.}/100)$

Where: a = Na
b = 7
c = SAR

This report is a summary containing the salinity package analytes.
For all the results requested for this sample, please refer to the complete report.

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SRC Group # 2019-11322

Aug 20, 2019

Salinity Package Summary Report

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45064
Description: 08/10/2019 19-REF06-B-SO *SOIL*

% Saturation:	36.6		
pH:	3.59		
EC (µS/cm):	323		
SAR:	0.1		
TGR *:	0		
	mg/L	meq/L	ug/g
Calcium:	24	1.2	8.8
Magnesium:	5	0.4	2
Sodium:	3	0.1	1
Potassium:	22	0.56	8.0
Chloride:	11	0.31	4.0
Sulfate:	27	0.56	9.9

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^{+}]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: $TGR = 0.335 \times a^2 \{(1/b^2) - (1/c^2)\} \times (\% \text{ sat.}/100)$

Where: a = Na
b = 7
c = SAR

This report is a summary containing the salinity package analytes.
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Golder
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Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45065
Description: 08/10/2019 19-REF06-C-SO *SOIL*

% Saturation:	25.7		
pH:	3.85		
EC (µS/cm):	177		
SAR:	0.2		
TGR *:	0		
	mg/L	meq/L	ug/g
Calcium:	11	0.55	2.8
Magnesium:	4	0.3	1
Sodium:	3	0.1	0.8
Potassium:	8	0.2	2
Chloride:	4	0.1	1
Sulfate:	6	0.1	2

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^+]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: TGR = 0.335 × a^2 {($1/b^2$) – ($1/c^2$)} × (% sat./100)

Where: a = Na
b = 7
c = SAR

This report is a summary containing the salinity package analytes.
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Salinity Package Summary Report

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45066
Description: 08/08/2019 19-EXP03-A-SO *SOIL*

% Saturation:	32.1		
pH:	4.27		
EC (µS/cm):	154		
SAR:	0.2		
TGR *:	0		
	mg/L	meq/L	ug/g
Calcium:	10	0.50	3.2
Magnesium:	3	0.2	1
Sodium:	2	0.09	0.6
Potassium:	6	0.2	2
Chloride:	4	0.1	1
Sulfate:	10	0.21	3.2

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^+]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: $TGR = 0.335 \times a^2 \{(1/b^2) - (1/c^2)\} \times (\% \text{ sat.}/100)$
Where: a = Na
b = 7
c = SAR

This report is a summary containing the salinity package analytes.
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SRC Group # 2019-11322

Aug 20, 2019

Salinity Package Summary Report

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45067
Description: 08/08/2019 19-EXP03-B-SO *SOIL*

% Saturation:	23.2
pH:	3.75
EC (µS/cm):	174
SAR:	0.5
TGR *:	0

	mg/L	meq/L	ug/g
Calcium:	10	0.50	2.3
Magnesium:	2	0.2	0.5
Sodium:	6	0.3	1
Potassium:	10	0.26	2.3
Chloride:	5	0.1	1
Sulfate:	12	0.25	2.8

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^+]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: $TGR = 0.335 \times a^2 \{(1/b^2) - (1/c^2)\} \times (\% \text{ sat.}/100)$

Where: a = Na
b = 7
c = SAR

This report is a summary containing the salinity package analytes.
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SRC Group # 2019-11322

Aug 20, 2019

Salinity Package Summary Report

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

SRC Sample #: 45068
Description: 08/08/2019 19-EXP03-C-SO *SOIL*

% Saturation:	24.5
pH:	3.57
EC (µS/cm):	176
SAR:	0.2
TGR *:	0

	mg/L	meq/L	ug/g
Calcium:	10	0.50	2.4
Magnesium:	2	0.2	0.5
Sodium:	3	0.1	0.7
Potassium:	7	0.2	2
Chloride:	4	0.1	1
Sulfate:	12	0.25	2.9

A target value of SAR = 7 is used for this calculation.
If the actual SAR is less than 7, then the TGR = 0.
TGR in tonnes per hectare (15 cm depth).

"Sodium adsorption ratio" (SAR) is a measure of the amount of sodium (Na+) relative to calcium (Ca2+) and magnesium (Mg2+) in the water extracted from a saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. SAR is calculated from the equation:

$$SAR = \frac{[Na^+]}{\sqrt{\{[Ca^{2+}] + [Mg^{2+}]\}/2}}$$

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook

Theoretical Gypsum Requirement: $TGR = 0.335 \times a^2 \{(1/b^2) - (1/c^2)\} \times (\%\ sat./100)$

Where: a = Na
b = 7
c = SAR

This report is a summary containing the salinity package analytes.
For all the results requested for this sample, please refer to the complete report.

APPENDIX C

Soils Inspection Site Data

Table C-1: Terrain and Soil Characteristics Obtained at Each Inspection Site

Site	Soil Order	Subgroup[a]	Horizon	Texture	Structure[b]	Top Depth (cm)	Bottom Depth (cm)	Horizon Thickness (cm)	Color	Mottle Abundance	Mottle Dimension	Mottle Contrast	Mottle Color	Drainage[c]	Slope Position[d]	Slope Class[e]	Parent Material[f]
NR18MS001	Brunisol	GLE.DYB	LFH	-	SGR	14	0	14	-	-	-	-	-				
			Ae	sand	SGR	0	10	10	10YR 5/3	-	-	-	-	MW	T	3	GLFL
			Bmgj	sand	SGR	10	24	14	7.5YR 3/3	-	-	-	-				
			BC	sand	SGR	24	40	16	7.5YR 6/3	-	-	-	-				
NR18MS002	Brunisol	E.DYB	LFH	-	-	9	0	9	-	-	-	-	-	R	L	5	GLFL
			Ae	sand	SGR	0	23	23	-	-	-	-	-				
			Bm	sand	SGR	23	50	27	-	-	-	-	-				
			BC	loamy sand	MA	50	65	15	-	-	-	-	-				
NR18MS003	Brunisol	GLE.DYB	LFH	-	-	20	0	20	-	-	-	-	-	-	-	-	GLFL
			Aegj	sand	SGR	0	10	10	-	-	-	-	-				
			Bmgj	sand	SGR	10	30	20	-	-	-	-	-				
NR18MS004	Brunisol	E.DYB	LFH	-	-	5	0	5	-	-	-	-	-	R	M	4	GLFL
			Ae	sand	SGR	0	28	28	7.5YR 7/1	-	-	-	-				
			Bm	sand	SGR	28	55	27	7.5YR 5/8	-	-	-	-				
			BC	sand	SGR	55	65	10	-	-	-	-	-				
NR18MS005	Brunisol	E.DYB	LFH	-	-	5	0	5	-	-	-	-	-	R	M	4	GLFL
			Ae	sand	SGR	0	14	14	7.5YR 7/1	-	-	-	-				
			Bm	sand	SGR	14	26	12	7.5YR 5/8	-	-	-	-				
			BC	sand	SGR	26	50	24	-	-	-	-	-				
			C	sand	SGR	50	75	25	-	-	-	-	-				
NR18MS006	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	R	U	7	GLFL
			Ae	sand	SGR	0	20	20	-	-	-	-	-				
			Bm	sand	SGR	20	35	15	-	-	-	-	-				
			BC	sandy loam	MA	35	45	10	-	-	-	-	-				
NR18MS007	Brunisol	E.DYB	LFH	-	-	6	0	6	-	-	-	-	-	W	L	4	GLFL
			Ae	sand	-	0	12	12	-	-	-	-	-				
			Bm	sand	-	12	33	21	-	-	-	-	-				
			BC	sand	-	33	65	32	-	-	-	-	-				
			C	loamy sand	-	65	100	35	-	-	-	-	-				
NR18MS008	Brunisol	E.DYB	LFH	-	-	5	0	5	-	-	-	-	-	R	U	4	GLFL
			Ae	sand	-	0	32	32	-	-	-	-	-				
			Bm	sand	-	32	45	13	-	-	-	-	-				
NR18MS009	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	R	U	3	GLFL
			Ae	sand	-	0	19	19	-	-	-	-	-				
			Bm	sand	-	19	35	16	-	-	-	-	-				
NR18MS010	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	R	U	5	GLFL
			Ae	sand	-	0	25	25	-	-	-	-	-				
			Bm	sand	-	25	40	15	-	-	-	-	-				
NR18MS011	Brunisol	E.DYB	LFH	-	-	6	0	6	-	-	-	-	-	R	U	5	GLFL
			Ae	sand	-	0	30	30	-	-	-	-	-				
			Bm	sand	-	30	60	30	-	-	-	-	-				
NR18MS012	Brunisol	E.DYB	LFH	-	-	5	0	5	-	-	-	-	-	R	U	5	GLFL
			Ae	sand	SGR	0	25	25	-	-	-	-	-				
			Bm	sand	SGR	25	35	10	-	-	-	-	-				

Table C-1: Terrain and Soil Characteristics Obtained at Each Inspection Site

Site	Soil Order	Subgroup[a]	Horizon	Texture	Structure[b]	Top Depth (cm)	Bottom Depth (cm)	Horizon Thickness (cm)	Color	Mottle Abundance	Mottle Dimension	Mottle Contrast	Mottle Color	Drainage[c]	Slope Position[d]	Slope Class[e]	Parent Material[f]
NR18MS013	Brunisol	E.DYB	LFH	-	-	6	0	6	-	-	-	-	-	R	M	6	GLFL
			Ae	sand	SGR	0	30	30	-	-	-	-	-				
			Bm	sandy loam	SGR	30	35	5	-	-	-	-	-				
NR18MS014	Brunisol	E.DYB	LFH	-	-	5	0	5	-	-	-	-	-	R	L	4	GLFL
			Ae	sand	SGR	0	15	15	-	-	-	-	-				
			Bm	sand	SGR	15	27	12	-	-	-	-	-				
			BCgj	sand	SGR	27	55	28	-	-	-	-	-				
			C	sand	SGR	55	100	45	-	-	-	-	-				
NR18MS015	Brunisol	GLE.DYB	Of	-	-	10	4	6	-	-	-	-	-	I	L	3	GLFL
			Oh	-	-	4	0	4	-	-	-	-	-				
			Aegj	loamy sand	PL	0	18	18	-	-	-	-	-				
			Bmgj	loamy sand	SBK	18	40	22	7.5YR 4/3	Few	Coarse	Faint	Faint				
			BCg	loamy sand	MA	40	100	60	-	-	-	-	-				
NR18MS016	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	R	C	2	GLFL
			Ae	sand	SGR	4	35	31	-	-	-	-	-				
			Ahe	sand	SGR	0	4	4	-	-	-	-	-				
			Bm	sand	SGR	35	45	10	-	-	-	-	-				
NR18MS017	Brunisol	E.DYB	LFH	-	-	5	0	5	-	-	-	-	-	W	L	3	GLFL
			Ae	loamy sand	PL	0	12	12	-	-	-	-	-				
			Bm	sand	SGR	12	30	18	-	-	-	-	-				
			C	sand	SGR	30	75	45	-	-	-	-	-				
NR18MS018	Brunisol	E.DYB	LFH	-	-	5	0	5	-	-	-	-	-	W	L	5	GLFL
			Ae	loamy sand	PL	0	10	10	-	-	-	-	-				
			Bm	sandy loam	SBK	10	40	30	-	-	-	-	-				
			C	sand	SGR	40	50	10	-	-	-	-	-				
NR18MS019	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	R	U	2	GLFL
			Ae	sand	SGR	0	12	12	7.5YR 6/2	-	-	-	-				
			Bm	loamy sand	SBK	12	26	14	10YR 5/8	-	-	-	-				
			C	sandy loam	MA	55	100	45	-	-	-	-	-				
			C	sand	SGR	26	55	29	10YR 7/6	-	-	-	-				
NR18MS020	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	R	U	2	GLFL
			Ae	sand	PL	0	9	9	7.5YR 6/2	-	-	-	-				
			Bm	loamy sand	SBK	9	22	13	10YR 5/8	-	-	-	-				
			BC	loamy sand	-	22	40	18	-	-	-	-	-				
			C	sand	-	40	60	20	-	-	-	-	-				
NR18MS021	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	U	2	GLFL
			Ae	loamy sand	-	0	20	20	-	-	-	-	-				
			Bm	loamy sand	-	20	40	20	-	-	-	-	-				
			C	sand	-	40	45	5	-	-	-	-	-				

Table C-1: Terrain and Soil Characteristics Obtained at Each Inspection Site

Site	Soil Order	Subgroup[a]	Horizon	Texture	Structure[b]	Top Depth (cm)	Bottom Depth (cm)	Horizon Thickness (cm)	Color	Mottle Abundance	Mottle Dimension	Mottle Contrast	Mottle Color	Drainage[c]	Slope Position[d]	Slope Class[e]	Parent Material[f]
NR18MS022	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	W	C	1	GLFL
			Ae	sand	SGR	0	18	18	-	-	-	-	-				
			Bm	loamy sand	SBK	18	45	27	-	-	-	-	-				
			C	sand	SGR	45	60	15	-	-	-	-	-				
NR18MS023	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	W	C	2	GLFL
			Ae	loamy sand	PL	0	6	6	-	-	-	-	-				
			Bm	loamy sand	SBK	6	30	24	-	-	-	-	-				
			C	sand	SGR	30	45	15	-	-	-	-	-				
NR18MS024	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	R	U	3	GLFL
			Ae	sand	SGR	0	22	22	-	-	-	-	-				
			Bm	sand	SGR	22	40	18	-	-	-	-	-				
			BC	sand	SGR	40	50	10	-	-	-	-	-				
NR18MS025	Brunisol	E.DYB	LFH	-	-	4	0	4	-	-	-	-	-	R	U	3	GLFL
			Ae	loamy sand	PL	0	22	22	-	-	-	-	-				
			Bm	loamy sand	SBK	22	35	13	-	-	-	-	-				
			BC	sand	SGR	35	50	15	-	-	-	-	-				
NR18MS026	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	R	U	3	GLFL
			Ae	sand	SGR	0	15	15	-	-	-	-	-				
			Bm	sand	SGR	15	40	25	-	-	-	-	-				
			C	sand	SGR	40	50	10	-	-	-	-	-				
NR18MS027	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	R	L	4	GLFL
			Ae	loamy sand	PL	0	20	20	-	-	-	-	-				
			Bm	loamy sand	SBK	20	35	15	-	-	-	-	-				
			C	sand	SGR	35	65	30	-	-	-	-	-				
			C	sand	SGR	65	75	10	-	-	-	-	-				
NR18MS028	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	R	C	3	GLFL
			Ae	loamy sand	PL	0	9	9	-	-	-	-	-				
			Bm	loamy sand	SGR	9	35	26	-	-	-	-	-				
			C	sand	SGR	35	45	10	-	-	-	-	-				
NR18MS029	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	W	L	5	GLFL
			Ae	loamy sand	PL	0	7	7	10YR 6/1	-	-	-	-				
			Btj	sandy loam	SBK	22	35	13	10YR 5/6	-	-	-	-				
			Bm	loamy sand	SBK	7	22	15	10YR 5/8	-	-	-	-				
			BC	sandy loam	MA	35	50	15	2.5Y 7/2	-	-	-	-				
			C	sand	SGR	50	75	25	7.5YR 7/3	-	-	-	-				
NR18MS030	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	R	M	4	GLFL
			Ae	sand	SGR	0	20	20	-	-	-	-	-				
			Bm	sand	SGR	20	40	20	-	-	-	-	-				
			C	sand	SGR	40	100	60	-	-	-	-	-				

Table C-1: Terrain and Soil Characteristics Obtained at Each Inspection Site

Site	Soil Order	Subgroup[a]	Horizon	Texture	Structure[b]	Top Depth (cm)	Bottom Depth (cm)	Horizon Thickness (cm)	Color	Mottle Abundance	Mottle Dimension	Mottle Contrast	Mottle Color	Drainage[c]	Slope Position[d]	Slope Class[e]	Parent Material[f]
NR18MS031	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	W	U	4	GLFL
			Ae	sand	SGR	1	18	17	-	-	-	-	-				
			Ah	loamy sand	-	0	1	1	-	-	-	-	-				
			Btj	sandy loam	SBK	18	40	22	-	-	-	-	-				
NR18MS032	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	W	C	2	GLFL
			Ae	loamy sand	PL	0	16	16	-	-	-	-	-				
			Bm	loamy sand	SBK	16	37	21	-	-	-	-	-				
			C	sand	SGR	37	70	33	-	-	-	-	-				
NR18MS033	Brunisol	GLE.DYB	LFH	-	-	4	0	4	-	-	-	-	-	MW	L	2	GLFL
			Aegj	loamy sand	-	8	20	12	-	-	-	-	-				
			Ahe	loamy sand	-	0	8	8	-	-	-	-	-				
			Btjgj	sandy loam	SBK	20	38	18	-	Common	Medium	Faint	Faint				
			BCgj	sandy loam	MA	38	75	37	-	-	-	-	-				
NR18MS034	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	MW	U	3	GLFL
			Ae	loamy sand	-	0	12	12	-	-	-	-	-				
			Bm	loamy sand	-	12	30	18	-	-	-	-	-				
			C	loamy sand	-	30	45	15	-	-	-	-	-				
NR18MS035	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	MW	U	3	GLFL
			Ae	loamy sand	-	0	9	9	-	-	-	-	-				
			Bm	loamy sand	-	9	26	17	-	-	-	-	-				
			C	loamy sand	-	26	30	4	-	-	-	-	-				
NR18MS036	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	M	5	GLFL
			Ae	loamy sand	PL	0	15	15	-	-	-	-	-				
			Bm	loamy sand	SBK	15	37	22	-	-	-	-	-				
			C	loamy sand	SGR	37	40	3	-	-	-	-	-				
NR18MS037	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	C	3	GLFL
			Ae	loamy sand	PL	0	10	10	-	-	-	-	-				
			Bm	loamy sand	SBK	10	22	12	-	-	-	-	-				
			BC	loamy sand	SBK	22	37	15	-	-	-	-	-				
			C	loamy sand	-	37	65	28	-	-	-	-	-				

Table C-1: Terrain and Soil Characteristics Obtained at Each Inspection Site

Site	Soil Order	Subgroup[a]	Horizon	Texture	Structure[b]	Top Depth (cm)	Bottom Depth (cm)	Horizon Thickness (cm)	Color	Mottle Abundance	Mottle Dimension	Mottle Contrast	Mottle Color	Drainage[c]	Slope Position[d]	Slope Class[e]	Parent Material[f]
NR18MS038	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	R	M	3	GLFL
			Ae	sand	SGR	5	20	15	7.5YR 6/2	-	-	-	-				
			Ahe	loamy sand	SGR	0	5	5	7.5YR 4/1	-	-	-	-				
			Bm	loamy sand	SBK	20	40	20	10YR 5/6	-	-	-	-				
			C	sand	SGR	40	50	10	-	-	-	-	-				
NR18MS039	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	R	U	2	GLFL
			Ae	sand	SGR	2	11	9	-	-	-	-	-				
			Ahe	loamy sand	-	0	2	2	-	-	-	-	-				
			Bm	loamy sand	SBK	11	36	25	-	-	-	-	-				
			C	sand	SGR	36	80	44	-	-	-	-	-				
NR18MS040	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	R	V	2	GLFL
			Ae	loamy sand	-	0	10	10	-	-	-	-	-				
			Bm	loamy sand	-	10	29	19	-	-	-	-	-				
			C	sand	SGR	29	60	31	-	-	-	-	-				
NR18MS041	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	R	M	3	GLFL
			Ae	loamy sand	SGR	0	17	17	-	-	-	-	-				
			Bm	loamy sand	SBK	17	40	23	-	-	-	-	-				
			C	sand	SBK	40	70	30	-	-	-	-	-				
NR18MS042	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	R	M	4	GLFL
			Ae	loamy sand	PL	0	10	10	-	-	-	-	-				
			Btj	sandy loam	SBK	10	35	25	-	-	-	-	-				
			C	sand	SGR	35	65	30	-	-	-	-	-				
NR18MS043	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	R	M	4	GLFL
			Ae	loamy sand	PL	1	1	0	-	-	-	-	-				
			Ahe	loamy sand	-	0	1	1	10YR 4/1	-	-	-	-				
			Bm	loamy sand	SBK	1	3	2	-	-	-	-	-				
			C	sand	SGR	3	25	22	-	-	-	-	-				
NR18MS044	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	R	M	3	GLFL
			Ae	-	-	0	8	8	-	-	-	-	-				
			Bm	loamy sand	-	8	30	22	-	-	-	-	-				
NR18MS045	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	W	M	4	GLFL
			Ae	loamy sand	PL	2	20	18	-	-	-	-	-				
			Ahe	loamy sand	-	0	2	2	-	-	-	-	-				
			Bm	loamy sand	SBK	20	40	20	-	-	-	-	-				
			C	loamy sand	-	40	100	60	-	-	-	-	-				

Table C-1: Terrain and Soil Characteristics Obtained at Each Inspection Site

Site	Soil Order	Subgroup[a]	Horizon	Texture	Structure[b]	Top Depth (cm)	Bottom Depth (cm)	Horizon Thickness (cm)	Color	Mottle Abundance	Mottle Dimension	Mottle Contrast	Mottle Color	Drainage[c]	Slope Position[d]	Slope Class[e]	Parent Material[f]
NR18MS046	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	R	M	5	GLFL
			Ae	loamy sand	-	2	10	8	-	-	-	-	-				
			Ahe	loamy sand	-	0	2	2	-	-	-	-	-				
			Bm	loamy sand	-	10	40	30	-	-	-	-	-				
			C	loamy sand	-	40	45	5	-	-	-	-	-				
NR18MS047	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	W	M	5	GLFL
			Ae	loamy sand	PL	0	19	19	-	-	-	-	-				
			Bm	loamy sand	SBK	19	45	26	-	-	-	-	-				
			BC	loamy sand	SBK	45	60	15	-	-	-	-	-				
			C	sand	SGR	60	75	15	-	-	-	-	-				
NR18MS048	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	W	M	6	GLFL
			Ae	loamy sand	-	0	20	20	-	-	-	-	-				
			Bm	loamy sand	-	20	35	15	-	-	-	-	-				
			C	loamy sand	-	35	50	15	-	-	-	-	-				
NR18MS049	Brunisol	GLE.DYB	LFH	-	-	5	0	5	-	-	-	-	-	MW	L	6	GLFL
			Ae	loamy sand	PL	0	24	24	-	-	-	-	-				
			Aegj	sandy loam	PL	24	32	8	-	Few	Fine	Faint	Faint				
			Btjgj	loam	SBK	32	47	15	-	Few	Fine	Faint	Faint				
			C	loamy sand	MA	47	65	18	-	-	-	-	-				
NR18MS050	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	U	3	GLFL
			Ae	loamy sand	PL	0	24	24	-	-	-	-	-				
			Bm	loamy sand	SBK	24	42	18	-	-	-	-	-				
			C	loamy sand	-	42	70	28	-	-	-	-	-				
NR18MS051	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	U	3	GLFL
			Ae	loamy sand	PL	0	9	9	-	-	-	-	-				
			Bm	loamy sand	SBK	9	30	21	-	-	-	-	-				
			C	sand	-	30	50	20	-	-	-	-	-				
NR18MS052	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	C	3	GLFL
			Ae	loamy sand	-	0	22	22	-	-	-	-	-				
			Bm	loamy sand	-	22	35	13	-	-	-	-	-				
			C	loamy sand	-	35	40	5	-	-	-	-	-				

Table C-1: Terrain and Soil Characteristics Obtained at Each Inspection Site

Site	Soil Order	Subgroup[a]	Horizon	Texture	Structure[b]	Top Depth (cm)	Bottom Depth (cm)	Horizon Thickness (cm)	Color	Mottle Abundance	Mottle Dimension	Mottle Contrast	Mottle Color	Drainage[c]	Slope Position[d]	Slope Class[e]	Parent Material[f]
NR18MS053	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	M	3	GLFL
			Ae	loamy sand	-	0	20	20	-	-	-	-	-				
			Bm	loamy sand	-	20	45	25	-	-	-	-	-				
			BC	loamy sand	-	45	55	10	-	-	-	-	-				
			C	loamy sand	-	55	60	5	-	-	-	-	-				
NR18MS054	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	M	4	GLFL
			Ae	loamy sand	PL	0	17	17	7.5YR 6/2	-	-	-	-				
			Bm	loamy sand	SBK	17	40	23	7.5YR 5/8	-	-	-	-				
NR18MS055	Gleysol	O.G	LFH	-	-	5	0	5	-	-	-	-	-	P	L	4	GLFL
			Aegj	loamy sand	PL	0	14	14	-	Few	Medium	Faint	Faint				
			Bg	loamy sand	SBK	14	50	36	-	Many	Medium	Prominent	Prominent				
			Cg	loamy sand	-	50	65	15	-	-	-	-	-				
NR18MS056	Brunisol	E.DYB	LFH	-	-	4	0	4	-	-	-	-	-	W	M	7	GLFL
			Ae	loamy sand	PL	0	16	16	-	-	-	-	-				
			Bm	loamy sand	SBK	16	45	29	-	-	-	-	-				
			C	loamy sand	MA	45	70	25	-	-	-	-	-				
NR18MS057	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	W	M	4	GLFL
			Ae	loamy sand	SBK	0	15	15	-	-	-	-	-				
			Bm	loamy sand	SBK	15	35	20	-	-	-	-	-				
			C	sand	SGR	35	60	25	-	-	-	-	-				
NR18MS058	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	U	3	GLFL
			Ae	loamy sand	PL	0	13	13	7.5 7/1	-	-	-	-				
			Bm	loamy sand	SBK	13	34	21	7.5YR 5/6	-	-	-	-				
			C	sand	SGR	34	100	66	10YR 7/3	-	-	-	-				
NR18MS059	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	M	3	GLFL
			Ae	sand	-	0	20	20	-	-	-	-	-				
			Bm	loamy sand	-	20	40	20	-	-	-	-	-				
			C	sand	-	40	100	60	-	-	-	-	-				
NR18MS060	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	M	4	GLFL
			Ae	loamy sand	SGR	0	14	14	-	-	-	-	-				
			Bm	loamy sand	SBK	14	34	20	-	-	-	-	-				
			C	sand	SGR	34	55	21	-	-	-	-	-				

Table C-1: Terrain and Soil Characteristics Obtained at Each Inspection Site

Site	Soil Order	Subgroup[a]	Horizon	Texture	Structure[b]	Top Depth (cm)	Bottom Depth (cm)	Horizon Thickness (cm)	Color	Mottle Abundance	Mottle Dimension	Mottle Contrast	Mottle Color	Drainage[c]	Slope Position[d]	Slope Class[e]	Parent Material[f]
NR18MS061	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	U	3	GLFL
			Ae	sand	SGR	0	14	14	-	-	-	-	-				
			Bm	loamy sand	SBK	14	40	26	-	-	-	-	-				
			BC	sand	SGR	40	55	15	-	-	-	-	-				
			C	sand	SGR	55	75	20	-	-	-	-	-				
NR18MS062	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	R	U	6	GLFL
			Ae	loamy sand	-	0	30	30	-	-	-	-	-				
			Bm	loamy sand	-	30	50	20	-	-	-	-	-				
			C	loamy sand	-	50	55	5	-	-	-	-	-				
NR18MS063	Brunisol	GLE.DYB	LFH	-	-	11	0	11	-	-	-	-	-	MW	M	3	GLFL
			Ae	sandy loam	PL	0	10	10	-	-	-	-	-				
			ABgj	sandy loam	PL	10	18	8	-	-	-	-	-				
			Bmgj	sandy loam	SBK	18	40	22	-	-	-	-	-				
			BCgj	sandy loam	MA	40	55	15	-	-	-	-	-				
			C	sandy loam	MA	55	75	20	-	-	-	-	-				
NR18MS064	Brunisol	E.DYB	LFH	-	-	8	0	8	-	-	-	-	-	W	M	3	GLFL
			Ae	loamy sand	PL	0	11	11	-	-	-	-	-				
			Btgj	sandy loam	SBK	11	25	14	-	-	-	-	-				
			C	loamy sand	MA	25	75	50	-	-	-	-	-				
			C	sand	SGR	75	100	25	-	-	-	-	-				
NR18MS065	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	W	L	3	GLFL
			Ae	sandy loam	PL	0	5	5	-	-	-	-	-				
			Bm	sandy loam	SBK	5	26	21	-	-	-	-	-				
			BCgj	sandy loam	SBK	26	40	14	-	-	-	-	-				
			Cgj	sand	MA	40	90	50	-	-	-	-	-				
NR18MS066	Brunisol	GLE.DYB	LFH	-	-	3	0	3	-	-	-	-	-	MW	V	1	GLFL
			Ae	sandy loam	-	0	22	22	-	-	-	-	-				
			Bmgj	sandy loam	-	22	35	13	-	Few	Fine	Faint	Faint				
			BCgj	loam	-	35	52	17	-	Many	Medium	Faint	Faint				
			Cgj	loamy sand	-	52	90	38	-	-	-	-	-				
NR18MS067	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	V	1	GLFL
			Ae	loamy sand	PL	0	15	15	-	-	-	-	-				
			Bm	loamy sand	SBK	15	29	14	-	-	-	-	-				
			C	sand	-	29	65	36	-	-	-	-	-				

Table C-1: Terrain and Soil Characteristics Obtained at Each Inspection Site

Site	Soil Order	Subgroup[a]	Horizon	Texture	Structure[b]	Top Depth (cm)	Bottom Depth (cm)	Horizon Thickness (cm)	Color	Mottle Abundance	Mottle Dimension	Mottle Contrast	Mottle Color	Drainage[c]	Slope Position[d]	Slope Class[e]	Parent Material[f]
NR18MS068	Brunisol	E.DYB	LFH	-	-	5	0	5	-	-	-	-	-	W	M	4	GLFL
			Ahb	silt loam	GR	18	21	3	-	-	-	-	-				
			Ae	sandy loam	PL	0	5	5	-	-	-	-	-				
			Aeb	sandy loam	PL	21	34	13	-	-	-	-	-				
			Bm	sandy loam	SBK	5	18	13	-	-	-	-	-				
			BC	sandy loam	MA	34	36	2	-	-	-	-	-				
			C	sand	SGR	56	70	14	-	-	-	-	-				
			C	sandy loam	MA	36	56	20	-	-	-	-	-				
NR18MS069	Brunisol	E.DYB	LFH	-	-	5	0	5	-	-	-	-	-	W	L	3	GLFL
			Ae	loamy sand	SBK	0	20	20	-	-	-	-	-				
			Bm	loamy sand	SBK	20	35	15	-	-	-	-	-				
			C	sand	SGR	35	60	25	-	-	-	-	-				
NR18MS070	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	M	6	GLFL
			Ae	loamy sand	PL	0	22	22	-	-	-	-	-				
			Bm	loamy sand	SBK	22	42	20	-	-	-	-	-				
			C	sand	SGR	42	95	53	-	-	-	-	-				
NR18MS071	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	M	6	GLFL
			Ae	loamy sand	PL	0	30	30	-	-	-	-	-				
			Bm	loamy sand	SBK	30	40	10	-	-	-	-	-				
NR18MS072	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	W	U	5	GLFL
			Ae	loamy sand	-	0	16	16	-	-	-	-	-				
			Bm	loamy sand	SBK	16	35	19	-	-	-	-	-				
			C	loamy sand	-	35	65	30	-	-	-	-	-				
NR18MS073	Brunisol	E.DYB	LFH	-	-	4	0	4	-	-	-	-	-	W	L	3	GLFL
			Ae	loamy sand	PL	0	17	17	-	-	-	-	-				
			Bm	sandy loam	SBK	17	40	23	-	-	-	-	-				
			C	sand	SGR	40	100	60	-	-	-	-	-				
NR18MS074	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	W	U	3	GLFL
			Ae	loamy sand	-	0	10	10	-	-	-	-	-				
			Bm	sandy loam	-	10	35	25	-	-	-	-	-				
			C	loamy sand	-	35	70	35	-	-	-	-	-				

Table C-1: Terrain and Soil Characteristics Obtained at Each Inspection Site

Site	Soil Order	Subgroup[a]	Horizon	Texture	Structure[b]	Top Depth (cm)	Bottom Depth (cm)	Horizon Thickness (cm)	Color	Mottle Abundance	Mottle Dimension	Mottle Contrast	Mottle Color	Drainage[c]	Slope Position[d]	Slope Class[e]	Parent Material[f]
NR18MS075	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	M	6	GLFL
			Ae	loamy sand	PL	0	19	19	7.5YR 6/2	-	-	-	-				
			Bm	loamy sand	SBK	19	40	21	10YR 4/6	-	-	-	-				
			C	sand	SGR	65	85	20	10YR 6/4	-	-	-	-				
			C	sand	SGR	40	65	25	10YR 6/4	-	-	-	-				
NR18MS076	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	M	6	GLFL
			Ae	sand	PL	0	15	15	-	-	-	-	-				
			Bm	sandy loam	SBK	15	38	23	-	-	-	-	-				
			C	sand	SGR	38	60	22	-	-	-	-	-				
NR18MS077	Organic	T.M	Of	-	-	0	40	40	-	-	-	-	-	VP	D	1	FNPT/GLFL
			Om	sand	-	40	95	55	-	-	-	-	-				
			Cg	loamy sand	-	95	110	15	-	-	-	-	-				
NR18MS078	Brunisol	E.DYB	LFH	-	-	8	0	8	-	-	-	-	-	W	U	7	GLFL
			Ae	loamy sand	PL	0	12	12	-	-	-	-	-				
			Btj	sandy loam	SBK	12	30	18	-	-	-	-	-				
			BC	loamy sand	-	30	45	15	-	-	-	-	-				
NR18MS079	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	W	U	4	GLFL
			Ae	loamy sand	PL	0	8	8	-	-	-	-	-				
			Bm	loamy sand	SBK	8	40	32	-	-	-	-	-				
			C	sand	SGR	40	90	50	-	-	-	-	-				
NR18MS080	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	W	M	3	GLFL
			Ae	loamy sand	-	0	12	12	-	-	-	-	-				
			Btj	sandy loam	-	12	25	13	-	-	-	-	-				
NR18MS081	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	R	M	4	GLFL
			Ae	sand	SGR	0	10	10	-	-	-	-	-				
			Bm	loamy sand	SBK	10	35	25	-	-	-	-	-				
			BC	loamy sand	SGR	35	40	5	-	-	-	-	-				
			C	-	-	40	-	-	-	-	-	-	-				
NR18MS082	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	R	U	3	GLFL
			Ae	loamy sand	PL	0	7	7	10YR 6/1	-	-	-	-				
			Btj	sandy loam	SBK	7	35	28	10YR 5/6	-	-	-	-				
			BC	loamy sand	MA	35	45	10	-	-	-	-	-				

Table C-1: Terrain and Soil Characteristics Obtained at Each Inspection Site

Site	Soil Order	Subgroup[(a)]	Horizon	Texture	Structure[(b)]	Top Depth (cm)	Bottom Depth (cm)	Horizon Thickness (cm)	Color	Mottle Abundance	Mottle Dimension	Mottle Contrast	Mottle Color	Drainage[(c)]	Slope Position[(d)]	Slope Class[(e)]	Parent Material[(f)]
NR18MS083	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	R	M	4	GLFL
			Ae	loamy sand	PL	0	8	8	-	-	-	-	-				
			Bm	loamy sand	SBK	8	30	22	-	-	-	-	-				
			C	loamy sand	SGR	30	55	25	-	-	-	-	-				
NR18MS084	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	R	M	3	GLFL
			Ae	loamy sand	-	0	10	10	-	-	-	-	-				
			Bm	loamy sand	-	10	35	25	-	-	-	-	-				
			C	loamy sand	-	35	100	65	-	-	-	-	-				
NR18MS085	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	R	M	2	GLFL
			Ae	loamy sand	PL	3	33	30	7.5YR 7/2	-	-	-	-				
			Ahe	loamy sand	PL	0	3	3	10YR 4/1	-	-	-	-				
			Bm	loamy sand	SBK	33	58	25	10YR 5/8	-	-	-	-				
			C	loamy sand	SGR	58	90	32	-	-	-	-	-				
NR18MS086	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	W	V	1	GLFL
			Ae	loamy sand	PL	0	9	9	-	-	-	-	-				
			Bm	loamy sand	SBK	9	34	25	-	-	-	-	-				
			C	loamy sand	MA	34	75	41	-	-	-	-	-				
NR18MS087	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	U	4	GLFL
			Ae	loamy sand	-	0	15	15	-	-	-	-	-				
			Bm	loamy sand	-	15	32	17	-	-	-	-	-				
			C	loamy sand	-	32	65	33	-	-	-	-	-				
NR18MS088	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	W	U	2	GLFL
			Ae	loamy sand	PL	0	5	5	-	-	-	-	-				
			AB	loamy sand	PL	5	10	5	-	-	-	-	-				
			Bm	loamy sand	SBK	10	30	20	-	-	-	-	-				
			C	loamy sand	SGR	30	100	70	-	-	-	-	-				
NR18MS089	Organic	FI.M	Of	-	-	0	80	80	-	-	-	-	-	VP	V	1	SPPT
			Om	-	-	80	220	140	-	-	-	-	-				
NR18MS090	Organic	ME.F	Of	-	-	0	125	125	-	-	-	-	-	VP	V	1	SPPT
			Om	-	-	125	220	95	-	-	-	-	-				
NR18MS091	Organic	FI.M	Of	-	-	0	85	85	-	-	-	-	-	VP	V	1	SPPT
			Om	-	-	85	220	135	-	-	-	-	-				

Table C-1: Terrain and Soil Characteristics Obtained at Each Inspection Site

Site	Soil Order	Subgroup[a]	Horizon	Texture	Structure[b]	Top Depth (cm)	Bottom Depth (cm)	Horizon Thickness (cm)	Color	Mottle Abundance	Mottle Dimension	Mottle Contrast	Mottle Color	Drainage[c]	Slope Position[d]	Slope Class[e]	Parent Material[f]
NR18MS092	Brunisol	GLE.DYB	LFH	-	-	1	0	1	-	-	-	-	-	MW	M	4	GLFL
			Ahe	loamy sand	-	0	3	3	-	-	-	-	-				
			Ae	sand	SGR	3	13	10	-	-	-	-	-				
			Bmgj	sand	SGR	13	37	24	-	-	-	-	-				
			Cgj	sand	SGR	37	65	28	-	-	-	-	-				
NR18MS093	Organic	T.M	Of	-	-	0	40	40	-	-	-	-	-	VP	V	1	SPPT
			Om	-	-	40	145	105	-	-	-	-	-				
			Cg	loamy sand	-	145	155	10	-	-	-	-	-				
NR18MS094	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	M	6	GLFL
			Ae	loamy sand	PL	0	12	12	-	-	-	-	-				
			Btj	sandy loam	SBK	12	40	28	-	-	-	-	-				
			C	loamy sand	MA	40	50	10	-	-	-	-	-				
NR18MS095	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	U	6	GLFL
			Ae	loamy sand	PL	0	10	10	-	-	-	-	-				
			Bm	loamy sand	SBK	10	33	23	-	-	-	-	-				
			C	loamy sand	MA	33	70	37	-	-	-	-	-				
NR18MS096	Brunisol	GLE.DYB	LFH	-	-	9	0	9	-	-	-	-	-	I	L	3	GLFL
			Ahe	silt loam	PL	0	5	5	10YR 5/1	Few	Fine	Faint	Faint				
			Bmgj	silt loam	SBK	5	24	19	10YR 6/6	Many	Medium	Distinct	Distinct				
			BCgj	sandy loam	SBK	24	55	31	10YR 6/4	Many	Fine	Faint	Faint				
			C	loamy sand	MA	55	100	45	10YR 7/4	Many	Fine	Faint	Faint				
NR18MS097	Brunisol	E.DYB	LFH	-	-	9	0	9	-	-	-	-	-	W	M	4	GLFL
			Ae	sandy loam	PL	0	14	14	-	-	-	-	-				
			Bm	sandy loam	-	14	19	5	-	-	-	-	-				
NR18MS098	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	W	L	4	GLFL
			Ae	loamy sand	PL	0	16	16	-	-	-	-	-				
			Bm	sandy loam	SBK	16	37	21	-	-	-	-	-				
			C	sand	SGR	37	65	28	-	-	-	-	-				
NR18MS099	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	W	M	4	GLFL
			Ae	loamy sand	PL	0	15	15	-	-	-	-	-				
			Bm	loamy sand	SBK	15	40	25	-	-	-	-	-				
			C	sand	SGR	40	70	30	-	-	-	-	-				
NR18MS100	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	W	M	4	GLFL
			Ae	loamy sand	-	0	17	17	-	-	-	-	-				
			Bm	loamy sand	-	17	35	18	-	-	-	-	-				
			BC	loamy sand	-	35	45	10	-	-	-	-	-				
			C	loamy sand	-	45	-	-	-	-	-	-	-				

Table C-1: Terrain and Soil Characteristics Obtained at Each Inspection Site

Site	Soil Order	Subgroup[a]	Horizon	Texture	Structure[b]	Top Depth (cm)	Bottom Depth (cm)	Horizon Thickness (cm)	Color	Mottle Abundance	Mottle Dimension	Mottle Contrast	Mottle Color	Drainage[c]	Slope Position[d]	Slope Class[e]	Parent Material[f]
NR18MS101	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	M	5	GLFL
			Ae	loamy sand	PL	0	10	10	-	-	-	-	-				
			Bm	loamy sand	SBK	10	35	25	-	-	-	-	-				
			C	loamy sand	MA	35	100	65	-	-	-	-	-				
NR18MS102	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	M	4	GLFL
			Ae	loamy sand	-	0	14	14	-	-	-	-	-				
			Bm	loamy sand	-	14	34	20	-	-	-	-	-				
			BC	loamy sand	-	34	45	11	-	-	-	-	-				
			C	sand	SGR	45	100	55	-	-	-	-	-				
NR18MS103	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	M	4	GLFL
			Ae	loamy sand	PL	0	7	7	7.5YR 6/1	-	-	-	-				
			Btj	sandy loam	SBK	7	32	25	10YR 5/8	-	-	-	-				
			C	loamy sand	MA	32	100	68	10YR 6/6	-	-	-	-				
NR18MS104	Brunisol	E.DYB	LFH	-	-	2	0	2	- --	-	-	-	-	W	L	5	GLFL
			Ae	loamy sand	PL	0	19	19	7.5YR 7/2	-	-	-	-				
			Bm	loamy sand	SBK	19	40	21	7.5YR 5/6	-	-	-	-				
			BC	loamy sand	-	40	65	25	10YR 6/6	-	-	-	-				
			C	sand	-	65	100	35	10YR 7/4	-	-	-	-				
NR18MS105	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	U	5	GLFL
			Ahe	loamy sand	PL	0	3	3	-	-	-	-	-				
			Ae	loamy sand	PL	3	12	9	-	-	-	-	-				
			Btg	loamy sand	SBK	12	30	18	-	-	-	-	-				
			C	loamy sand	-	30	60	30	-	-	-	-	-				
NR18MS106	Brunisol	GLE.DYB	LFH	-	-	2	0	2	-	-	-	-	-	MW	T	4	GLFL
			Ae	sandy loam	-	0	5	5	-	-	-	-	-				
			Bmgj	sandy loam	-	5	40	35	-	Common	Medium	Faint	Faint				
			BCgj	sandy loam	-	40	75	35	-	Many	Medium	Distinct	Distinct				
NR18MS107	Organic	T.H	Of	-	-	0	20	20	-	-	-	-	-	VP	M	3	FNPT/GLFL
			Om	-	-	20	30	10	-	-	-	-	-				
			Oh	-	-	30	60	30	-	-	-	-	-				
			Cg	loamy sand	-	60	75	15	-	-	-	-	-				
NR18MS008	Brunisol	E.DYB	LFH			5	0	5	-					R	U	4	GLFL
			Aegj	sand		0	32	32	-								
			Bg	sand		32	45	13	-								

Table C-1: Terrain and Soil Characteristics Obtained at Each Inspection Site

Site	Soil Order	Subgroup[a]	Horizon	Texture	Structure[b]	Top Depth (cm)	Bottom Depth (cm)	Horizon Thickness (cm)	Color	Mottle Abundance	Mottle Dimension	Mottle Contrast	Mottle Color	Drainage[c]	Slope Position[d]	Slope Class[e]	Parent Material[f]
NR18MS109	Brunisol	E.DYB	LFH	-	-	2	0	2	-	-	-	-	-	W	U	3	GLFL
			Ae	loamy sand	PL	0	5	5	-	-	-	-	-				
			Bm	loamy sand	SBK	5	30	25	-	-	-	-	-				
			C	loamy sand	MA	30	60	30	-	-	-	-	-				
NR18MS110	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	W	V	2	GLFL
			Ahe	loamy sand	PL	3	9	6	10YR 5/1	-	-	-	-				
			Ah	loamy sand	PL	0	3	3	10YR 3/1	-	-	-	-				
			Bm	loamy sand	PL	9	50	41	10YR 6/8	-	-	-	-				
			C	sand	SGR	50	65	15	-	-	-	-	-				
NR18MS111	Brunisol	GLE.DYB	LFH	-	-	3	0	3	-	-	-	-	-	MW	L	3	GLFL
			Ae	loamy sand	PL	0	6	6	7.5YR 6/2	-	-	-	-				
			Btjgj	sandy loam	SBK	6	30	24	10YR 6/6	Many	Medium	Distinct	Distinct				
			BCgj	sandy clay loam	MA	30	50	20	2.5Y 5/2	Few	Fine	Faint	Faint				
			C	sand	SGR	50	65	15	10YR 7/6	-	-	-	-				
NR18MS112	Brunisol	GLE.DYB	LFH	-	-	10	0	10	-	-	-	-	-	MW	M	3	GLFL
			Ae	sandy loam	PL	0	10	10	-	-	-	-	-				
			Bmgj	sandy loam	SBK	10	40	30	-	Many	Medium	Distinct	Distinct				
			Cgj	sandy loam	MA	60	80	20	-	-	-	-	-				
			Cgj	sandy loam	MA	40	60	20	-	-	-	-	-				
19-EXP01-A-SO1	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	-	-	-	GLFL
			Ahe	loamy sand	SGR	0	3	3	7.5YR 5/1	-	-	-	-				
			Ae	loamy sand	SGR	3	17	14	10YR 7/1	-	-	-	-				
			Bm	loamy sand	SBK	17	34	17	10YR 6/6	-	-	-	-				
			C	sand	MA	34			10YR 7/2	-	-	-	-				
19-EXP01-A-SO2	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	-	-	-	GLFL
			Ahe	loamy sand	SGR	0	1	1	7.5YR 5/1	-	-	-	-				
			Ae	loamy sand	SGR	1	22	21	10YR 7/1	-	-	-	-				
			Bm	loamy sand	SBK	22	36	14	10YR 6/6	-	-	-	-				
			C	loamy sand	MA	36			10YR 7/2	-	-	-	-				
19-EXP01-A-SO3	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	-	-	-	GLFL
			Ahe	loamy sand	SGR	0	4	4	7.5YR 5/1	-	-	-	-				
			Ae	loamy sand	SGR	4	18	14	10YR 7/1	-	-	-	-				
			Bm	loamy sand	SBK	18	45	27	7.5YR 5/8	-	-	-	-				
			C	loamy sand	MA	45			10YR 7/2	-	-	-	-				
19-EXP01-B-SO1	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	-	-	-	GLFL
			Ahe	loamy sand	SGR	0	4	4	7.5YR 4/1	-	-	-	-				
			Ae	loamy sand	SGR	4	27	23	7.5YR 7/2	-	-	-	-				
			Bm	loamy sand	SBK	27	40	13	10YR 5/8	-	-	-	-				
			C	loamy sand	MA	40			10YR 8/3	-	-	-	-				
19-EXP01-B-SO2	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	-	-	-	GLFL
			Ahe	loamy sand	SGR	0	3	3	7.5YR 5/2	-	-	-	-				
			Ae	loamy sand	SGR	3	13	10	7.5YR 6/2	-	-	-	-				
			Bm	loamy sand	SBK	13	20	7	7.5YR 5/8	-	-	-	-				
			C	loamy sand	MA	20			10YR 6/4	-	-	-	-				
19-EXP01-B-SO3	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	-	-	-	GLFL
			Ae	loamy sand	SGR	0	17	17	10YR 7/3	-	-	-	-				
			Bm	loamy sand	SBK	17	32	15	7.5YR 5/8	-	-	-	-				
			C	loamy sand	MA	32			10YR 5/6	-	-	-	-				
19-EXP01-C-SO1	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	-	-	-	GLFL
			Ahe	loamy sand	SGR	0	2	2	7.5YR 5/2	-	-	-	-				
			Ae	loamy sand	SGR	2	14	12	10YR 7/2	-	-	-	-				
			Bm	loamy sand	SBK	14	39	25	10YR 5/8	-	-	-	-				
			C	sand	MA	39			10YR 7/2	-	-	-	-				
			LFH	-	-	1	0	1	-	-	-	-	-				
			Ahe	loamy sand	SGR	0	4	4	7.5YR 4/1	-	-	-	-				

Table C-1: Terrain and Soil Characteristics Obtained at Each Inspection Site

Site	Soil Order	Subgroup[a]	Horizon	Texture	Structure[b]	Top Depth (cm)	Bottom Depth (cm)	Horizon Thickness (cm)	Color	Mottle Abundance	Mottle Dimension	Mottle Contrast	Mottle Color	Drainage[c]	Slope Position[d]	Slope Class[e]	Parent Material[f]
19-EXP01-C-SO2	Brunisol	E.DYB	Ae	loamy sand	SGR	4	13	9	7.5YR 7/2	-	-	-	-	-	-	-	GLFL
			Bm	loamy sand	SBK	13	36	23	7.5YR 5/8	-	-	-	-				
			C	loamy sand	MA	36			10YR 8/3	-	-	-	-				
19-EXP01-C-SO3	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	-	-	-	GLFL
			Ahe	loamy sand	SGR	0	3	3	7.5YR 5/2	-	-	-	-				
			Ae	loamy sand	SGR	3	24	21	7.5YR 7/2	-	-	-	-				
			Bm	loamy sand	SBK	24	40	16	7.5YR 5/8	-	-	-	-				
			C	sand	MA	40			7.5YR 8/3	-	-	-	-				
19-EXP02-A-SO1	Regosol	O.R	LFH	-	-	8	0	8	-	-	-	-	-	-	-	-	GLFL
			Ae	loamy sand	SGR	0	17	17	10YR 5/4	-	-	-	-				
			C	loamy sand	MA	17			10YR 6/6	-	-	-	-				
19-EXP02-A-SO2	Brunisol	E.DYB	LFH	-	-	7	0	7	-	-	-	-	-	-	-	-	GLFL
			Ae	loamy sand	SGR	0	15	15	7.5YR 7/2	-	-	-	-				
			Bm	loamy sand	SGR	15	32	17	10YR 6/8	-	-	-	-				
			C	loamy sand	MA	32			10YR 6/3	-	-	-	-				
19-EXP02-A-SO3	Regosol	O.R	LFH	-	-	7	0	7	-	-	-	-	-	-	-	-	GLFL
			Ae	loamy sand	SGR	0	8	8	7.5YR 5/2	-	-	-	-				
			C	-	MA	8			7.5YR 6/2	-	-	-	-				
19-EXP02-B-SO1	Brunisol	E.DYB	LFH	-	-	7	0	7	-	-	-	-	-	-	-	-	GLFL
			Ahe	loamy sand	SGR	0	9	9	10YR 3/2	-	-	-	-				
			Ae	loamy sand	SGR	9	33	24	7.5YR 7/2	-	-	-	-				
			Bm	loamy sand	SGR	33	49	16	10YR 7/8	-	-	-	-				
			C	loamy sand	MA	49			10YR 8/4	-	-	-	-				
19-EXP02-B-SO2	Regosol	O.R	LFH	-	-	5	0	5	-	-	-	-	-	-	-	-	GLFL
			Ae	loamy sand	SGR	0	37	37	10YR 8/1	-	-	-	-				
			C	loamy sand	MA	37			10YR 5/6	-	-	-	-				
19-EXP02-B-SO3	Brunisol	E.DYB	LFH	-	-	9	0	9	-	-	-	-	-	-	-	-	GLFL
			Ahe	loamy sand	SGR	0	1	1	5YR 5/2	-	-	-	-				
			Ae	loamy sand	SGR	1	18	17	7.5YR 7/1	-	-	-	-				
			Bm	loamy sand	SGR	18	34	16	7.5YR 5/6	-	-	-	-				
			C	loamy sand	MA	34			10YR 7/1	-	-	-	-				
19-EXP02-C-SO1	Brunisol	E.DYB	LFH	-	-	7	0	7	-	-	-	-	-	-	-	-	GLFL
			Ae	loamy sand	SGR	0	23	23	7.5YR 5/3	-	-	-	-				
			Bm	loamy sand	SBK	23	38	15	7.5YR 4/4	-	-	-	-				
			C	loamy sand	MA	38			10YR 4/3	-	-	-	-				
19-EXP02-C-SO2	Brunisol	E.DYB	LFH	-	-	6	0	6	-	-	-	-	-	-	-	-	GLFL
			Ae	loamy sand	SGR	0	14		7.5YR 6/2	-	-	-	-				
			Bm	loamy sand	SBK	14	39	25	7.5YR 4/4	-	-	-	-				
			C	loamy sand	MA	39			10YR 4/4	-	-	-	-				
19-EXPO3-A-SO1	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	-	-	-	GLFL
			Ahe	loamy sand	SGR	0	1	1	5YR 5/1	-	-	-	-				
			Ae	loamy sand	SGR	1	28	27	5YR 8/1	-	-	-	-				
			Bm	loamy sand	SBK	28	36	8	10YR 6/8	-	-	-	-				
			C	loamy sand	MA	36			10YR 7/4	-	-	-	-				
19-EXPO3-B-SO1	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	-	-	-	GLFL
			Ahe	loamy sand	SGR	0	6	6	7.5YR 3/1	-	-	-	-				
			Ae	loamy sand	SGR	6	25	19	5YR 7/2	-	-	-	-				
			Bm	loamy sand	SBK	25	40	15	10YR 6/8	-	-	-	-				
			C	loamy sand	MA	40			10YR 7/3	-	-	-	-				
19-EXPO3-C-SO3	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	-	-	-	GLFL
			Ahe	loamy sand	SGR	0	1	1	10YR 5/1	-	-	-	-				
			Ae	loamy sand	SGR	1	22	21	7.5YR 7/3	-	-	-	-				
			Bm	loamy sand	SBK	22	33	11	10YR 5/6	-	-	-	-				
			C	loamy sand	MA	33			10YR 6/4	-	-	-	-				
			LFH	-	-	1	0	1	-	-	-	-	-				

Table C-1: Terrain and Soil Characteristics Obtained at Each Inspection Site

Site	Soil Order	Subgroup[a]	Horizon	Texture	Structure[b]	Top Depth (cm)	Bottom Depth (cm)	Horizon Thickness (cm)	Color	Mottle Abundance	Mottle Dimension	Mottle Contrast	Mottle Color	Drainage[c]	Slope Position[d]	Slope Class[e]	Parent Material[f]
19-REF04-A-SO1	Brunisol	E.DYB	Ahe	loamy sand	SGR	0	2	2	10YR 4/1	-	-	-	-	-	-	-	GLFL
			Ae	loamy sand	SGR	2	12	10	10YR 7/2	-	-	-	-				
			Bm	loamy sand	SBK	12	42	30	10YR 5/6	-	-	-	-				
			C	loamy sand	MA	42			10YR 8/4	-	-	-	-				
19-REF04-B-SO1	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	-	-	-	GLFL
			Ae	sand	SGR	0	12	12	10YR 7/2	-	-	-	-				
			Bm	loamy sand	SGR	12	21	9	10YR 5/8	-	-	-	-				
			C	sand	MA	21			5Y 7/2	-	-	-	-				
19-REF04-C-SO1	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	-	-	-	GLFL
			Ae	sand	SGR	0	5	5	5YR 7/2	-	-	-	-				
			Bm	sand	SGR	5	22	17	10YR 8/6	-	-	-	-				
			C	sand	MA	22			5Y 8/4	-	-	-	-				
19-REF05-A-SO1	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	-	-	-	GLFL
			Ahe	loamy sand	SGR	0	4	4	10YR 4/1	-	-	-	-				
			Ae	loamy sand	SGR	4	9	5	10YR 7/1	-	-	-	-				
			Bm	loamy sand	SBK	9	32	23	7.5YR 5/8	-	-	-	-				
			C	loamy sand	MA	32			10YR 6/6	-	-	-	-				
19-REF05-B-SO1	Brunisol	E.DYB	LFH	-	-		0		-	-	-	-	-	-	-	-	GLFL
			Ae	sandy loam	SGR	0	5	5	7.5YR 6/2	-	-	-	-				
			Bm	sandy loam	SBK	5	18	13	7.5YR 4/4	-	-	-	-				
			C	loamy sand	MA	18			10YR 5/6	-	-	-	-				
19-REF05-C-SO1	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	-	-	-	GLFL
			Ahe	loamy sand	SGR	0	3	3	7.5YR 4/1	-	-	-	-				
			Ae	loamy sand	SGR	3	10	7	7.5YR 7/2	-	-	-	-				
			Bm	sandy loam	SBK	10	40	30	10YR 5/8	-	-	-	-				
			C	loamy sand	MA	40			10YR 5/6	-	-	-	-				
19-REF06-A-SO1	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	-	-	-	GLFL
			Ahe	sand	SGR	0	1	1	10YR 3/2	-	-	-	-				
			Ae	sand	SGR	1	23	22	5Y 7/3	-	-	-	-				
			Bm	sand	SBK	23	30	7	7.5YR 5/8	-	-	-	-				
			C	sand	MA	30			10YR 8/4	-	-	-	-				
19-REF06-B-SO1	Brunisol	E.DYB	LFH	-	-	3	0	3	-	-	-	-	-	-	-	-	GLFL
			Ahe	sand	SGR	0	4	4	10YR 4/1	-	-	-	-				
			Ae	sand	SGR	4	59	55	5Y 7/2	-	-	-	-				
			Bm	sand	SGR	59	66	7	7.5YR 5/8	-	-	-	-				
			C	sand	MA	66			10YR 6/6	-	-	-	-				
19-REF06-C-SO1	Brunisol	E.DYB	LFH	-	-	1	0	1	-	-	-	-	-	-	-	-	GLFL
			Ae	sand	SGR	0	10	10	7.5YR 7/2	-	-	-	-				
			Bm	loamy sand	SGR	10	34	24	10YR 5/8	-	-	-	-				
			C	loamy sand	MA	34			10YR 7/4	-	-	-	-				

a) Soil subgroups: E.DYB = Eluviated Dystric Brunisol; FI.M = Fibric Mesisol; GLE.DYB = Gleyed Eluviated Dystric Brunisol; ME.F = Mesic Fibrisol; O.G = Orthic Gleysol; O.R = Orthic Regosol; T.H = Terric Humisol; T.M = Terric Mesisol.

b) Soil structure: SGR = single grain; SBK = subangular blocky; PL = platy; MA = amorphous (massive); GR = granular.

c) Drainage: W = well; VP = very poor; R = ; MW = moderately well; I = imperfect.

d) Slope position: V = level; U = upper slope; T = toe slope; M = mid slope; L = lower slope; D = depression; C = crest.

e) Slope class: 1 = level (0 to 0.5%); 2 = nearly level (0.5 to 2.0%); 3 = very gentle (2.0 to 5.0%); 4 = gentle (5.0 to 10.0%); 5 = moderate (10 to 15%); 6 = strong (15 to 30%); 7 = very strong (30 to 45%).

f) Parent material: SPPT = sphagnum peat; GLFL = glacial fluvial; FNPT = sedge (fen) peat.

APPENDIX D

Soil Map Characteristics

Table D-1: Soil Map Unit Characteristics

Soil Map Unit	Dominant/Co-dominant Soil Subgroup		Sub-dominant Soil Subgroup	Inclusions	Landscape	Slope Class Range	Drainage	Surface Stoniness	Comments
	>30% to <60-100%	Parent Material	>10% to <40%	<10-20%					
Mineral Soils									
Mineral-1 (M1)	Eluviated Dystric Brunisol	GLFL	-	-	Hummocky and Ridged - high relief	3 to 6 (>2% - 30%)	Rapid to Well	S4 to S5 (15% to >50%)	-
Mineral-2 (M2)	Eluviated Dystric Brunisol	GLFL	-	Gleyed Eluviated Dystric Brunisol	Undulating and Rolling	3 to 5 (>2% - 15%)	Rapid to Moderately Well	S2 to S3 (0.1% to 3%)	Gleyed Eluviated Dystric Brunisol found at low and toe
Mineral-3 (M3)	Eluviated Dystric Brunisol	GLFL	-	Gleyed Eluviated Dystric Brunisol	Hummocky and Ridged - high relief	4 to 7 (>5% - 45%)	Rapid	S4 to S5 (15% to >50%)	Gleyed Eluviated Dystric Brunisol found at low and toe; high coarse fragments in profile
Mineral-4 (M4)	Eluviated Dystric Brunisol	GLFL	Gleyed Eluviated Dystric Brunisol	Misc. Gleysols	Nearly Level to Undulating	1 to 3 (0% to 5%)	Well to Imperfect	S2 to S3 (0.1% to 3%)	-
Mineral-5 (M5)	Gleyed Eluviated Dystric Brunisol	GLFL	Eluviated Dystric Brunisol	Misc. Gleysols, Terric Mesisols	Undulating	2 to 3 (>0.5% - 5%)	Moderately Well	S2 to S3 (0.1% to 3%)	-
Mineral-6 (M6)	Orthic Gleysol	GLFL	Terric Mesisols	Gleyed Eluviated Dystric Brunisol	Level to Nearly Level	1 to 2 (0% to 2%)	Imperfect to Very Poor	S0 to S1 (<0.01% to 0.1%)	-
Mineral-7 (M7)	Eluviated Dystric Brunisol	GLFL	-	Gleyed Eluviated Dystric Brunisol	Hummocky and Ridged - low relief	2 to 4 (>0.5% to 10%)	Rapid to Well	S2 (0.1% to 3%)	Gleyed Eluviated Dystric Brunisol found at low and toe; minor amount (10-20%) of inspections showed evidence of clay
Mineral-8 (M8)	Eluviated Dystric Brunisol	GLFL	-	Gleyed Eluviated Dystric Brunisol	Hummocky and Ridged - high relief	4 to 7 (>5% - 45%)	Rapid	S4 to S5 (15% to >50%)	Gleyed Eluviated Dystric Brunisol found at low and toe; high coarse fragments in profile; moderate amount (20-40%) of
Mineral-9 (M9)	Eluviated Dystric Brunisol	GLFL	Gleyed Eluviated Dystric Brunisol	-	Undulating - low relief	2 to 4 (>0.5% to 10%)	Well to Moderately Well	S2 to S3 (0.1% to 3%)	-
Mineral-10 (M10)	Eluviated Dystric Brunisol	GLFL	-	Gleyed Eluviated Dystric Brunisol	Inclined - level	2 to 5 (>0.5% to 15%)	Rapid to Well	S3 (3% to 15%)	Gleyed Eluviated Dystric Brunisol found at low and toe; high coarse fragments in profile
Mineral-11 (M11)	Gleyed Eluviated Dystric Brunisol	GLFL	Eluviated Dystric Brunisol Misc. Gleysols	Terric Mesisol	and significant drainage channels	2 to 3 (>0.5% - 5%)	Moderately Well to Very Poor	S0 to S3 (<0.01% to 15%)	-
Mineral-12 (M12)	Eluviated Dystric Brunisol	GLFL	-	Gleyed Eluviated Dystric Brunisol, Misc. Gleysols	Undulating and Rolling	2 to 4 (>0.5% - 10%)	Rapid to Moderately Well	S1 to S2 (0.01% to 3%)	Gleyed Eluviated Dystric Brunisol found at low and toe; low coarse fragments in profile
Organic Soils									
Organic-1 (O1)	Terric Mesisol	FNPT/GLFL	-	Misc. Gleysols	Organic - level	1 (0% - 0.5%)	Very Poor	S0 (<0.01%)	-
Organic-2 (O2)	Typic Mesisol	FNPT	-	Terric Mesisol	Organic - level	1 (0% - 0.5%)	Very Poor	S0 (<0.01%)	-
Organic-3 (O3)	Typic Mesisol	FNPT	Terric Mesisol	Misc. Gleysols, Gleyed Eluviated Dystric Brunisol	Organic - level with mineral soil hummocks	1 to 3 (0% to 5%)	Imperfect to Very Poor	S0 to S2 (<0.01% to 3%)	-

GLFL = glacial-fluvial; FNPT = sedge (fen) peat; - = not applicable; % = percent.

Rook I Project

Environmental Impact Statement

Annex VII: Vegetation Baseline Road Map

GOLDER
MEMBER OF WSP

VEGETATION BASELINE ROAD MAP FOR THE ROOK I PROJECT

Prepared for:

NexGen Energy Ltd.

Prepared by:

Golder Associates Ltd.

March 2022

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FIGURES

APPENDICES

1 INTRODUCTION

This road map provides an overview of the vegetation baseline program undertaken by NexGen Energy Ltd. (NexGen) for the Rook I Project (Project). Section 2, Ecological Setting, describes the location of the proposed Project in relation to its regional ecozone and landscape areas. Section 3, Joint Working Group Feedback, provides context on NexGen's approach to engagement and where feedback related to the vegetation baseline from the Joint Working Group (JWG) meetings can be found. Section 4, Vegetation Baseline Document Map, provides information on the scope of each baseline report and identifies where key topics associated with the vegetation baseline program can be found in the reports appended to this road map.

The characterization of baseline vegetation for the Project was based on desktop analyses, field studies, and feedback from First Nations and Métis Groups (collectively referred to as Indigenous Groups). The various baseline reports, presented as Annexes VII.1 through VII.3, are part of the comprehensive baseline program that documents different aspects of the terrestrial environment in the anticipated area of the Project. These reports provide context for the assessment of incremental and cumulative effects from the proposed Project and other developments in the local and regional study areas:

- Annex VII.1: Vegetation Baseline Report 1 (Mapping)
- Annex VII.2: Vegetation Baseline Report 2 (Inventory, Rare Plants, and Wetlands)
- Annex VII.3: Vegetation Chemistry Characterization Report

Vegetation Baseline Report 1 was completed by Omnia Ecological Services (Omnia), Vegetation Baseline Report 2 was completed by Canada North Environmental Services (CanNorth), and the Vegetation Chemistry Characterization Report was completed by Golder Associates Ltd. (Golder). Vegetation Baseline Report 1 provides the basis for the vegetation mapping for the Project incorporating available provincial mapping, overlaid by available disturbance mapping, recent aerial images, combined with photointerpretation, and the 2018 and 2019 field surveys to verify ecosite characterizations and assess natural regeneration of linear disturbances. Vegetation Baseline Report 2 presents work completed in 2018 to characterize terrestrial and aquatic vegetation communities, conduct surveys for rare and weedy species, and characterize wetlands. These programs complemented the mapping of ecosites and characterization of baseline terrestrial and aquatic ecosystems. The Vegetation Chemistry Characterization Report analyzed metals and radionuclides in lichen and blueberry.

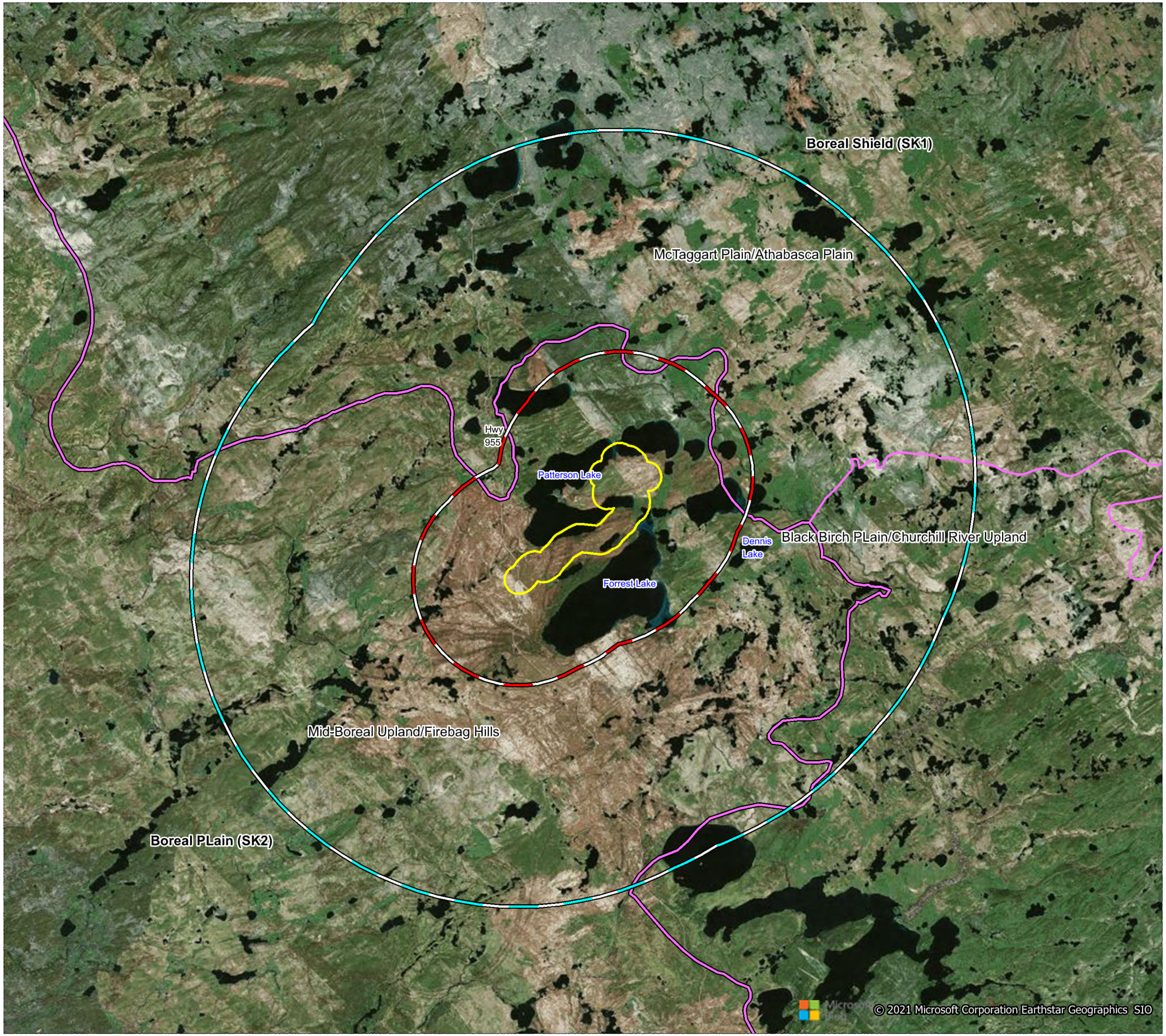
2 ECOLOGICAL SETTING

The proposed Project is located within the Boreal Plain Ecozone, near the boundary between Boreal Plain and Boreal Shield Ecozones. The area of the Project overlaps both the Boreal Shield Ecozone and the Boreal Plain Ecozone. The Boreal Shield Ecozone extends across Canada from the Atlantic coast to northern Alberta (Government of Canada 2019). In Saskatchewan, the Boreal Shield Ecozone is located between the Boreal Plain Ecozone to the south and the Taiga Shield Ecozone to the north (Acton et al. 1998). The Boreal Shield Ecozone consists of boreal forest associated with the Canadian Shield and has two ecoregions: the Athabasca Plain and Churchill River Upland. Where soil conditions allow moderate tree growth, the climax (i.e., final stable stage plant community) vegetation community is closed black spruce (*Picea mariana)* forest with understory (i.e., vegetation layer below the forest canopy) of feather mosses. Mixed stands of jack pine (*Pinus banksiana*) and black spruce grow on thin upland soils, and tamarack (*Larix laricina*) are typically found within poorly drained lowlands. Fire has historically been the dominant disturbance mechanism. White spruce (*Picea glauca*), balsam fir (*Abies balsamea*), trembling aspen (*Populus tremuloides*), and balsam poplar (*Populus balsamifera* spp. *balsamifera*) grow on more productive sites.

The Boreal Plain Ecozone covers portions of Manitoba, Saskatchewan, and Alberta, with minor extensions into British Columbia and the Northwest Territories (Government of Canada 2019). Most of the ecozone is covered by boreal forest, though a portion along the southern boundary has been converted to agricultural cropland (Acton et al. 1998). In Saskatchewan, the Boreal Plain Ecozone has three ecoregions: Mid-Boreal Upland, where the proposed Project would be located; Mid-Boreal Lowland; and Mid-Boreal Transition. The climate of the Boreal Plain Ecozone is warmer than the Boreal Shield Ecozone, and consequently the productivity is higher, and the diversity of vegetation is greater. Climax communities include closed-crown mixedwood and coniferous forest with trembling aspen, balsam poplar, and paper birch (*Betula papyrifera*) in the Mid-Boreal Transition Ecoregion and white and black spruce, tamarack, and jack pine in the Mid-Boreal Upland and Mid-Boreal Lowland ecoregions.

The ecological setting in the vicinity of the proposed Project is shown in Figure 1.

Figure 1. Ecological Setting in the Vicinity of the Project



Legend

- Local Study Area (LSA)
- Regional Study Area (RSA)
- Caribou Regional Study Area (CRSA)
- Ecoregion / Landscape Area
- Ecozone

OMNIA ECOLOGICAL SERVICES

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3 INDIGENOUS GROUP FEEDBACK

Since exploration at the Project site commenced in 2013, NexGen has engaged regularly and established relationships with local Indigenous Groups and northern communities, specifically those closest and with greatest access to the proposed Project.

An important component of engagement to date has been the establishment of JWGs to support the gathering and incorporation of Indigenous Knowledge throughout the Environmental Assessment (EA) process. A summary of feedback from JWGs related to the vegetation baseline program is presented in Appendix A of this memorandum, and includes feedback from the Birch Narrows Dene Nation, Buffalo River Dene Nation, Clearwater River Dene Nation, and Métis Nation – Saskatchewan. Indigenous and Local Knowledge was also included, where appropriate, from Project-specific studies completed by Indigenous Groups, which included Traditional Land Use and Occupancy studies, Traditional Knowledge and Use studies, Indigenous Rights and Knowledge studies (henceforth referred collectively as Indigenous Knowledge and Traditional Land Use [IKTLU] Studies[1]) (TSD II: BNDN; TSD III: BRDN; TSD IV: MN-S; TSD V: CRDN; TSD VI: YNLR). Baseline vegetation surveys provided pertinent data on the presence and abundance of traditional food and medicine types that were identified as important by Indigenous Peoples in the region through IKTLU Studies and JWGs.

4 VEGETATION BASELINE DOCUMENT MAP

Table 1 provides a summary of key topics related to the vegetation baseline program and cross references to where analysis and discussion of key topics are located within the individual vegetation baseline reports. The topics in Table 1 are listed in roughly descending order of spatial scale from regional spatial scale to smaller areas, consistent with the order of the vegetation baseline reports. Section 4.1 through Section 4.8 provide context and direction to where information related to key vegetation topics can be found.

[1] Referred to as TLU Studies in the baseline reports.

Table 1: Vegetation Baseline Key Topic Location Summary

Key Topic	Baseline Report Title	Baseline Report Section Reference	Approach to Topic[1]
Existing landscape disturbance	Annex VII.1 Vegetation Baseline Report 1 (Mapping)	Section 3.0 Anthropogenic Disturbance Mapping Section 4.0 Fire Mapping Section 7.0 Linear Feature Natural Regeneration Assessment	Primary data source
Ecological Landscape Classification	Annex VII.1 Vegetation Baseline Report 1 (Mapping)	Section 2.0 Study Areas Section 5.0 Ecosite Mapping Section 6.0 Ecosite Characterization, Structural Diversity, and Species Richness	Primary and applied data source
	Annex VII.2 Vegetation Baseline Report 2 (Inventory, Rare Plants, and Wetlands)	Section 1.2.1 Ecoregion Description Section 4.0 Wetland Classification	Primary and applied data source
Upland Ecosystems	Annex VII.1 Vegetation Baseline Report 1 (Mapping)	Section 5.0 Ecosite Mapping Section 6.0 Ecosite Characterization, Structural Diversity, and Species Richness	Primary and applied data source
	Annex VII.2 Vegetation Baseline Report 2 (Inventory, Rare Plants, and Wetlands)	Section 3.0 Vegetation Inventory and Rare Plant Survey	Primary data source
Wetlands, and Riparian Ecosystems	Annex VII.1 Vegetation Baseline Report 1 (Mapping)	Section 5.0 Ecosite Mapping Section 6.0 Ecosite Characterization, Structural Diversity, and Species Richness	Primary and applied data source
	Annex VII.2 Vegetation Baseline Report 2 (Inventory, Rare Plants, and Wetlands)	Section 3.0 Vegetation Inventory and Rare Plant Survey Section 4.0 Wetland Classification	Primary data source
Rare plant species	Annex VII.1 Vegetation Baseline Report 1 (Mapping)	Section 5.0 Ecosite Mapping Section 6.0 Ecosite Characterization, Structural Diversity, and Species Richness	Primary and applied data source
	Annex VII.2 Vegetation Baseline Report 2 (Inventory, Rare Plants, and Wetlands)	Section 2.0 Database Searches Section 3.0 Vegetation Inventory and Rare Plant Survey	Primary and applied data source
Traditional use plants	Annex VII.1 Vegetation Baseline Report 1 (Mapping)	Section 5.0 Ecosite Mapping Section 6.0 Ecosite Characterization, Structural Diversity, and Species Richness Section 7.0 Linear Feature Natural Regeneration Assessment"	Primary and applied data source
	Annex VII.2 Vegetation Baseline Report 2 (Inventory, Rare Plants, and Wetlands)	Section 2.0 Database Searches Section 3.0 Vegetation Inventory and Rare Plant Survey Section 4.0 Wetland Classification	Primary and applied data source
	Annex VII.3 Vegetation Chemistry Characterization Report	All sections	Primary data source

Table 1: Vegetation Baseline Key Topic Location Summary

Key Topic	Baseline Report Title	Baseline Report Section Reference	Approach to Topic[1]
Weedy / invasive species	Annex VII.2 Vegetation Baseline Report 2 (Inventory, Rare Plants, and Wetlands)	Section 3.0 Vegetation Inventory and Rare Plant Survey	Primary data source
Vegetation chemistry	Annex VII.3 Vegetation Chemistry Characterization Report	All sections	Primary data source

[1]Approach to Topic is noted as either primary data source or applied data source. Primary data source refers to field data collected for the Project. Applied data source refers to modelling, analysis or characterization of conditions informed by primary and second-hand data sources (e.g., government).

4.1 Existing Landscape Disturbance

As part of the vegetation baseline, field studies and mapping were completed to characterize the existing anthropogenic disturbance (e.g., roads, exploration camps, cutlines) and natural disturbance (e.g., fires, landslides). Existing landscape disturbance provides an understanding of the current conditions that may be influenced by the Project.

The landscape disturbance baseline is included in Annex VII.1, Vegetation Baseline Report 1 (mapping). Anthropogenic disturbance and fire mapping was completed using data from Axiom orthorectified aerial map (4.88 cm pixel; June 2019), Ministry of Environment (ENV) SK2 West Caribou Administration Unit anthropogenic disturbance layer (2019), and Environment and Climate Change Canada anthropogenic disturbance layer (Environment Canada 2015). A field survey was also completed to assess the regeneration of linear disturbances surrounding the Project.

4.2 Ecological Landscape Classification

An Ecological Land Classification (ELC) map was developed for the Project for detailed characterization of the vegetation associations. Results from mapping the ecosites were used to support the development of wildlife habitat suitability index models (Section 14, Wildlife and Wildlife Habitat; Appendix 14A, Wildlife Habitat Models), the assessment of impacts, and reclamation planning.

Ecosite mapping followed the methodologies presented in Annex VII.1, Vegetation Baseline Report 1 incorporating provincial mapping, updated with current disturbance mapping and imagery, and field sampling to verify the ecosite classifications.

Annex VII.2, Vegetation Baseline Report 2 (Inventory, Rare Plants, and Wetlands) included ecoregion descriptions and wetland classification surveys linked to the ecosite types.

4.3 Upland Ecosystems

Upland ecosystems consist of graminoid, shrub-dominated, and treed communities containing mainly facultative upland (i.e., species that can grow in either upland or alternate habitats), and obligate upland plant species (i.e., species that grow in upland ecosystems only). The water table is rarely above the substrate surface and vernal pooling (i.e., seasonal depressional wetlands) is minimal. Upland ecosystems were characterized through the ecosite mapping in Vegetation Baseline Report 1 (Annex VII.1) and in the vegetation surveys in Vegetation Baseline Report 2 (Annex VII.2). The upland vegetation characterizations were also used to characterize wildlife habitats.

4.4 Wetlands and Riparian Ecosystems

Wetlands are ecosystems containing soils that are saturated with moisture either permanently or seasonally and are further characterized by the presence of hydrophytic (i.e., water-adapted) vegetation. Riparian ecosystems are zones of interaction between aquatic and terrestrial environments within watersheds that function in linking terrestrial ecosystems to watercourses, stabilizing streambanks and floodplains, regulating stream temperatures, and providing a source of large woody debris and organic matter for aquatic ecosystems. Data collected for the Vegetation Baseline Report 1 (Annex VII.1) mapping were used to characterize the vegetation within wetland ecosystems and identify the locations of wetland ecosystems for the Project study area. Vegetation Baseline Report 2 (Annex VII.2) also completed wetland classification following the Canadian Wetland Classification System. Riparian ecosystems were characterized through the ecosite mapping and surveys in Vegetation Baseline

Report 1 (Annex VII.1) and further characterized in field studies in Vegetation Baseline Report 2 (Annex VII.2). The wetlands and riparian vegetation characterizations were also used to characterize wildlife habitats.

Aquatic vegetation described in Vegetation Baseline Report 2 (Annex VII.2) were also used to characterize fish habitat.

4.5 Rare Plant Species

Rare plant species are usually species of conservation concern because they are limited in their distribution, are sensitive, or require specific soil, moisture, and climatic conditions. A database search was included in Vegetation Baseline Report 2 (Annex VII.2) to determine the potential for rare vascular plant species of conservation concern to occur in the area of the Project. Federally and provincially listed and/or tracked vascular (i.e., plants with specialized tissue for transporting water and nutrients) plant species are collectively referred to as “rare” vascular plant species for this Project. Potential for rare plant species to occur in the area of the Project was determined through review of historical element occurrences on the Hunting, Angling, and Biodiversity of Saskatchewan (HABISask) database (SKCDC 2021b) and the Tracked Vascular Plant Taxa by Ecoregion and Landscape Area (SKCDC 2021c); vegetation data collected during the baseline surveys (Annex VII.1; Annex VII.2); and habitat and distribution data detailed in COSEWIC Assessment and Status Reports (COSEWIC 2002a, COSEWIC 2002b, COSEWIC 2006a, COSEWIC 2006b, COSEWIC 2011a, COSEWIC 2011b, COSEWIC 2012, COSEWIC 2013, COSEWIC 2018) and *Species at Risk Act* (SARA; Government of Canada 2021) recovery strategies (Environment Canada 2012).

The literature search was used to plan field surveys. No COSEWIC- or SARA-listed (federally listed) vascular plant species were detected during baseline field surveys (Annex VII.1; Annex VII.2). However, seven provincially tracked plant species were observed during the baseline field surveys.

4.6 Traditional Use Plants

Traditional use plant species are used by Indigenous Groups as an important part of their culture and way of life. Plant use varies and includes food, ceremonial, medicinal, and other purposes. Traditional use plant species were identified in the IKTLU Studies (TSD II: BNDN; TSD III: BRDN; TSD IV: MN-S; TSD V: CRDN; TSD VI: YNLRO) and comments from CRDN (2019b) on the Cluff Lake Mine licence renewal. The list of traditional use plant species was analyzed against those species observed during baseline surveys (Annex VII.1; Annex VII.2) to identify all related candidate species. Twenty-eight plant species or groups of plant species plant species were identified as traditional plant species used for food, medicinal, ceremonial, or other purposes within the IKTLU Studies, of which 34 species or genera potentially identified traditional use plant species were observed during the baseline surveys.

Vegetation chemistry baseline was completed (Annex VII.3) for blueberry, which is an important plant for Indigenous Peoples.

4.7 Weedy / Invasive Species

Weedy species are often referred to as invasive plants. Weeds include species that are undesirable in a location because they often overgrow natural vegetation and can outcompete native species, which can result in a less desirable habitat with lower diversity. Vegetation Baseline Report 2 (Annex VII.2) surveyed for weedy species during the rare plant surveys to determine the presence and distribution of weedy species.

4.8 Vegetation Chemistry

The vegetation chemistry baseline program focused on lichen and blueberry due to the importance of these species in the diets of caribou and Indigenous Peoples, respectively. Soil sample sites were selected to coincide with the vegetation chemistry baseline reference and future exposure sites (Annex VI, Terrain and Soils Baseline Report). These programs supported the ecological risk assessment and can be used for long-term monitoring.

APPENDIX A

Joint Working Group Feedback Applicable to Vegetation Baseline

Table A-1 presents the comments and feedback NexGen has received from members of local Indigenous communities through established JWG meetings. Where appropriate, feedback from local Indigenous communities was considered within the baseline and/or EA processes or tracked as issues or concerns for resolution. NexGen continues to engage with communities, and the feedback presented in Table A-1 reflects comments and feedback received through March 2020 that were related to baseline vegetation or the comprehensive baseline program generally.

Table A-1: Joint Working Group Feedback Related to Baseline Vegetation

Community	Comment
Birch Narrows Dene Nation (BNDN)	Are you aware of any huge adverse environmental impacts in any of the current mine sites?
	Important topics for the Joint Working Group moving forward are Indigenous Knowledge, traditional land use, the species discussion, water quality, environmental monitoring, employment, and business opportunities.
	Could we ask that you take samples here? That way we can see changes into the future. Even if it isn't affected by the mine. Respectfully, I request that samples are taken here.
	It depends on the feed, the vegetation, the lichen.
	Respect the land, the water, the trees. Don't clear-cut the small trees – they take 50 years to grow back. (inaudible) water in one big lake, trout, everything, – just grass there now. They didn't put the water back. Didn't fix it. It used to be a big lake, but now there's nothing there.
	I think we eat more berries.
Buffalo River Dene Nation (BRDN)	Have you gone to communities to show what you are doing? If so, what was the feedback?
	It's important to explain the Project to Elders in a way that they can then explain it to other Elders in the communities.
	In 2001 in Dillon, the water was shallow. Since then, it never went down; still going up. This lake is still full here. In Dillon the water is just about full now. But a lot of things are going to change; there are signs of acid rain from Alberta – changes to trees. Half of the trees are different colours. Every time it rains, the trees look a little but different.
	I also acknowledge we are in Treaty 10 traditional territory, where we get our food, medicines, water different species, some of which grow only in that area, which none of you are familiar with but our Elders know that. They fish there. The caribou – we saw 11 recently at km 140 – haven't been around for a long, long time. They're very sensitive. The migration routes – we haven't seen them for a long time, and it was nice to see them. The comparison: when we go to a farmer's back yard, the farmer wouldn't want you to start drilling in his back yard. It's the same with our traditional territory. Treaty 10 was signed for the whole area, not parts of it. That's recognized on the maps.
	What would you miss if you were in the city? Mostly hunting and trapping. People who live in the city always ask us to bring fish, meat, berries. They miss all those foods.
Clearwater River Dene Nation (CRDN)	Remember we're trying to implement a plain speak document because of visual concepts of understanding. That is what the Chief is talking about.
	In terms of baseline studies, are there any opportunities for community involvement with any of your residual baseline work, from fish, terrestrial, etc.?
	We will eventually throw in our environmental monitors. I don't know if you knew that. We want to train our own people because of lack of trust of government and industry.
	The interim CRDN Rights and Knowledge study will come out of the CRDN-defined initial list of valued components (VCs) that we want to talk to you about. As we go through there may be additional ones. We know there's a certain window, but we'll try to be as comprehensive as possible. It may not be as linear as moose; it might be having undisturbed places on waterbodies. They might be more complex.
	Not on the old or existing mines that are sitting there?
	Golder does the same thing – hires three or four band members to do the interviews, then takes the notes and puts the document together. When you find the stuff it's not always based on the relationship to the stuff. It's based on what the government's qualifications are on the environmental assessment's impacts, and not the actual concerns of it. I'm trying to reach what [CRDN member] is saying between traditional and modern ways.
	When we started looking at the strategy process, there is that interpretation of cumulative effects. Then we define and introduce an interpretation for that. It's not just one side, western science, we're doing the traditional side as well. That's what the Chief's referring to.

Table A-1: Joint Working Group Feedback Related to Baseline Vegetation

Community	Comment
Clearwater River Dene Nation (CRDN)	Both traditional and western science are very important.
	Will we see the results of those studies?
	How many other projects are in that square box [referring to map]?
	Do other companies have mineral holdings in that box on the map – like for oil and gas?
	What are the rare species? How did you come up with those?
	I think it's really important to compare Cluff Lake to what's happening in the baseline studies. It's a good question.
	Right now, I would not want to drink water from Cluff Lake, whoever told me it was safe. We've been hunting there for a long time, but I've never shot a moose from that area. Or eaten the berries. It's all messed up.
	It (traditional food consumption) will change, based on fear of what's going to happen in the future. I do see it as another tool for a study, but as soon as the fear comes up...
	This is one of the studies [traditional food assumptions] you'll be doing as you go along?
	What's the purpose of trying to gather all this information?
Métis Nation – Saskatchewan (MN-S)	We have to understand all living and non-living things.
	Are any community members involved in the establishment of the baseline for environmental monitoring, so can they verify their accuracy? Would the results be released and reviewed by the community? From a trust point of view, our people will want to know that those numbers are accurate now, not later. Just a comment to think about.
	How would this group know – is there a way for the people involved in the studies to inform the group of what they saw and if they are confident, they are accurate? Once the stuff hits the Environmental Impact Statement, how do we know that it is good? If community folks that were involved in that process and they can validate the results, that brings comfort to community members.
	How often are you monitoring?
	It's that validation we're looking for. When I had to involve community members in monitoring, I would get them to write a report if they couldn't speak to the broader community in general. If they didn't feel like writing it, they could talk so someone who would transcribe it. That report could give a summary of how things went, what they saw, were the readings accurate; that could come back to this group, if they couldn't present themselves. The point [MN-S member's] trying to make is, we need some connection to that community resource that's out there doing the monitoring and seeing this stuff. We know who they are, and we're confident in the results. That builds trust.
	Do you have instruments or people taking samples? What does an instrument look like?
	We've already lost it around Cluff Lake. Do you pick and eat blueberries right there, or just leave them because they're scary? If there's dust on that berry, am I eating raw uranium? The worst way to be involved with uranium is to ingest. If you get it on your hands you can wash it off, but once it's inside you've got a serious problem.
	The studies we did a few years back, these guys don't want to use them. That's what I heard.
	I had feedback on community engagement, and I'm trying to figure out how we can move forward in a responsible way where people have their input without being offended. We're working towards a bigger goal than what is currently perceived. We need a discussion on how we can approach it. I can offer some high-level thinking to help bring my community around.
	How much land is disturbed – we are 50 km east of the Alberta border and the oil operations right up to the Territories.
	What's the percentage of fire disturbance compared to human disturbance?
	15 years ago we were fighting forest fires all over, so it was easier; now they just monitor. Once it starts burning it's going to burn.

Table A-1: Joint Working Group Feedback Related to Baseline Vegetation

Community	Comment
Métis Nation – Saskatchewan (MN-S)	We should have more of these meetings with other companies like this. I’d like to get a Métis community member to work side by side with you guys and report the environmental side to the community instead of you guys doing it, so we know where we are and how much damage is being done to the land.
	About 15 years ago at a workshop in Saskatoon, we knew why there were dying trees along the road – acid rain on the lakes. I said at least where I live, that nice clean water. I was introduced to a political scientist. She said the water looks clean but it’s not. But I still drink water out of the lake when I camp, but it’s getting there.
	We are seeing lots of effects from the oil sands – water is changing, plants and animals are dying.
	When we see the damage Fort McMurray is doing to our area – it’s 100+ miles from us, but it’s still affecting us. So much sulphur is put into the air and it comes down as acid rain. That changes our lake structures and the pH balance. It gets rid of the aquatic life. That oil industry is vastly affecting our area. Our lakes are turning to blue-green algae from the lower pH from acid rain. They have no concern for me if my fishing industry dies, as long as they get the last gallon of oil. They should be a lot more aware. Our government doesn't care about it as long as they get their percentage. It’s about money with everything.
	We live in a very clean environment, other than Fort McMurray - we can sometimes smell the oil. The air is very clean; we can drink the water and eat the berries wherever they are. As you come south, those things change. We live in a very clean land; in our culture we call it the “land of the white eagle” because of the snow, and that represents clean.
	It’s mainly the food, for everything. We put seeds out, all kinds of birds come. Food is the main item of why things move around; water’s the second one. Because of the Let it Burn policy, fire destroyed their food habitat. It’s gone, and I don't know what I could tell you to change that. Go and find caribou moss is the simplest solution I could tell you. In the North West Territories, pipelines affect them – they are a big barrier.
	[MN-S member] described some of the changes he's seen to vegetation and waterbodies over time. We’re losing a lot of plants too. Back when I was young, we used to see beautiful mornings, we saw all the butterflies, all the flowers. Now, you can hardly see a grasshopper. Before, there were thousands of grasshoppers; now if you walk in the bush you might see one or two. Where did they all go? Where are the beautiful flowers? Back in the day we were full of butterflies, all kinds. Where are they all? They’re fading away in front of our eyes. It’s not just animals. I’ve seen a big difference from the late 70s to today. I see a lot of change. Before the Fort McMurray plant started, we had crystal-clear ponds. Now the rain on the west side is yellow. Resource management says it’s jackpine dust. Are they stupid? All of a sudden jackpine dust? I mentioned it a lot of times to a lot of different people, everywhere.
	I eat more game than fish. For me, it would be close to equal for game and fish. Berries are very important; we harvest them and keep them to eat year-round. We consume a lot of berries.
	We have to consider the impact from 20 years to today – you guys weren't here, Cenovus and Oilsands Quest were here, Cluff Lake was there, Purepoint has been here for 10 years – so what happened in between? Was it forest fires or some other elements that created conditions for caribou to stay away from this area? How did conditions change?
	How fast is the growth of caribou moss?
	A lot of fires happen around the communities. I understand caribou are dependent on caribou moss, and it takes 50 years for it to come back.
	They live on caribou moss. If the moss burns and it’s not coming back for 50 years, they go somewhere else. They can't go much further north because that’s all burned too.
	It’s also pollution. We used to see all kinds of wild flowers; we hardly see butterflies or grasshoppers now; there used to be thousands. Now we might see one or two. There’s lots we’ve lost from Fort McMurray.
	The way she put it, if it’s not right in the area you’re excluded, yet we are there. I spoke with her in Buffalo, where she asked me a question. I'm farther north, but it doesn’t mean ... next year the blueberries are going to be in my area; it might be around Patterson that I go harvest the berries, or a moose – I heard this year the moose gathered at Patterson. We go by that, not by where our cabins are. We all use the whole area. I use land from Buffalo Narrows right to Lake Athabasca. If something is there, I'm going to be there, whether for fishing, hunting, harvesting berries, whatever. It’s land use, and we use it in many ways.
	We are the world’s water purifying system – the swamps and muskegs break down all kinds of pollutants and turns it back to normal. That’s one of the benefits of our north; we are the filter for most of the world’s water. Each forest plays a role in everything, like rainforest in B.C.

Table A-1: Joint Working Group Feedback Related to Baseline Vegetation

Community	Comment
Métis Nation – Saskatchewan (MN-S	When you talk about using local, that's good. For example, we wanted to re-establish the fish population in our lakes, that had been taken out. Government said no, we'll bring you the eggs. We wanted to use the eggs from our own lakes. They said no. Today we have sauger in the lakes that should never ever be there. That's from taking something from somewhere else and bringing it here. You can't take a lady slipper from up north and plant it in Saskatoon and expect it to grow. The environment is not right. But you can plant it up where I live and it will grow. Using local is the best opportunity to re-establish the vegetation.

BNDN = Birch Narrows Dene Nation; BRDN = Buffalo River Dene Nation; CRDN = Clearwater River Dene Nation; MN-S = Métis Nation – Saskatchewan; VC = valued component.

Rook I Project

Environmental Impact Statement

Annex VII.1: Vegetation Baseline Report 1 (Mapping)

NexGen Energy Ltd.
Rook I Project

Terrestrial Environment
Vegetation Baseline Report I
(Mapping)

December 2023

OMNIA
ECOLOGICAL SERVICES

OMNIA
ECOLOGICAL SERVICES

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Vegetation Baseline Report 1 (Mapping)

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December 2023

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LIST OF ACRONYMS

Abbreviation	Explanation
ATV	all-terrain vehicle
DBH	diameter at breast height
CRDN	Clearwater River Dene Nation
CWD	coarse woody debris
EC	Environment Canada (1971 - 2015)
ECCC	Environment and Climate Change Canada (2015 - Current)
ENV	Saskatchewan Ministry of Environment
JWG	Joint Working Groups
LSA	local study area
RSA	regional study area
CRSA	caribou regional study area
P	probability
PEM	Predictive Ecosite Mapping
ROW	right-of-way
sp.	species
spp.	multiple species
TLU	Traditional Land Use
UTM	Universal Transverse Mercator
VC	valued component

1.0 INTRODUCTION

The Rook I Project (Project) is a proposed new uranium mining and milling operation that is 100% owned by NexGen Energy Ltd. (NexGen). The Project would be located in northwestern Saskatchewan, approximately 40 kilometres (km) east of the Alberta-Saskatchewan border, 130 km north of the town of La Loche, and 640 km northwest of the city of Saskatoon. The Project would reside within Treaty 8 territory and within the Métis Homeland. At a regional scale, the Project would be situated within the southern Athabasca Basin adjacent to Patterson Lake, and along the upper Clearwater River system. Access to the Project would be from an existing road off Highway 955. The Project would include underground and surface facilities to support the extraction and processing of uranium ore from the Arrow deposit, a land-based, basement-hosted, high-grade uranium deposit.

The vegetation baseline report represents a component of a comprehensive baseline program that documents the natural and socio-economic environments in the anticipated area of the Project. The vegetation baseline program was undertaken to provide context from which Project environmental vegetation effects could be assessed in the Environmental Impact Statement (EIS).

Since exploration at the Project commenced in 2013, NexGen has engaged regularly and established relationships with local First Nations and Métis Groups (collectively referred to as Indigenous Groups) and northern communities, specifically those closest and with greatest access to the proposed Project. NexGen respects the rights of Indigenous Peoples and the unique relationship Indigenous Peoples have with the environment, and recognizes the importance of full and open discussion with interested or potentially affected Indigenous communities regarding the development, operation, and decommissioning of the proposed Project. Engagement activities to date, as well as future planned engagement activities, reflect the value NexGen places on meaningful engagement with Indigenous and northern communities who could be potentially affected by the proposed Project. Engagement mechanisms have included, but are not limited to: meetings with leadership, workshops and community information sessions, Project site tours, establishing Joint Working Groups to support the gathering and incorporation of Indigenous and Métis Knowledge throughout the Environmental Assessment (EA) process, and providing funding for Traditional Land Use (TLU) Studies[1] to understand how the proposed Project may interact with the Indigenous communities' traditional use of the anticipated area of the Project.

Feedback received during engagement activities was documented for contribution to the EIS for the Project; examples of feedback received include discussion of concerns, interests, potential adverse effects, mitigation, and design alternatives. Many baseline studies were initiated in advance of formal engagement on the EA for the Project; however, engagement during the execution of baseline studies has helped inform the understanding of baseline conditions and confirmed components of the natural and socio-economic environments that required study. A summary of feedback related to the vegetation baseline program is presented in Appendix A of the Vegetation Baseline Road Map (Annex VII).

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[1] Traditional Land Use (TLU) Studies include all land use studies developed by the Project's affected Indigenous Groups, including Traditional Land Use and Occupancy studies, Traditional Knowledge and Use studies, and Indigenous Rights and Knowledge studies, henceforth referred collectively as TLU Studies.

1.1 Study Objectives

The Omnia terrestrial baseline data was used to support the environmental effects assessment for the Project.

The objectives of the Omnia terrestrial baseline surveys were to:

- characterize the existing terrestrial environment (natural and anthropogenic elements) in the Project study areas through the use of available peer reviewed research, applicable professional protocols, and provincial and federal guidelines;
- inform environmental effects and technical assessments;
- ensure the baseline studies meet all provincial and federal regulatory requirements for the effects assessment;
- capture information from community engagements and stakeholder considerations;
- establish a framework to facilitate future environmental effects monitoring; and
- support the development of project specific mitigation strategies.

This report documents and summarizes baseline (current) anthropogenic and natural disturbance, ecosite characterization, and linear feature natural regeneration based on data obtained during field programs completed in 2018 and 2019.

2.0 STUDY AREAS

2.1 Study Area Selection

The Project is located approximately 130 km north of La Loche, Saskatchewan along Patterson Lake near the northern edge of the Boreal Plain Ecozone, in the Mid-Boreal Uplands Ecoregion. The regional study areas extend into the Boreal Shield Ecozone. These Omnia terrestrial baseline surveys were established using three nested study areas to guide impact assessments of Project-specific and cumulative impacts on potential valued components (VC) including: a local study area (LSA), a regional study area (RSA), and a caribou regional study area (CRSA) (Figure 2.1-1). These study areas were developed to account for the entire Project footprint and surrounding regions to help assess both local and regional impacts.

Specifically, the LSA was 41 km^2 and sized to account for direct Project effects and includes a sensory buffer (1.0 km) for the proposed mine access road and mine site development footprint (Figure 2.1-1). The 1.0 km buffer was selected to take into account potential habitat alienation effects on large mammals from mining activity, construction noise and road traffic as per Cristescu et al. (2016).

The RSA was 400 km^2 and designed to account for the potential cumulative effects of the Project at a sub-regional scale (including species with larger home ranges) (Figure 2.1-1). The RSA was also designed to support future impact assessments on VCs and includes areas with potential direct and indirect effects of the Project in addition to suitable reference areas. The size of the RSA was selected to align with those from several other regional studies across Northern Saskatchewan as outlined by McLoughlin et al. (2016).

Both LSA and RSA boundaries are of an appropriate size and location for the inventory and assessment of both local and regional effects on vegetation and wildlife from existing and planned activities.

The CRSA was 2,380 km^2 and accounts for the mean annual home range size of woodland caribou (*Rangifer tarandus caribou*) in the region, and to provide regional context for caribou occurrence and habitat supply as mapped by Environment and Climate Change Canada (ECCC 2018) and the Saskatchewan

Ministry of Environment (ENV 2018) (Figure 2.1-1). No woodland caribou home range data is available for the CRSA. However, a study in the Boreal Shield completed by McLoughlin et al. (2016), to the east of the study area, estimated mean annual home range to be 407 km^2. The mean diameter (24 km) of the home range was used as a buffer for the proposed mine access road and mine site development and to delineate the CRSA.

2.2 Ecological Setting

2.2.1 Ecoregions and Landscape Areas

The Project study areas straddle two Ecozones, three Ecoregions, and three Landscape Areas (Acton et al. 1998) (Table 2.1-1). The entire LSA is situated within the Firebag Hills Plain Landscape Area (E1) in the Mid-Boreal Upland Ecoregion of the Boreal Plain Ecozone. The RSA is situated within the Firebag Hills Plain Landscape Area (93.7%) of the Boreal Plain, and the McTaggart Plain Landscape Area (C3) (6.3%) in the Athabasca Plain Ecoregion of the Boreal Shield Ecozone. The CRSA is situated within the Firebag Hills Landscape Area (58.8%) of the Boreal Plain, the McTaggart Plain Landscape Area (33.6%) of the Boreal Shield, and the Black Birch Plain Landscape Area (D1) (7.6%) in the Churchill River Upland Ecoregion of the Boreal Shield.

Table 2.2-1 Distribution of Project Study Areas within Ecozones, Ecoregions & Landscape Areas.

Ecozone		Boreal Shield		Boreal Plain	**Total Area (km^2)**
Ecoregion		Athabasca Plain	Churchill River Upland	Mid Boreal Upland	
Landscape Area		McTaggart Plain (C3)	Black Birch Plain (D1)	Firebag Hills (E1)	
LSA	km^2	0	0	41.1	**41.1**
	%	0	0	100.0	**100.0**
RSA	km^2	25.1	0	375.0	**400.1**
	%	6.3	0	93.7	**100.0**
CRSA	km^2	798.4	181.2	1400.1	**2,379.7**
	%	33.6	7.6	58.8	**100.0**

Source: Acton et al. 1998.

2.2.2 Landforms

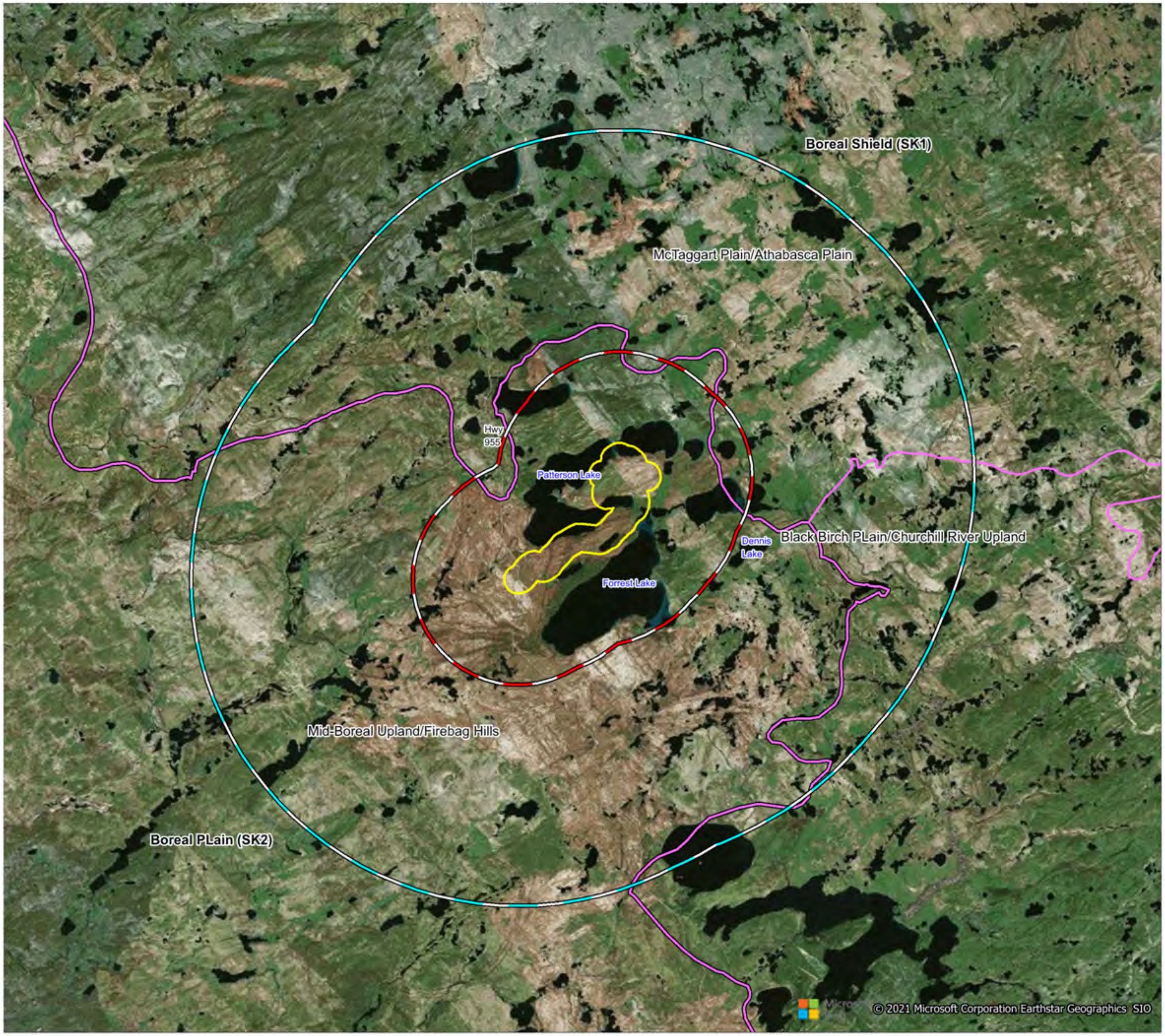
All three Landscape Areas (C3, D1, and E1) have similar landforms characterized by hummocky, sandy glacial till and glaciofluvial deposits, with large areas of bogs and peatlands (Acton et al. 1998). The landforms in these areas are more representative of Boreal Shield landforms than Boreal Plain landforms. Typically, the Boreal Plain usually contains more clay-sized materials and has a more diverse mineralogy (Acton et al. 1998).

2.2.3 Regional Vegetation

The three Landscape Areas are also similar in that jack pine (*Pinus banksiana*) with a lichen understory is prevalent due to the sandy surface materials and frequency of the fire regime. A mixture of black spruce (*Picea mariana*) and jack pine can be found on the slopes of eskers, and closed stands of black spruce are found in the boggy lowland areas with occasional tamarack (*Larix laricina*) trees found in fens (Acton et al. 1998).

As fire in lichen-dominated systems generally do not increase the amount of deciduous shrubs, the vegetation in this area is typical of the Boreal Shield where frequent fires have promoted the dominance of jack pine. The forests of the Boreal Plain (and particularly the Mid-Boreal Upland Ecoregion) are more commonly represented by a mixture of deciduous and coniferous trees, with closed stands of trembling aspen (*Populus tremuloides*), jack pine, black spruce, white spruce (*Picea glauca*), and balsam poplar (*Populus balsamifera*); these species are listed in order of dominance (Acton et al. 1998).

Figure 2.1-1 Omnia Terrestrial Baseline Study Areas of the Project



Legend

- Local Study Area (LSA)
- Regional Study Area (RSA)
- Caribou Regional Study Area (CRSA)
- Ecoregion / Landscape Area
- Ecozone

0 7.5 15
kilometers
Scale = 1 : 270,000

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3.0 ANTHROPOGENIC DISTURBANCE MAPPING

Anthropogenic disturbance mapping was created, compiled, and refined for the Project LSA and RSA. For the CRSA, federal and provincial government data sources were used. The data is presented in three ways:

- total area disturbed (km^2) by feature type (LSA and RSA);
- linear feature density (km/km^2) by feature type (LSA and RSA); and
- total area disturbed (km^2), including 500 m buffer, by feature type (LSA, RSA, and CRSA).

3.1 Study Objectives

The objective of this mapping was to provide baseline anthropogenic disturbance mapping for the LSA, RSA and CRSA.

3.2 Methods

To develop baseline anthropogenic disturbance mapping for the LSA and RSA, a two-step procedure was used. First, the Environment and Climate Change Canada (ECCC) national level anthropogenic disturbance map was downloaded and clipped to the study area boundaries (EC 2012a, ECCC 2015). Detailed (unbuffered) data has been made available from the 2012 dataset (EC 2012a), while the updated disturbance data from 2015 (ECCC 2015) includes the 500 m buffer (no detailed unbuffered data is available for this dataset). NexGen baseline anthropogenic disturbance data was also included in this step.

Second, to improve the resolution and ensure completeness, all visually discernible anthropogenic features in the LSA and RSA were digitized at a 1:5,000 scale. This was completed to provide the most accurate and complete refined data set to identify existing disturbance and provide information and assistance with future reclamation goals. To support this process and enhance the final product, a combination of 2018 Project-specific ortho-photography, Landsat Imagery (2018), and Map Info Microsoft Bing Imagery (2018) were used to visually identify anthropogenic features. Industrial clearings (i.e., polygons) were hand drawn based on imagery. All linear features were digitized as lines, the feature widths were measured based on imagery, and the average widths were used to create polygons per the widths detailed below:

- cutline: 1.75 m;
- right-of-way: 2.5 m;
- trail: 4 m;
- rough road: 5.5 m; and
- road: 12 m.

The digitized features were layered according to the following priority; where the layers overlapped, the higher priority layer took precedence over the lower priority layer:

1. industrial clearing;
2. road;
3. rough road;
4. trail;
5. cutline; and
6. right-of-ways (ROW).

For the CRSA, the most up to date ECCC (2015) non-refined national level anthropogenic disturbance mapping (footprint and 500 m buffer) was used.

3.3 Results

3.3.1 Total Area Disturbed (km²)

The results of the anthropogenic disturbance mapping for the LSA and RSA are displayed in Figure 3.3-1. Using the refined anthropogenic disturbance map product (unbuffered), the total amount of anthropogenic disturbance was 0.8 km^2 (2.0%) in the LSA and 2.1 km^2 (0.5%) in the RSA (Table 3.3-1). Industrial clearings, rough roads, and right-of-ways were the most common anthropogenic disturbance types in the LSA.

Table 3.3-1 Refined Mapping of Anthropogenic Disturbance in the Project LSA and RSA.

Disturbance Feature	LSA		RSA	
	km^2	**%**	**km^2**	**%**
Cutline	0.025	0.06	0.454	0.11
Right-of-Way	0.077	0.19	0.146	0.04
Trail	0.050	0.12	0.320	0.08
Rough Road	0.123	0.30	0.332	0.08
Road	0.028	0.07	0.208	0.05
Industrial Clearing	0.534	1.30	0.644	0.16
Total Disturbance	**0.84**	**2.04**	**2.11**	**0.53**

Note: Unbuffered anthropogenic disturbance

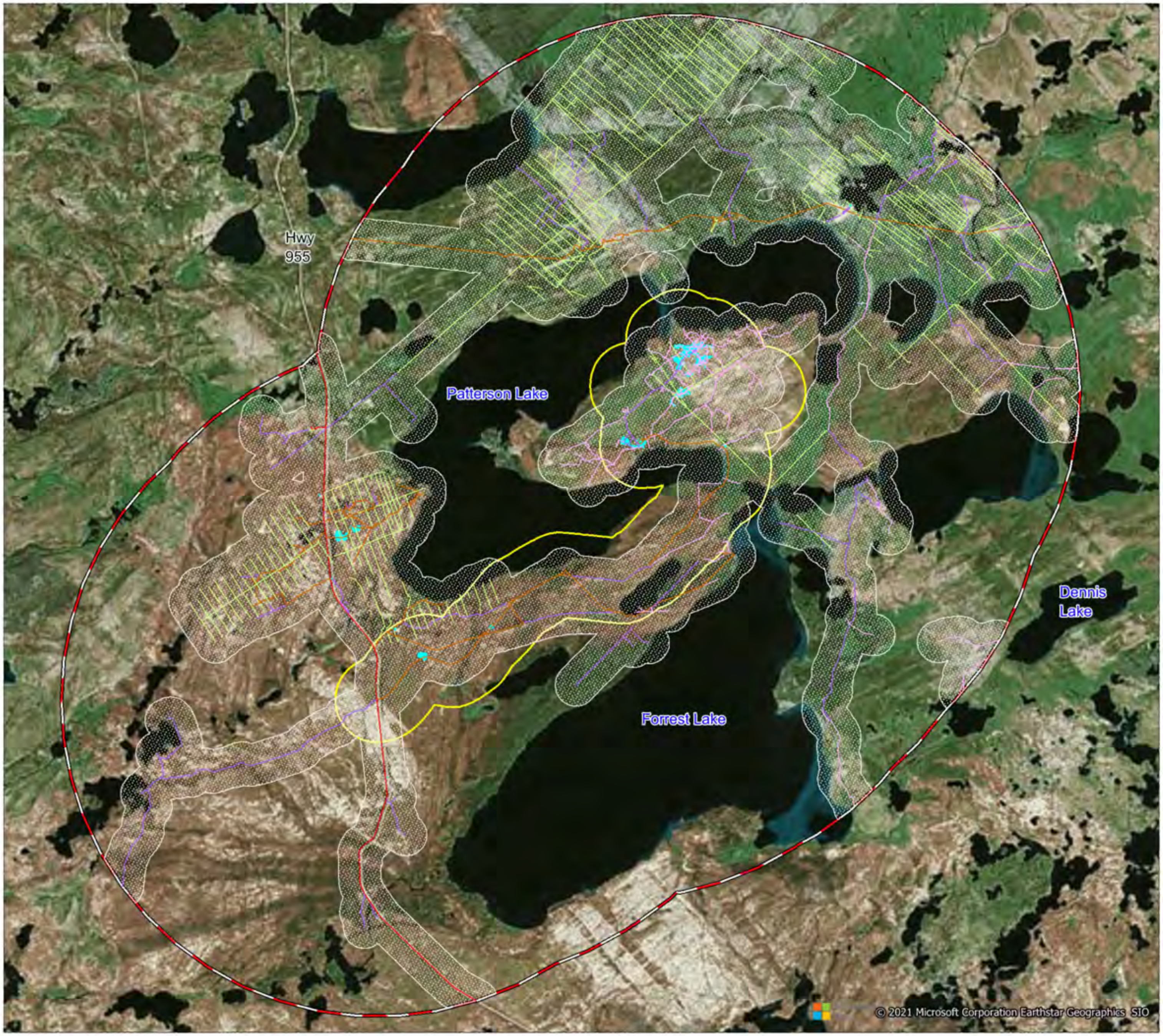
3.3.2 Linear Feature Density (km/km²)

Per the Environment Canada (EC 2012a) mapping, the density of linear feature disturbances was approximately 0.3 km per km^2 in the LSA and approximately 0.2 km per km^2 in the RSA (Table 3.3-2). A comparison of the refined anthropogenic disturbance mapping versus the unbuffered EC (2012a) linear feature data set found the refined LSA map had a linear feature density 8.3 times higher than the EC (2012a) data set. The refined RSA anthropogenic disturbance map had a linear feature density that was 7.6 times greater than EC (2012a) data set. Refined anthropogenic disturbance mapping indicated five linear feature types (road, rough road, trail, cutline, and ROW) in the LSA and RSA, while the EC (2012a) data set only detected one type (road). This difference was likely a result of the approach and scale (1:30,000) of the mapping completed by EC (2012a).

3.3.3 Total Area Disturbed (km²), Including 500 m Buffer

The results of the updated and improved anthropogenic footprint mapping including 500 m CRSA buffer were compared to the buffered ECCC (2015) anthropogenic disturbance data set (Table 3.3-3). The refined anthropogenic disturbance map for the LSA resulted in total buffered linear disturbance of 33.6 km^2 (81.7%), versus the ECCC (2015) dataset that included 10.5 km^2 (31.5%) of buffered linear disturbance. For the RSA the refined anthropogenic footprint was 195.4 km^2 (48.8%) compared to 65.0 km^2 (16.3%) using the ECCC (2015) dataset. For the CRSA the anthropogenic footprint was 226.72 km^2 (9.5%) using the ECCC (2015).

Figure 3.3-1 Project Anthropogenic Disturbance Mapping



Legend

Disturbance Type - Width

- Cutline (1.75m)
- ROW (2.5m)
- Trail (4m)
- Rough Road (5.5m)
- Road (12m)
- 500m Anthropogenic Buffer
- Clearing
- Regional Study Area (RSA)
- Local Study Area (LSA)

0 2.5 5
kilometers
Scale = 1 : 90,000

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Table 3.3-2 Linear Feature Density in the Area of the Project (ECCC 2015).

Linear Feature	LSA (km/km^2)		RSA (km/km^2)		CRSA (km/km^2)	
	ECCC (2015)	Refined Mapping	ECCC (2015)	Refined Mapping	ECCC (2015)	Refined Mapping
Cutline	0.00	0.38	0.00	0.66	0.00	N/A
Right-of-Way	0.00	0.98	0.00	0.17	0.00	
Trail	0.00	0.34	0.00	0.20	0.00	
Rough Road	0.00	0.53	0.00	0.15	0.00	
Road	0.27	0.06	0.16	0.04	0.09	
Total	**0.27**	**2.28**	**0.16**	**1.23**	**0.09**	

Table 3.3-3 Comparison of updated and improved Anthropogenic Footprint with the ECCC (2015) Footprint.

Study Area		Anthropogenic Footprint (500m buffer included)		Total Area (km^2)
		ECCC (2015)	Refined Mapping	
LSA	**km^2**	10.51	33.58	41.12
	%	25.5	81.7	
RSA	**km^2**	65.03	195.36	400.12
	%	16.3	48.8	
CRSA	**km^2**	226.72	N/A	2,379.63
	%	9.5		

4.0 FIRE MAPPING

The Recovery Strategy for the woodland caribou Boreal Population in Canada applied a threshold of 40 years and beyond for when habitat becomes available for woodland caribou following wildfire (EC 2012b, Skatter et al. 2017). Fire mapping was created/compiled based on federal and provincial government data sources.

4.1 Study Objectives

The objective of this mapping was to provide baseline fire mapping to identify the amount of young forest within the study areas.

4.2 Methods

Historical fire data (mapping) was obtained from the Saskatchewan Ministry of Environment (ENV) Wildfire Management Branch (Jones 2018). The fire data spanned from 1945 to 2018 and was provided as a shapefile. The data was downloaded, clipped, and overlaid onto the Project study areas. The mapped fire polygons included water bodies; therefore, the hydrological layer developed by Natural Resources Canada (2017) was used to exclude water polygons. The resulting imagery was then queried to analyze fire history for the LSA, RSA, and CRSA. The data was presented as percent burned area as a function of the study areas and percent burn of the terrestrial (excluding water) study areas.

The coarse level of fire polygon mapping did not account for residual patches (unburned areas) within the larger fire polygon; the results below are therefore an overestimation of total area burned. It is nevertheless useful as it is the only available source of fire mapping for the CRSA. Further interpretation required to provide a more accurate delineation of burned areas within the LSA and RSA are completed and presented in Section 5.0.

4.3 Results

A total of 19 fires have occurred in the Project CRSA since 1945. The age of these fires ranges from recent (2018) to 51 years (Table 4.3-1). The fires that have occurred within the CRSA during the last 40 years (1979-2018) are displayed in Figure 4.3-1.

Fires in the LSA:

- Two fires occurred within the LSA historically, both within the last 40 years (one in 1990 and the other in 1995) (Table 4.3-1, Figure 4.3-1).
- The two fires covered 28.7 km^2, which equates to 69.7% of the LSA (including water) and 85.9% of the terrestrial area only.

Fires in the RSA:

- Ten fires have occurred in the RSA historically. Nine of these fires have occurred within the last 40 years (Table 4.3-1, Figure 4.3-1).
- These nine fires covered 263.2 km^2, which equates to 65.8% of the RSA (including water) and 90.4% of the terrestrial area only.

Fires in the CRSA:

- Nineteen fires have occurred within the CRSA since 1945. Sixteen of these fires have occurred within the last 40 years (Table 4.3-1, Figure 4.3-1).
- These 16 fires comprise 1,938.2 km^2, which equates to 81.5% of the CRSA (including water) and 94.3% of the terrestrial area only.

Table 4.3-1 Overview of Historical Fires from 1945 - 2018 in the Project LSA, RSA and CRSA.

Fire Period	Year	LSA			RSA			CRSA		
		km^2	% of Total	% of Terrestrial	km^2	% of Total	% of Terrestrial	km^2	% of Total	% of Terrestrial
>40 years	1967	-	-	-	14.2	3.5	4.9	23.4	1.0	1.1
	1970	-	-	-	-	-	-	<0.01	0.0	0.0
	1978	-	-	-	-	-	-	2.2	0.1	0.1
Total area burned >40 years		0.0	0.0	0.0	14.2	3.5	4.9	25.7	1.1	1.2
<40 years	1980	-	-	-	6.3	1.6	2.2	191.4	8.0	9.3
	1981	-	-	-	26.0	6.5	8.9	253.1	10.6	12.3
	1990	13.4	32.6	40.2	23.5	5.9	8.1	23.5	1.0	1.1
	1993	-	-	-	-	-	-	18.6	0.8	0.9
	1995	15.2	37.1	45.7	115.9	29.0	39.8	372.9	15.7	18.1
	2002	-	-	-	-	-	-	14.4	0.6	0.7
	2004	-	-	-	-	-	-	2.2	0.1	0.1
	2006	-	-	-	14.2	3.6	4.9	537.5	22.6	26.2
	2009	-	-	-	2.1	0.5	0.7	56.0	2.4	2.7
	2010	-	-	-	-	-	-	16.2	0.7	0.8
	2012	-	-	-	4.0	1.0	1.4	4.0	0.2	0.2
	2014	-	-	-	-	-	-	0.0	0.0	0.0
	2015	-	-	-	-	-	-	155.9	6.6	7.6
	2016	-	-	-	25.0	6.3	8.6	194.9	8.2	9.5
	2017	-	-	-	46.1	11.5	15.8	70.4	3.0	3.4
	2018	-	-	-	-	-	-	27.2	1.1	1.3
Total area burned <40 years		**28.7**	**69.7**	**85.9**	**263.2**	**65.8**	**90.4**	**1,938.2**	**81.5**	**94.3**
Total of study area (km^2)		41.1			400.1			2,379.6		
Waterbodies (km^2)		7.8			109.0			324.6		
Total terrestrial study area (km^2)		33.4			291.1			2,055.0		

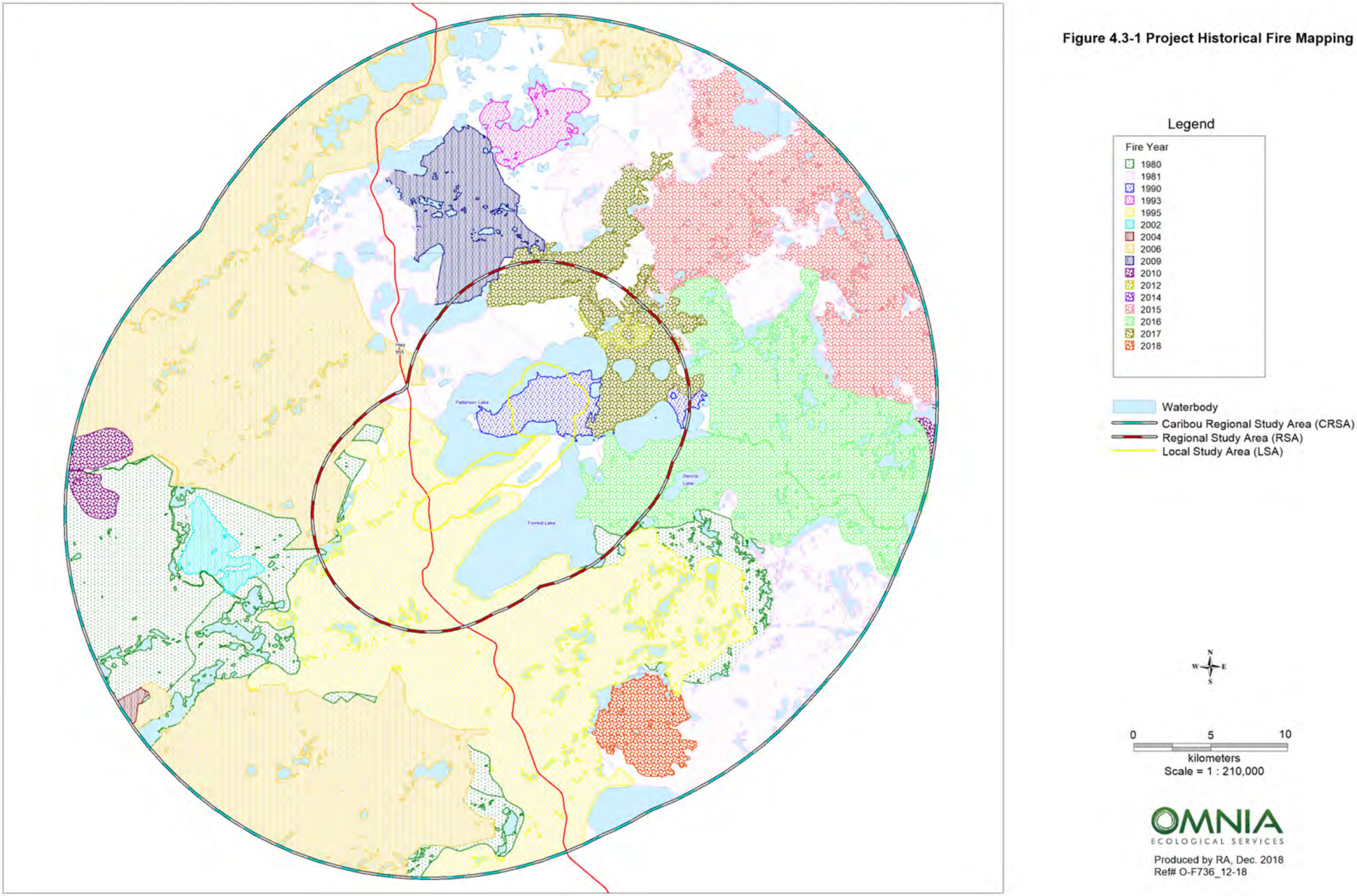

Figure 4.3-1 Project Historical Fire Mapping
Legend
Fire Year
1980
1981
1990
1993
1995
2002
2004
2006
2009
2010
2012
2014
2015
2016
2017
2018
Waterbody
Caribou Regional Study Area (CRSA)
Regional Study Area (RSA)
Local Study Area (LSA)
0
5
10
kilometers
Scale = 1 : 210,000
OMNIA
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5.0 ECOSITE MAPPING

An Interpreted Ecosite map was created, compiled, and refined for the Project LSA and RSA. For the CRSA, federal and provincial government data sources were used.

5.1 Study Objectives

The objectives of this mapping were to provide baseline information on vegetation cover to:

- refine fire mapping to accurately identify residual (non-burned) patches within government-mapped fire polygons, and identify amount of young and old forest types within the study areas; and
- support monitoring and/or assessment of impacts.

Predictive Ecosite Mapping (PEM) was available at the Saskatchewan Technical Branch. The goal was to use the PEM, but if this map was not deemed to have sufficient accuracy, the development of an interpreted Ecosite map would be required.

5.2 Methods

5.2.1 Predictive Ecosite Map

Predictive Ecosite Mapping data was obtained from the Saskatchewan Technical Branch to support the creation of a study area specific ecosite map (Henkleman and Johnstone 2017). The PEM that was obtained only covered the Boreal Plain portion of the study area. To support expansion of the mapping and to further refine and assess mapping accuracy, a ground truth component was included in the baseline field studies.

A total of 1,366 field sampling/ground truthing sites were used, where an ecosite delineation was completed. The sampling sites provided the supporting data for expanding, refining and assessing the accuracy of the PEM for the LSA and RSA.

Field sampling/ground truthing sites included data from:

- ungulate pellet group/browse availability survey: 1,219 locations;
- small mammal trapping program: 21 locations;
- vegetation/ecosite characterization survey: 69 locations; and
- ground control points: 57 locations.

Half of the locations sampling sites (n=650) were used for the map accuracy assessment. The remaining locations were set aside to support ecosite mapping in the event that the PEM was found to have insufficient accuracy. The ground control points were overlain onto the mapped ecosites to assess accuracy of the Predictive Ecosite Map.

5.2.2 Interpreted Ecosite Map

To create a refined ecosite map to accurately outline the current ecosites (including regenerating stages) in the LSA and RSA, a combination of the existing PEM and alternative sources including Landsat Imagery (2018), Bing and Google Earth Imagery (2017-2018), and aerial photographs taken during the aerial waterfowl survey in June 2018 (Figure 5.2-1) were utilized. Visual interpretation was guided by collected baseline field data not used for the accuracy assessment. The resulting ecosite map was completed at a 1:20,000 scale.

The regenerating land cover types less than 40 years old that did not match any of the ecosites described by McLaughlan et al. (2010) were categorized based on vegetation height and therefore broadly on stand age; this follows methods outlined by Skatter et al. (2017). The categories were grouped as recent burn: (0 to 5 years of age), low shrub (< 1m tall, approximately 5 to 20 years of age), tall shrub (1 m to 5 m tall, approximately 20 to 35 years of age), and treed (> 5 m tall, approximately 25 to 0 years of age). The categories were further divided into three vegetation types (bog, coniferous, and deciduous) based on moisture regime (upland versus lowland), and dominant tree species in the upland areas (coniferous versus deciduous).

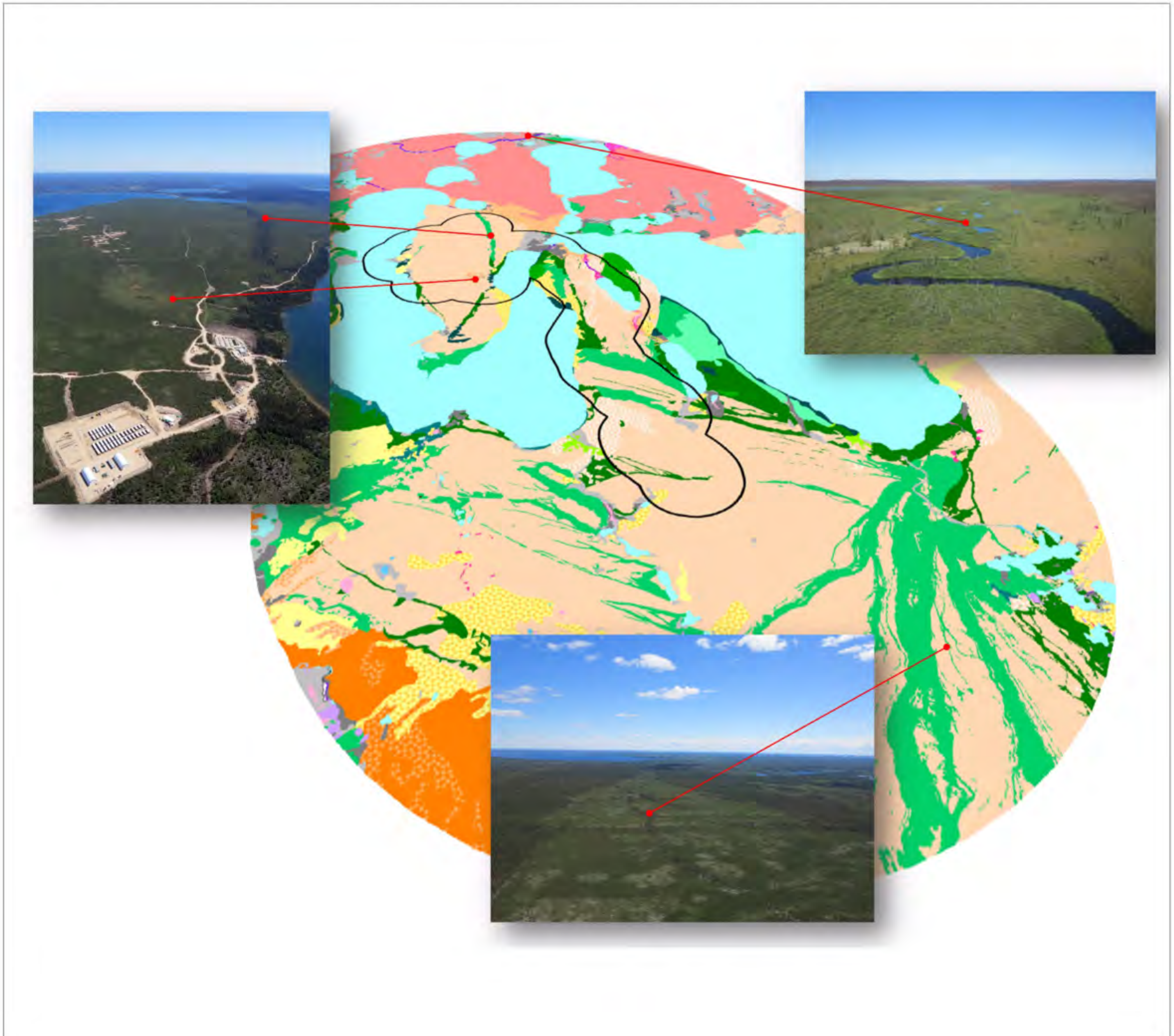

Figure 5.2-1 Example Aerial Photos Used to Assist Ecosite Mapping

Legend

Ecosite Type

- BP02 - Jackpine - lichen
- BP03 - Jackpine / feathermoss
- BP04 - Jackpine - trembling aspen / prickly rose / grass
- BP12 - Jackpine - spruce / feathermoss
- BP14 - Black spruce / Labrador tea / feathermoss
- BP16 - Balsam poplar - trembling aspen / prickly rose
- BP19 - Black spruce treed bog
- BP20 - Labrador tea shrubby bog
- BP21 - Graminoid bog
- BP22 - Open bog
- BP23 - Tamarack treed fen
- BP24 - Leatherleaf shrubby poor fen
- BP25 - Willow shrubby rich fen
- BP26 - Graminoid fen
- BP27 - Open fen
- BS14 - White birch / lingonberry - Labrador tea
- BS26 - Rush sandy shore
- DL1 - Disturbed lands - vegetated
- LAKE - Water body
- RF1-C - Regenerating coniferous forest - treed >5 m tall
- RF1-D - Regenerating deciduous forest - treed >5 m tall
- RF2-B - Regenerating bog - tall shrub 1-5 m tall
- RF2-C - Regenerating coniferous forest - tall shrub 1-5 m ta
- RF2-D - Regenerating deciduous forest - tall shrub 1-5 m ta
- RF3-B - Regenerating bog- low shrub <1 m tall
- RF3-C - Regenerating coniferous forest - low shrub <1 m t
- RF4 - Recent burn (0-5 years)

Local Study Area (LSA)

N

0 7.5 15

kilometers

Approximate Scale = 1 : 270,000

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The RSA occurs predominantly (94%) within the Boreal Plain (Table 2.1-1); therefore, the Boreal Plain key and corresponding ecosite codes in McLaughlan et al. (2010) were used. However, it should be noted that the region displays characteristics of the Boreal Shield Ecozone and two ecosite types detected could not be classified using the Boreal Plain key in McLaughlan et al. (2010). Ecosites BS14 – White birch / lingonberry (*Vaccinium vitis-idaea*)- Labrador tea (*Rhododendron groenlandicum*) and BS26 – Rush sandy shore were identified using the Boreal Shield key in McLaughlan et al. (2010) and are presented as such in this report.

5.3 Results

5.3.1 Predictive Ecosite Map

Predictive Ecosite Map accuracy was 6.8% or 44 of 650 correct ground control points. The accuracy level is due to McLaughlan et al. (2010) not describing forest types under 40 years of age in their ecosite classification system. The majority (94.3%) of the RSA is mapped as having burned within the last 40 years (see Section 4.3), and are therefore covered by regenerating forests that are not described by the McLaughlan et al. (2010). Therefore the PEM was not suitable on its own to map the ecosites in the LSA and RSA, and an interpreted ecosite map was created.

5.3.2 Interpreted Ecosite Map

The accuracy of the resulting ecosite map, taking into consideration the newly created regenerating forest ecosite types, was 80.2%, and included 27 different ecosite classifications (Figure 5.3-1). This accuracy is considered acceptable (Lillesand and Kiefer, 2000). The most abundant ecosites in the RSA were water bodies (27.3%), RF2-C (regenerating coniferous forest) (26.6%), RF4 (recent burn) (16.4%), and BP2 (jack pine / lichen) (9.3%). These four ecosites accounted for 79.6% of the RSA. The most abundant ecosites in the LSA were RF2-C (regenerating coniferous forest) (51.6%), water bodies (18.9%), and BP2 (jack pine / lichen) (6.9%), accounting for 77.4% of the LSA (Table 5.3-1).

The ecosite map outlined several areas of unburned residual patches that were mapped as burned in the fire map provided by ENV (Figure 4.3-1). The ENV mapping overestimated the burned areas by 3.2 km^2 (11.0%) in the LSA and 56.5 km^2 (21.5%) in the RSA (Table 5.3-2). The total areas burned are 25.5 km^2 and 206.6 km^2 in the LSA and RSA, respectively. Findings from other studies in the region have documented similar results. Kansas et al. (2016) studied the potential for residual fire patches to occur in the Saskatchewan Boreal Shield and documented that 25% of the area within mapped fire polygons was unburned (excluding water, which accounted for 8% of the area). Therefore, residual patches can make up a considerable amount of the landscape within this region. Skatter et al. (2017) documented woodland caribou use of these areas for calving. Notwithstanding, refined Project-specific mapping demonstrates that 76.4% of the LSA and 71.0% of the RSA has burned within the last 40 years.

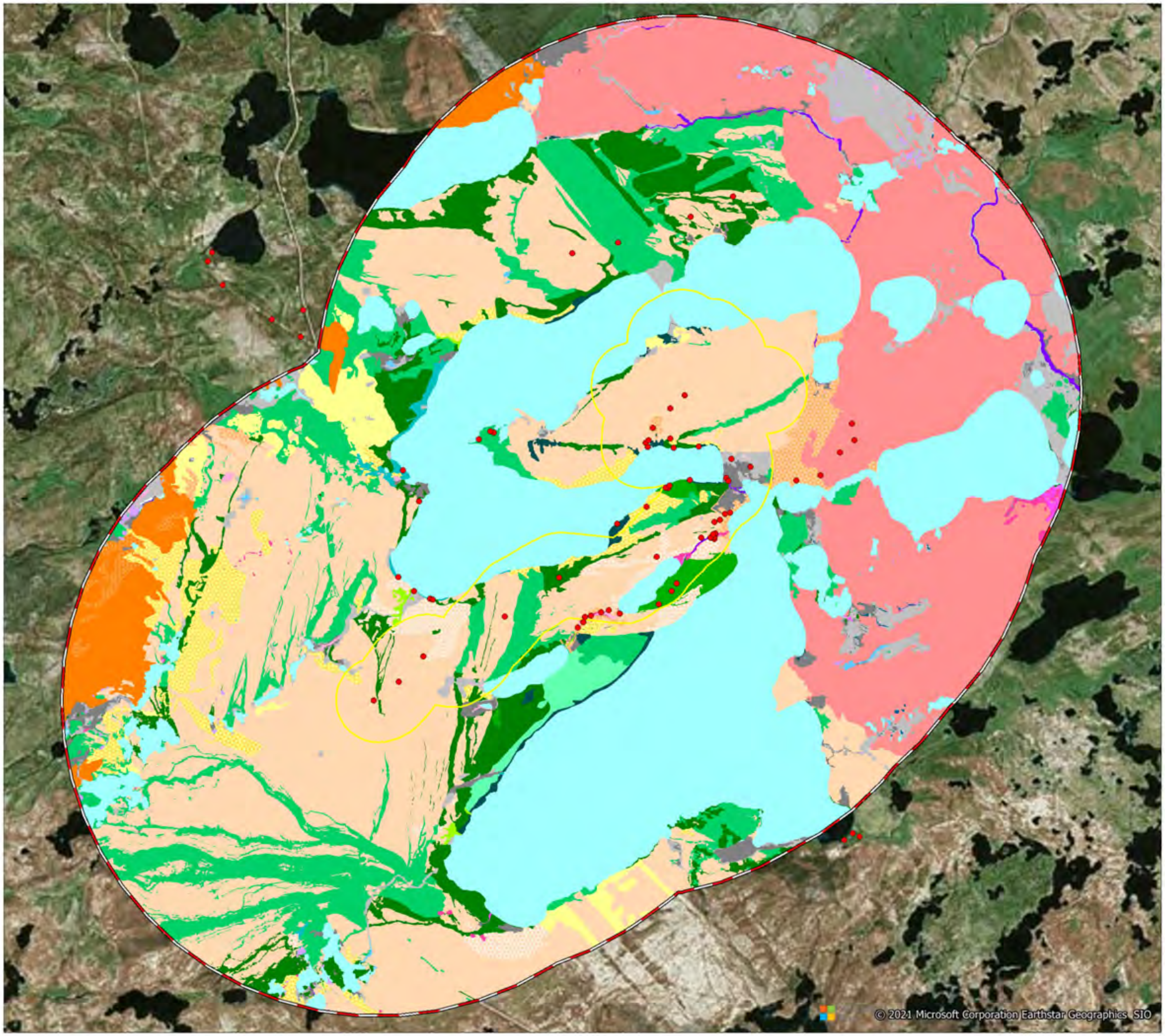

Figure 5.3-1 Project Interpreted Ecosite Mapping

Legend

Ecosite Type
- BP02 - Jackpine - lichen
- BP03 - Jackpine / feathermoss
- BP04 - Jackpine - trembling aspen / prickly rose / grass
- BP12 - Jackpine - spruce / feathermoss
- BP14 - Black spruce / Labrador tea / feathermoss
- BP16 - Balsam poplar - trembling aspen / prickly rose
- BP19 - Black spruce treed bog
- BP20 - Labrador tea shrubby bog
- BP21 - Graminoid bog
- BP22 - Open bog
- BP23 - Tamarack treed fen
- BP24 - Leatherleaf shrubby poor fen
- BP25 - Willow shrubby rich fen
- BP26 - Graminoid fen
- BP27 - Open fen
- BS14 - White birch / lingonberry - Labrador tea
- BS26 - Rush sandy shore
- DL1 - Disturbed lands - vegetated
- LAKE - Water body
- RF1-C - Regenerating coniferous forest - treed >5 m tall
- RF1-D - Regenerating deciduous forest - treed >5 m tall
- RF2-B - Regenerating bog - tall shrub 1-5 m tall
- RF2-C - Regenerating coniferous forest - tall shrub 1-5 m tall
- RF2-D - Regenerating deciduous forest - tall shrub 1-5 m tall
- RF3-B - Regenerating bog- low shrub <1 m tall
- RF3-C - Regenerating coniferous forest - low shrub <1 m tall
- RF4 - Recent burn (0-5 years)

Vegetation Plot
Regional Study Area (RSA)
Local Study Area (LSA)

N W E S

0 2.5 5
kilometers
Scale = 1 : 90,000

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Table 5.3-1 Ecosites in the Area of the Project.

Ecosite Code		Ecosite Name/ Description	RSA (Ha)	LSA (Ha)	RSA (%)	LSA (%)
Boreal Plain	Boreal Shield					
RF4		Recent burn (Age: 1 year)	6,581.9	0.0	16.4	0.0
RF3-Coniferous		Regenerating coniferous forest - low shrub <1 m tall (15-20 years)	965.3	0.0	2.4	0.0
RF3-Bog		Regenerating bog- low shrub <1 m tall (15-20 years)	127.9	0.0	0.3	0.0
RF2-Coniferous		Regenerating coniferous forest - tall shrub 1-5 m tall (20-35 years)	10,636.5	2,123.6	26.6	51.6
RF2-Deciduous		Regenerating deciduous forest - tall shrub 1-5 m tall (20-35 years)	474.3	219.0	1.2	5.3
RF2-Bog		Regenerating bog - tall shrub 1-5 m tall (20-35 years)	343.5	52.6	0.9	1.3
RF1-Coniferous		Regenerating coniferous forest - treed >5 m tall (25-40 years)	612.9	20.6	1.5	0.5
RF1-Deciduous		Regenerating deciduous forest - treed >5 m tall (25-40 years)	919.8	133.7	2.3	3.3
BP2	BS3	Jack pine - lichen	3,729.2	282.3	9.3	6.9
BP3	BS4	Jack pine / feathermoss	1,972.4	187.8	4.9	4.6
BP4	BS6	Jack pine - trembling aspen / prickly rose / grass	173.1	104.5	0.4	2.5
BP12	BS4	Jack pine - spruce / feathermoss	216.2	0.0	0.5	0.0
N/A	BS14	White birch / lingonberry - Labrador tea	74.6	0.8	0.2	0.0
BP14	N/A	Black spruce / Labrador tea / feathermoss	132.2	28.8	0.3	0.7
BP16	BS16	Balsam poplar - trembling aspen / prickly rose	33.2	0.6	0.1	0.0
BP19	BS17	Black spruce treed bog	499.1	59.4	1.2	1.4
BP20	BS18	Labrador tea shrubby bog	1,321.2	95.6	3.3	2.3
BP21	BS19	Graminoid bog	25.3	0.0	0.1	0.0
BP22	BS20	Open bog	8.6	0.0	0.0	0.0
BP23	BS21	Tamarack treed fen	21.1	0.8	0.1	0.0
BP24	BS22	Leatherleaf shrubby poor fen	54.1	12.9	0.1	0.3
BP25	BS23	Willow shrubby rich fen	68.9	4.8	0.2	0.1
BP26	BS24	Graminoid fen	45.1	7.7	0.1	0.2
BP27	BS25	Open fen	55.6	0.0	0.1	0.0
N/A	BS26	Rush sandy shore	16.9	0.8	0.0	0.0
DL1		Disturbed lands - vegetated	0.3	0.0	0.0	0.0
LK		Water body	10,903.5	775.6	27.3	18.9
Total			**40,012.6**	**4,111.7**	**100.0**	**100.0**

Table 5.3-2 Comparison of Areas Burned the Last 40 years in the LSA and RSA.

Mapping Product		LSA			RSA		
		km²	% of Total	% of Terrestrial	km²	% of Total	% of Terrestrial
ENV Fire Mapping (2018)		28.7	69.7	85.9	263.2	65.8	90.4
Refined Fire Ecosite Mapping[a]		25.5	62.0	76.4	206.6	51.6	71.0
Difference	km²	3.2	7.7	9.5	56.6	14.2	19.4
	%	11.0			21.5		

a) Refined fire mapping created from refined ecosite mapping

6.0 ECOSITE CHARACTERIZATION, STRUCTURAL DIVERSITY, AND SPECIES RICHNESS

6.1 Study Objectives

The objectives of the detailed vegetation and wildlife habitat characterization field surveys were to:

- describe and quantify the ecological and botanical conditions within recurring mapped ecosite types and regeneration forest types;
- describe, evaluate, and map the relative ecological importance and integrity of landscapes in the study area; and
- evaluate the structural and compositional diversity and species richness components.

6.2 Methods

In order to describe and classify the vegetation cover types, data for five main vegetation components and four structural components were collected:

Vegetation components:
1. woody plants;
2. graminoids;
3. forbs;
4. bryophytes; and
5. lichens.

Structural components:
1. standing dead trees (Snags);
2. coarse woody debris (CWD);
3. percent cover of bare soil, rock, and open water; and
4. foliar and horizontal hiding cover.

6.2.1 Vegetation Components

<u>Woody Plants</u>

Woody plants were segregated by tree and shrub layer, and these were further divided into five sub-layers as follows (Figure 6.2-1):

A) Trees were defined as all woody plants greater than 5 m tall. Within the tree layer, three sub-layers were recognized:

A1) Super canopy - included the tallest trees of the main canopy, which may be veterans of one or more fires, or the tallest trees of the same age class as the main canopy (usually a minor portion of the stand composition).

A2) Main tree canopy (co-dominant trees) - the main layer of tree cover, composed of trees whose crowns form the upper layer of foliage; typically, the major portion of the stand composition.

A3) Sub-canopy trees - included trees greater than 5 m tall that do not reach the main canopy. These may form a distinct secondary canopy and were often a mixture of trees of various heights younger than those in the main canopy, or they were suppressed trees of the same age.

To be defined as a multi-layer tree stand, tree layers had to differ by at least 2 m.

B) The shrub layer included all woody plants less than 5 m tall. Established tree species regeneration less than 5 m in height was considered part of the shrub layer. Two sub-layers were recognized:

B1) Tall shrub layer – included all woody plants 1 m to 5 m tall, including shrubs and advanced tree regeneration and trees in poorly growing stands where the canopy was less than 5 m high.

B2) Low shrub layer – included all woody plants less than 1 m tall. This layer included dwarfed or immature specimens of species normally considered in tall shrub or tree layers (Figure 6.2-1).

Graminoids, Forbs, Bryophytes and Lichens

Graminoids (Gr) were defined as grasses and grass-like species such as sedges and rushes. Forbs (Fo) were defined as herbaceous flowering plants that were not graminoids. Bryophytes (Br) included mosses and liverworts, whereas lichens (Li) were limited to terrestrial lichen species.

6.2.2 Structural Components

Snags were defined as standing dead trees greater than 10 cm in diameter at breast height (DBH), and at least two metres in height. These were categorized to species and stages of decay based on criteria developed by Lee et al. (1995) (Figure 6.2-2). Coarse woody debris (CWD) comprised any deadfall greater than 10 cm in diameter. Percent cover of bare soil, rock, and open water and foliar and horizontal hiding cover are discussed in Sections 6.2.3 and 6.2.4.

6.2.3 Sampling Plot Layout

Each vegetation/wildlife habitat plot sampling site consisted of: one 30 m x 20 m main plot; five 1 m x 1 m sub-plots; and five 20 cm x 50 cm sub plots (Figure 6.2-3) (see Skatter et al. [2014] and Charlebois et al. [2015] for details). A 30 m tape was laid out to establish the start and end points of the sample site. The 1 m x 1 m sub-plots were placed at 5 m intervals along the sampling transect, and the 20 cm x 50 cm sub-plots were placed within the 1 m x 1 m sub-plots. The Universal Transverse Mercator (UTM) locations for the start and end points of the 30 m transect were recorded and a photograph was taken of each sampling site.

Data for the tree and tall shrub layers, as well as snag data, were collected within the main 30 m x 20 m plots. For each tree layer, species composition, percent canopy closure, median height, and DBH was estimated. Tree core samples were taken to determine the age of representative trees for each layer and cores were age adjusted. The percent canopy closure and median height of tall shrub species within the 30 m x 20 m main plot were estimated. The number and decay class (Lee et al. 1995) of CWD intercepts along the 30 m tape were recorded.

In each of the 1 m x 1 m sub-plots the percent cover of each low shrub, forb and graminoid species were recorded.

In the 20 cm x 50 cm sub-plots, the percent cover of bryophyte and lichen species as well as bare soil, rocks and open water were estimated. Plant species that could not be identified in the field were collected, pressed, and provided to a plant taxonomist for identification.

Figure 6.2-1 Tree and Shrub Vegetation Layer Criteria (Lee et al. 1995)

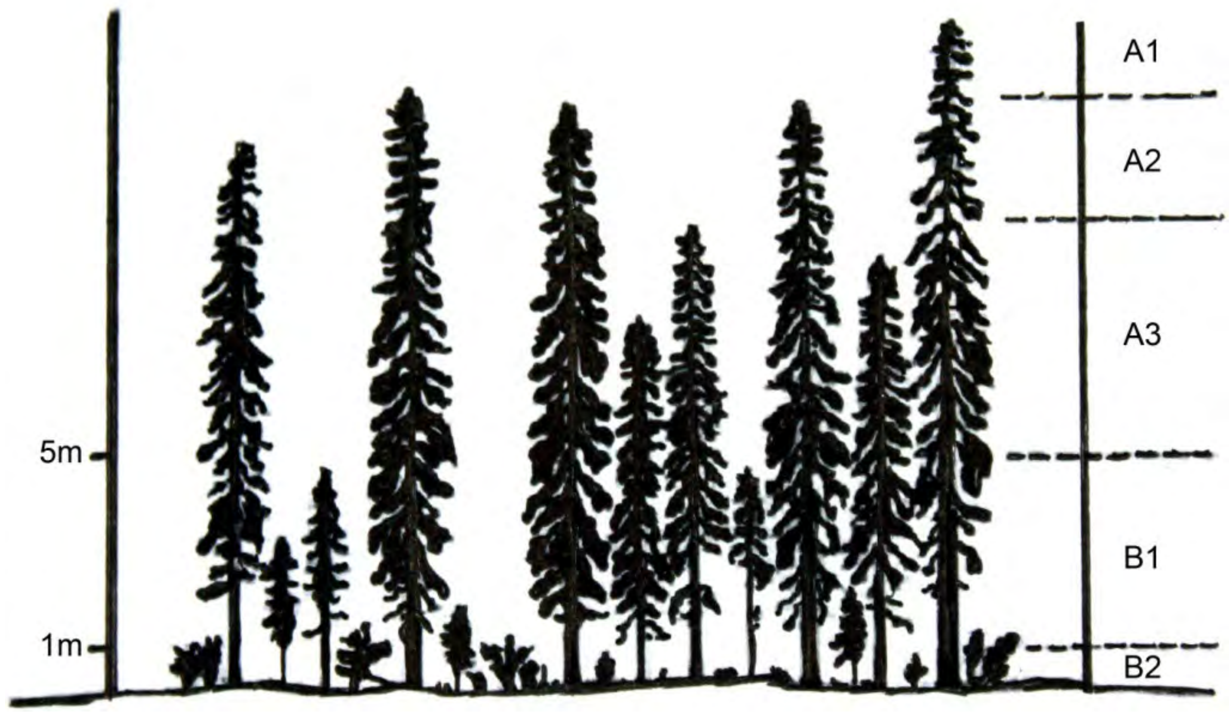


Figure 6.2-2 Decay Classification System for Snags (Lee et al. 1995)

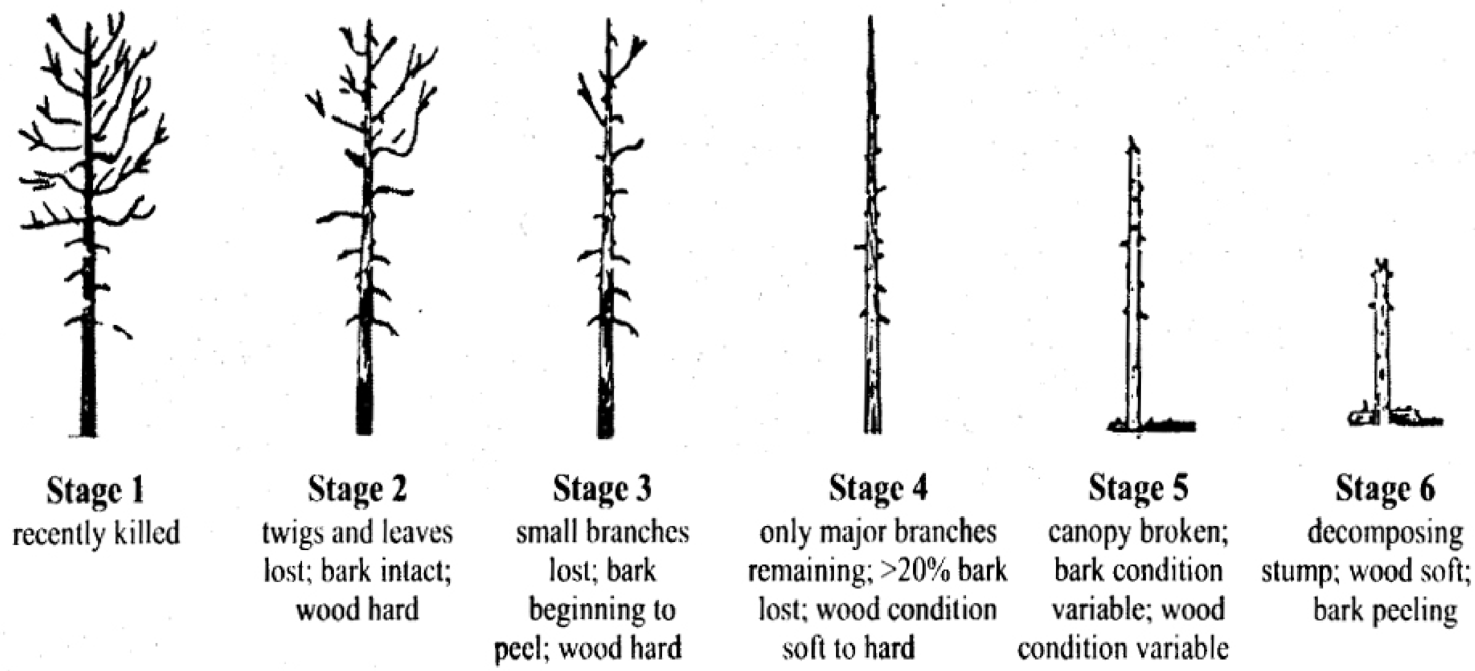
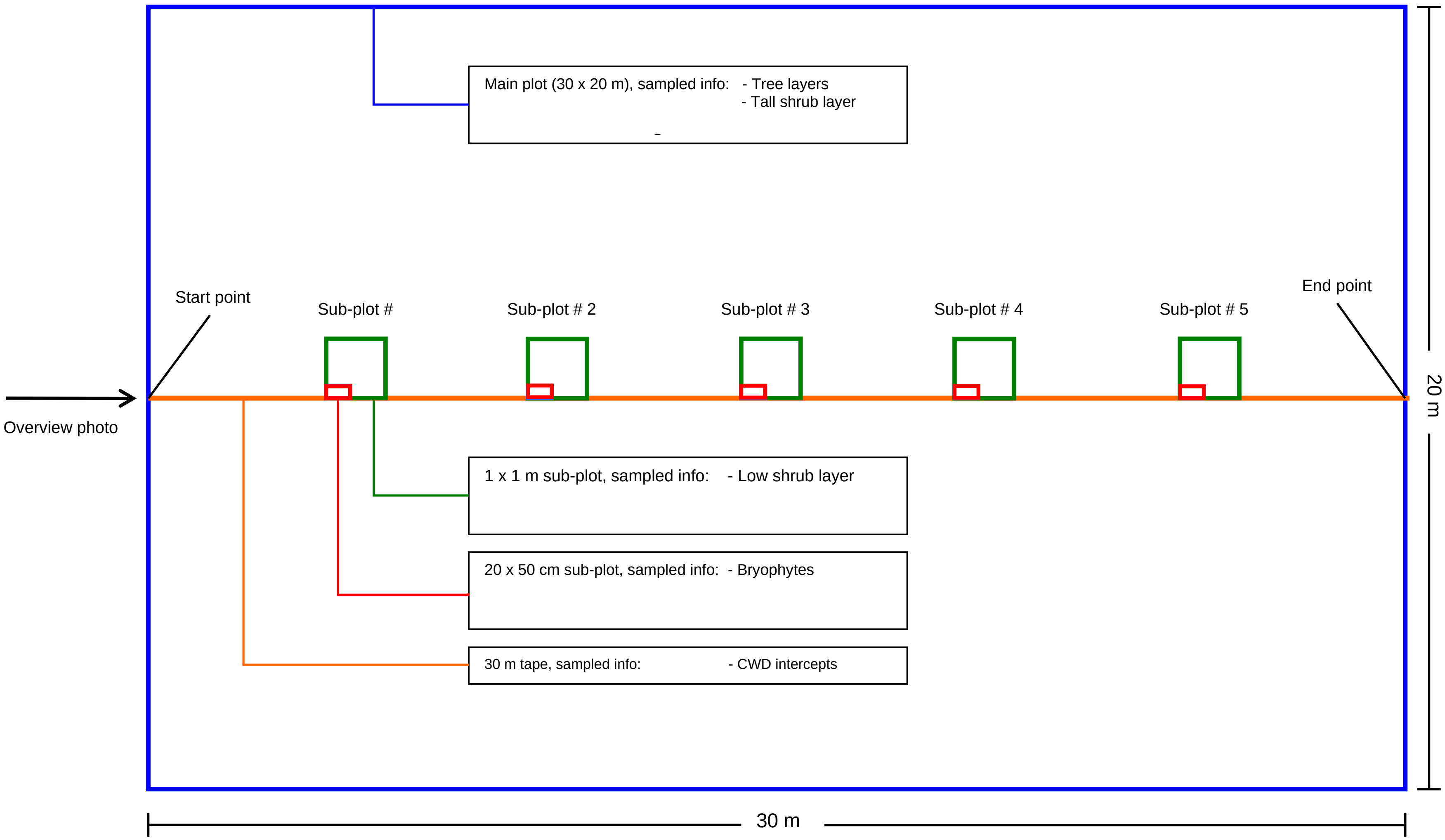


Figure 6.2-3 Layout of the vegetation sampling site.



6.2.4 Hiding Cover

The level of hiding cover afforded by vegetation within each vegetation cover type was measured using methods developed by Nudds (1977). A canvas cloth with ten alternating 25 cm x 30 cm bands of white and red paint at heights from ground level to 2.5 m was held up and viewed in four cardinal directions at a distance of 15 m from the plot centre (Figure 6.2-4). The percent of each of the ten bands that was hidden by vegetation was estimated to the nearest 10%.

6.2.5 Ecosite Fact Sheets

A detailed description of each sampled ecosite type is provided in the form of a two-page fact sheet. The first page of the fact sheet contains information about species composition and vegetation layers. The second page provides information about structural attributes and ratings as well as biodiversity information and ecosite supply in the RSA. An example of the two-page fact sheet is provided in Figure 6.2-5 and Figure 6.2-6. Instructions on how to read the fact sheets are outlined below.

An identification banner at the top of each fact sheet provides the ecosite code [1] and the ecosite name followed by the number of sample plots completed [2] (Figure 6.2-5). The codes and names follow McLaughlan et al. (2010). For habitats that did not match any of the ecosites described in McLaughlan et al. (2010), a two-letter and one number code was assigned. This was predominantly the case for the post fire regenerating stages. In most cases, these would be classified as BP2 (Jack pine/lichen). However, since McLaughlan et al. (2010) did not describe forests younger than 40 years, this would result in a large portion of the RSA that would be excluded because there were extensive areas of young forest. By characterizing each regeneration stage, these younger forests and their attributes are described in detail.

The name of the ecosite conveys information about the ecology of the unit, such as the species and soil conditions that are used to name the site and are diagnostic of the ecosite (McLaughlan et al. 2010). A sample photograph [3] taken from one of the plots for each ecosite provides a photographic representation of the site. A short text description [4] of the ecosite is provided under the Ecosite Description heading. This description is usually taken directly from McLaughlan et al. (2010), but contains additional study area specific comments, obtained during the field program, where applicable.

A bar graph [5] is used to depict the mean percent cover of each vegetation layer. The Species and Vegetation Layer Info section [6] provides the average, minimum, and maximum number of plant and lichen species per sample plot. Detailed botanical and structural information for each vegetation layer within the ecosite is provided in two separate tables. The first table provides information (total number of species observed, average crown closure, mean tree height, mean DBH, species composition, and year of origin) for each tree layer (A1, A2, and A3). The second table provides botanical and structural information for all remaining vegetation layers, including: total number of species observed; species composition; and average percent cover.

On the second fact sheet, the Structural Attributes and Relative Rating table [7] provides information about snags (mean number, diameter, height, and decay class), coarse woody debris (mean frequency, diameter, and decay class), and mean percent cover of litter, bare soil, bare rock, and open water (Figure 6.2-6). A bar graph [8] is displayed to show the vertical distribution of hiding cover for the ecosite. Each bar represents the average hiding cover for each 25 cm layer. The overall average hiding cover (for all vertical layers) per ecosite is presented at the top of the graph.

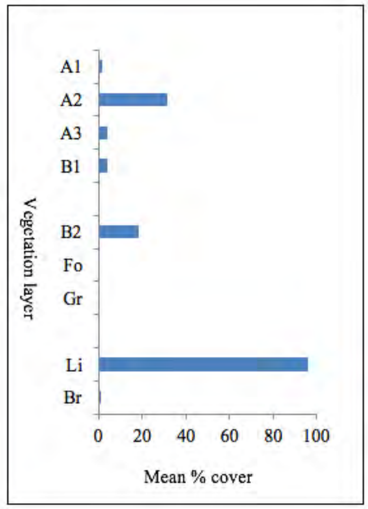
Section [9] of the second fact sheet page provides information about structural diversity (value), species richness (average number of species per plot), and unique and rare species occurrences (total numbers observed per ecosite). A rating for each of these values is provided in a separate column.

Figure 6.2-4 Display of the Hiding Cover Cloth

Figure 6.2-5 Page 1 of the Ecosite Fact Sheets

1 → **BS3** **Jack pine/blueberry/lichen: Moderately fresh sand** (n=4) ← 2

3 → 



4 → ***Ecosite Description*** ← 5

BS3 is dominated by jack pine in the overstory. The vascular plant understory is relatively sparse but includes Labrador tea, blueberry, and bog cranberry. Herbs are virtually absent. The forest floor is covered with reindeer lichen. Lichen species diversity is high. The age for this ecosite ranges from approximately 80 years old in the study area.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 17 (15, 19)

6 → Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=0):						
A2 (n=5):	1	27%	9.2 m	13.4 cm	Pj10	1938
A3 (n=6):	2	2%	7.2 m	9.0 cm	Pj9 Sb1	1962

Lower Vegetation Layer info:

Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	2	4%	Pinuban10
B2	6	18%	Vaccmyr7 Vaccvit2 Ledugro1
Forb			
Graminoid			
Lichen	20	96%	Cladmit6 Cladunc2 Cladste1
Bryophyte	5	1%	Polypil6 Pholnut2 Polyjun1 Dicrpol1

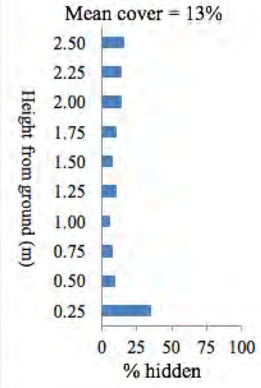
*Only including species that constitute 10% or more by composition.

Figure 6.2-6 Page 2 of the Ecosite Fact Sheets

BS3 **Jack pine/blueberry/lichen: Moderately fresh sand** (n=4)

7 → ***Structural Attributes and Relative Rating***

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.3	Low
	Mean snag diameter (cm)	10.1	
	Mean snag height (m)	0.9	
	Mean snag decay Class	5.0	
Course Woody Debris	Mean frequency of CWD	0.8	Moderate
	Mean CWD diameter (cm)	11.5	
	Mean CWD decay class	3.0	
Mean Percent Ground Cover	Litter Cover	25.5	Moderate
	Litter Depth (cm)	0.9	Moderate
	Bare Soil	1.8	Low
	Bare Rock	0.0	Low
	Open Water	0.0	Low



← 8

9 → ***Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation***

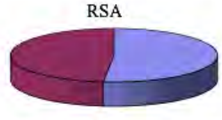
Attribute	Value	Rating
Structural diversity	1.0	Moderate
Species richness	17	Moderate
Unique species	3	Moderate
Provincially listed species	0	Low

Unique species observed:
Pholia moss (*Pholia nutans*), Shingled Cladonia (*Cladonia scabriuscula*), Common bearberry (*Arctostaphylos uva-ursi*)

Provincially listed species observed:
None

10 → ***Ecosite Supply***

Areas occupied by Jack pine /blueberry /lichen forests comprised 3404.3 ha (70.3%) of the LSA and 20678.4 ha (51.6%) of the RSA. It is the most common ecosite in the area.



11 → ***Ecological Interpretation***

BS3 ecosites are relatively dry and occur in almost every topographic position and with every slope class. They are associated with the hills of eskers and drumlins as well as level plains. Following disturbance, these ecosites will usually return to being pine dominated, provided an adequate cone crop existed prior to disturbance. When compared to BS4 ecosites these ecosites tend to be drier, have less understory, and more open canopy. In the absence of disturbance, these ecosites may transition toward the BS7 ecosite condition.

Structural diversity is a measure of the manner in which species are arranged vertically into categories within an ecosystem (Kimmins 1997). Therefore, vegetation structure is based on size and physical features (e.g., trees, tall shrubs, forbs, etc.) rather than taxonomy. Ecosystems that support a high level of diversity of plant species tend to be structurally diverse and productive (Meffe et al. 1997), and these areas in turn support a wide variety and abundance of insect and animal forms. This is especially true for vertebrate wildlife species that require unique and variable reproductive, forage, and cover opportunities or “niches” for survival and reproduction. Areas with high structural diversity also tend to provide greater amounts of hiding cover.

A structural diversity index value was calculated for each sampled ecosite using a Shannon-Wiener coefficient (Shannon 1948). This calculation took into account the number of vegetation layers present in each plot as well as the percent cover of each layer. Due to similarity in height, bryophytes and lichens were considered as one layer. A mean value for each ecosite was calculated. The higher the number of cover and evenness of vegetation layers present, the higher the structural diversity value.

A fundamental principle of conservation biology is to protect sites that support high levels of local species richness (the number of different species present in an area) (Noss 1990; Council on Environmental Quality 1993). Ecosystems that support a high level of diversity of plant species tend to be structurally diverse and productive (Meffe et al. 1997), and these areas in turn support a wide variety and abundance of insect and animal forms.

To estimate and rank the relative plant and lichen species diversity among the different ecosite types in the Project LSA, two species richness measures were used, which were based on plant and lichen species data collected during the field survey. The first measure, species richness of ecosite types, was developed by dividing the total number of plant species found in sampling plots in each ecosite by the number of plots completed per ecosite. A second diversity metric was a count of the number of plant species that were unique to each ecosite type. Both types of measures were rank-ordered by ecosite and rated from Low to High by sorting ecosites from highest to lowest value. The upper 1/3 of the ecosites was given a High value, the middle 1/3 of the ecosites was given Medium value, and the lower 1/3 of the ecosites was given a Low value.

Section [10] (Ecosite Supply) shows the relative proportion of LSA and RSA occupied by the ecosite. Section [11] (Ecological Interpretations) is taken primarily from McLaughlan et al. (2010). It provides a written description of how the site may respond to disturbances such as fire, harvesting, etc. It may also include a predicted successional trajectory of the ecosite.

6.3 Results

The vegetation and wildlife habitat characterization field surveys were completed between 9 and 17 August 2018. Sample site locations were widely distributed throughout the study area (Figure 5.3-1), with a focus on the local study area. A total of 167 species and/or genus of spp. were observed during the survey. In some circumstances, a plant observation could not be identified to species level (e.g., if the head of a sedge species could not be located in the plot and species identification was impossible). In these cases the observation would be counted as an unknown sedge species (*Carex sp*.). A list of all plant and lichen species detected is provided in Appendix A.

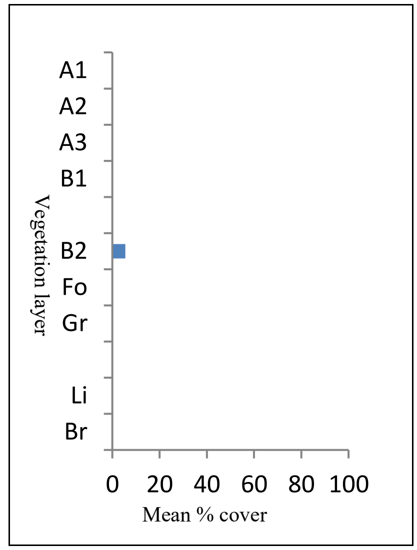
A total of 74 vegetation/wildlife habitat sampling plots were completed in the Project RSA. Two to four sample plot sites were completed in each sampled ecosite. Based on species composition and structural attributes a total of 22 distinct ecosite/regenerating types were identified (Table 6.3-1).

Table 6.3-1 Ecosites Identified in Vegetation Analysis.

Ecosite Code SK2 (SK1)	Ecosite Name
RF4	Recent burn (Age: 1 year)
RF3-Coniferous	Regenerating coniferous forest - low shrub <1 m tall (15-20 years)
RF2-Coniferous	Regenerating coniferous forest - tall shrub 1-5 m tall (20-35 years)
RF2-Deciduous	Regenerating deciduous forest - tall shrub 1-5 m tall (20-35 years)
RF2-Bog	Regenerating bog - tall shrub 1-5 m tall (20-35 years)
RF1-Coniferous	Regenerating coniferous forest - treed >5 m tall (25-40 years)
RF1-Deciduous	Regenerating deciduous forest - treed >5 m tall (25-40 years)
BP2 (BS3)	Jack pine - lichen
BP3 (BS4)	Jack pine / feathermoss
N/A (BS14)	White birch / lingonberry - Labrador tea
BP14 (N/A)	Black spruce / Labrador tea / feathermoss
BP15 (BS16)	Balsam poplar / white spruce / feathermoss
BP19 (BS17)	Black spruce treed bog
BP20 (BS18)	Labrador tea shrubby bog
BP23 (BS21)	Tamarack treed fen
BP24 (BS22)	Leatherleaf (*Chamaedaphne calycaluta*) shrubby poor fen
BP25 (BS23)	Willow (*Salix spp.)* shrubby rich fen
BP26 (BS24)	Graminoid fen
BP27 (BS25)	Open fen
N/A (BS26)	Rush sandy shore
DL1	Disturbed lands - vegetated
DL2	Disturbed lands – non-vegetated

Plot sampling was not conducted for water body (LK), regenerating bog- low shrub (RF3-B), jack pine-spruce / feathermoss (BP12), graminoid bog (BP21) and open bog (BP22), hence no ecosite fact sheets were developed for these types. These ecosites are rare (with the exception of LK) and do not occur in the LSA. As such, no detailed vegetation plots were completed for these types. They were, however, encountered (and confirmed) during pellet group count surveys, allowing for mapping of these types. Land Area (supply) data for these types are included with the total set of ecosite types in Table 5.3-1. Fact sheets for each of the sampled ecosite types are provided below.

RF4 **Recent Burn** (n=4)



Ecosite Description

The RF4 ecosite includes regions that have experienced forest fires within the last 5 years. Tree species are virtually absent and may exist as burnt snags. Blueberry and jack pine are the most common low shrub species. The ground is characterized by a high percentage cover of litter, sand, and CWD (<10cm). Forbs, graminoids, mosses and lichens are virtually absent. The average age of this ecosite is 1 year old.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 4 (2, 6)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=0):						
A2 (n=0):						
A3 (n=0):						

Lower Vegetation Layer info:

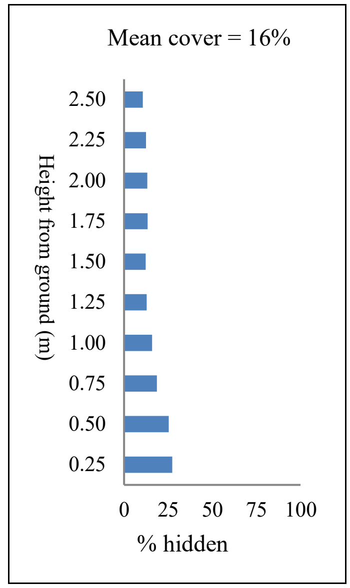
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1			
B2	5	6%	Vaccmyr8 Pinuban1 Alnucri1
Forb	1	<1%	Epilang10
Graminoid	1	<1%	Carecon10
Lichen			
Bryophyte	1	<1%	Polyjun10

*Only including species that constitute 10% or more by composition.

RF4 Recent Burn (n=4)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	3.0	High
	Mean snag diameter (cm)	11.9	
	Mean snag height (m)	9.0	
	Mean snag decay Class	2.0	
Course Woody Debris >10cm	Mean frequency of CWD	0.0	Low
	Mean CWD diameter (cm)		
	Mean CWD decay class		
Mean Percent Ground Cover	Litter Cover	70.5	High
	Litter Depth (cm)	0.7	Low
	Bare Soil	0.0	Low
	Bare Rock	0.0	Low
	CWD <10cm	14.8	High
	Sand	14.8	Moderate
	Open Water	0.0	Low



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

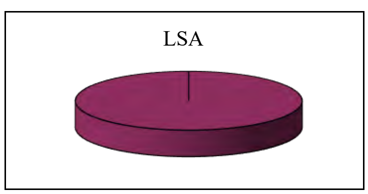
Attribute	Value	Rating
Structural diversity	0.3	Low
Species richness	4	Low
Unique species	2	Low
Provincially listed species	1	Low

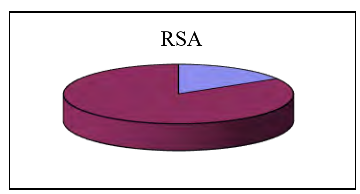
Unique species observed:
Low northern sedge (*Carex concinna*); Billberry willow (*Salix myrtillifolia*)

Provincially listed species observed:
Low northern sedge (*Carex concinna*)

Ecosite Supply

No areas with the RF4 ecosite were located in the LSA, however 6581.9 ha (16.4%) of the RSA were occupied by this ecosite.

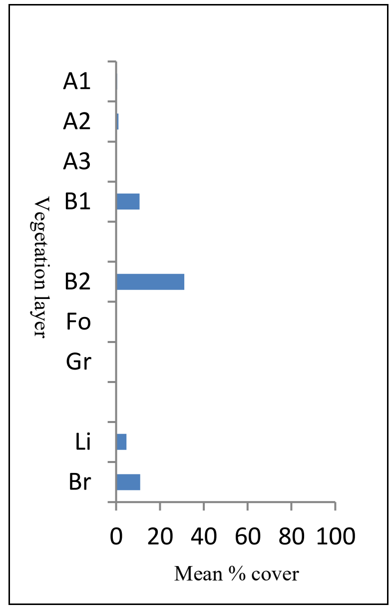




Ecological Interpretation

RF4 ecosites are poor in plant and lichen species diversity. The RF4 ecosite is a pioneer stage following forest fires, and will succeed towards RF3 in absence of fire.

RF3 Regenerating forest – low shrub dominated (n=4)



Ecosite Description

The RF3 regeneration stage is a pioneer stage following forest fires; therefore, it is low shrub dominated. Blueberry and jack pine are the most common low shrub species, though leatherleaf is found in some plots. There are scattered tall shrubs as well, including jack pine and alder. The ground is characterized by a high percentage cover of bare soil and litter. Forbs, graminoids, mosses and lichens are virtually absent. The average age of this stage is 15-20 years in the study area.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 15 (14, 15)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=1):	1	<1%	8.3 m	13.2 cm	Pj10	1983
A2 (n=1):	1	1%	5.1 m	6.3 cm	Pj10	1983
A3 (n=0):						

Lower Vegetation Layer info:

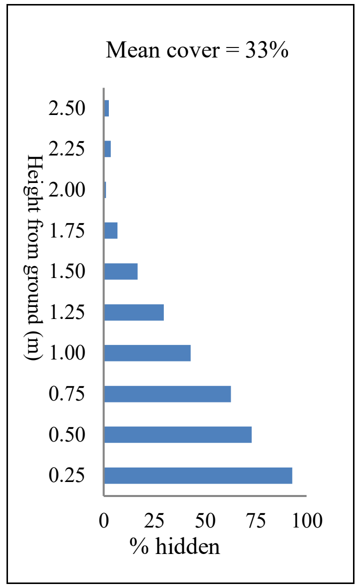
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	4	11%	Pinuban8 Alnucri2
B2	9	31%	Pinuban6 Vaccmyr3 Chamcal1
Forb	4	<1%	Lycocom4 Potetri3 Maiacan2 Melalin1
Graminoid	2	<1%	Oryzpun8 Carefoe2
Lichen	11	5%	Cladsp.7 Cladmit2 Claddef1
Bryophyte	2	11%	Polypil7 Polyjun3

*Only including species that constitute 10% or more by composition.

RF3 Regenerating forest – low shrub dominated (n=4)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.25	Low
	Mean snag diameter (cm)	11.1	
	Mean snag height (m)	3.2	
	Mean snag decay Class	5.0	
Course Woody Debris >10cm	Mean frequency of CWD	0.5	Low
	Mean CWD diameter (cm)	10.5	
	Mean CWD decay class	3.0	
Mean Percent Ground Cover	Litter Cover	71.9	High
	Litter Depth (cm)	0.5	Low
	Bare Soil	7.3	Moderate
	Bare Rock	1.1	Moderate
	CWD <10cm	0.0	Low
	Sand	2.7	Low
	Open Water	0.0	Low



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

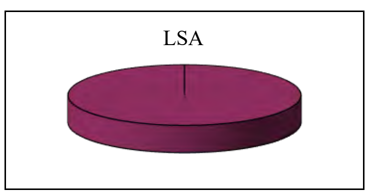
Attribute	Value	Rating
Structural diversity	1.1	Moderate
Species richness	15	Moderate
Unique species	4	Moderate
Provincially listed species	0	Low

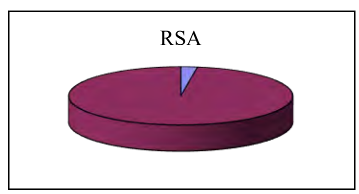
Unique species observed:
Ground cedar (*Lycopodium complanatum*), Three-toothed cinquefoil (*Potentilla tridentate*)
Hay Sedge (*Carex foenea*), Northern rice grass (*Oryzopsis pungens*)

Provincially listed species observed:
None

Ecosite Supply

No areas with the RF3 ecosite were located in the LSA, however 965.3 ha (2.4%) of the RSA were occupied by this ecosite.

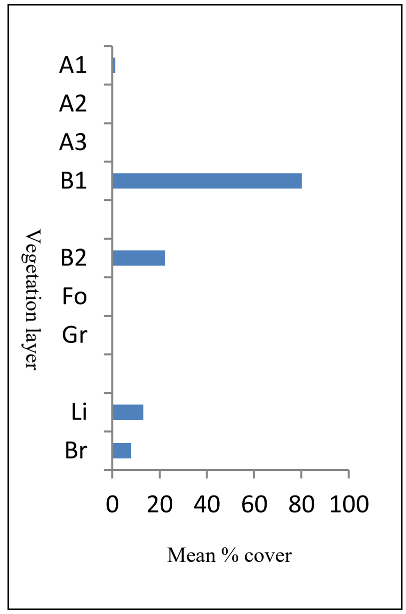




Ecological Interpretation

This ecosite is associated with the hills of eskers and drumlins as well as level plains. RF3 ecosites are moderate in plant and lichen species diversity. The RF3 ecosite is a pioneer stage following forest fires and will succeed towards RF2 in absence of fire.

RF2 - C **Regenerating forest coniferous – tall shrub dominated** (n=4)



Ecosite Description

This regeneration stage is usually dominated by a thick cover of tall jack pine shrubs. Some areas have residual patches of trees within. The low shrub layer is dominated by blueberry. The dominant ground cover is reindeer lichen. The average age of this phase is 20-35 years in the study area.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 18 (11, 22)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=2):	1	1%	10.7 m	15.9 cm	Pj10	1945
A2 (n=0):						
A3 (n=0):						

Lower Vegetation Layer info:

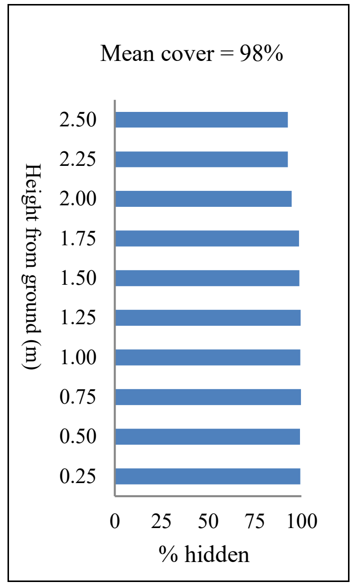
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	4	80%	Pinuban9 Alnucri1
B2	5	22%	Vaccmyr6 Vaccvit2 Pinuban1 Arctuva1
Forb	2	<1%	Corncan9 Maiacan1
Graminoid	1	<1%	Caresp.10
Lichen	15	13%	Cladmit4 Cladgra3 Claddef1 Cladcor1
Bryophyte	5	8%	Pleusch8 Polypil2

*Only including species that constitute 10% or more by composition.

RF2 - C Regenerating forest coniferous– tall shrub dominated (n=4)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.25	Low
	Mean snag diameter (cm)	12.1	
	Mean snag height (m)	2.4	
	Mean snag decay Class	5.0	
Course Woody Debris >10cm	Mean frequency of CWD	1.0	Moderate
	Mean CWD diameter (cm)	11.6	
	Mean CWD decay class	3.75	
Mean Percent Ground Cover	Litter Cover	76.4	High
	Litter Depth (cm)	1.3	Moderate
	Bare Soil	0.0	Low
	Bare Rock	0.0	Low
	CWD <10cm	0.0	Low
	Sand	0.0	Low
	Open Water	0.0	Low



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

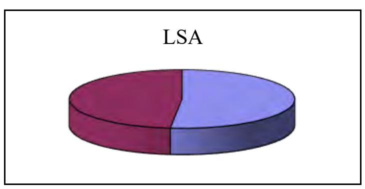
Attribute	Value	Rating
Structural diversity	1.0	Low
Species richness	18	High
Unique species	0	Low
Provincially listed species	0	Low

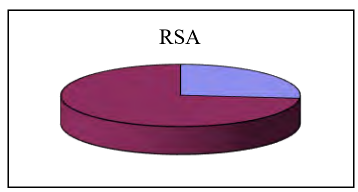
Unique species observed:
None

Provincially listed species observed:
None

Ecosite Supply

Areas occupied by the RF2-C ecosite comprised 2123.6 ha (51.6%) of the LSA and 10636.5 ha (26.6%) of the RSA.

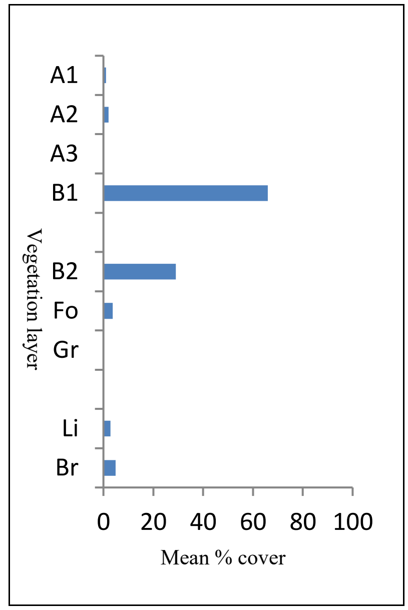




Ecological Interpretation

RF2-Coniferous ecosites are relatively poor in vascular species diversity. However, lichen diversity is relatively high. They closely resemble the RF1 ecosite but are generally younger. This is a commonly encountered ecosite on the Boreal Plain. They are associated with the hills of eskers and drumlins as well as level plains. The RF2 ecosite succeeds the RF3 ecosite, and will continue to succeed towards RF1 in absence of fire.

RF2 - D **Regenerating forest deciduous – tall shrub dominated** (n=3)



Ecosite Description

This regeneration stage is dominated by deciduous tall shrub cover, predominantly white birch. Some areas have residual patches of trees within. The low shrub layer is dominated by blueberry. The ground cover is largely made up of litter and includes several species of lichen and bryophytes. The average age of this phase is 20-35 years in the study area.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 18 (14, 24)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=1):	1	1%	7.6 m	12.9 cm	Pj10	1967
A2 (n=1):	1	2%	6.4 m	6.3 cm	Bw10	1987
A3 (n=0):						

Lower Vegetation Layer info:

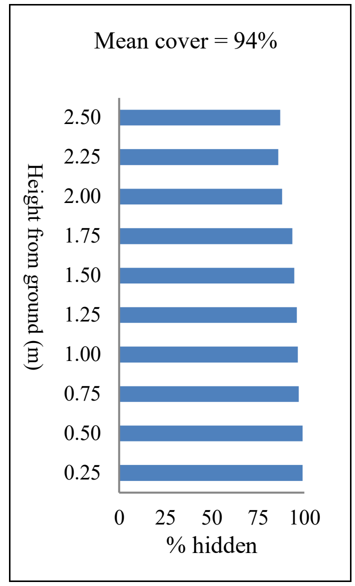
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	7	66%	Betupap6 Alnucri2 Pinuban1
B2	7	30%	Vaccmyr6 Ledugro3 Vaccvit1
Forb	4	4%	Corncan7 Maiacan2 Epilang1
Graminoid			
Lichen	9	3%	Cladgra5 Claddef1 Cladcor1 Cladmit1
Bryophyte	5	5%	Lophven4 Pleusch2 Polypil2 Polyjun1

*Only including species that constitute 10% or more by composition.

RF2 - D Regenerating forest deciduous – tall shrub dominated (n=3)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.0	Low
	Mean snag diameter (cm)		
	Mean snag height (m)		
	Mean snag decay Class		
Course Woody Debris >10cm	Mean frequency of CWD	1.0	Moderate
	Mean CWD diameter (cm)	11.3	
	Mean CWD decay class	4.3	
Mean Percent Ground Cover	Litter Cover	92.0	High
	Litter Depth (cm)	3.9	High
	Bare Soil	0.0	Low
	Bare Rock	0.7	Low
	CWD <10cm	0.0	Low
	Sand	0.0	Low
	Open Water	0.0	Low



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

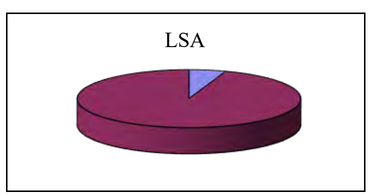
Attribute	Value	Rating
Structural diversity	1.1	Moderate
Species richness	18	High
Unique species	1	Low
Provincially listed species	0	Low

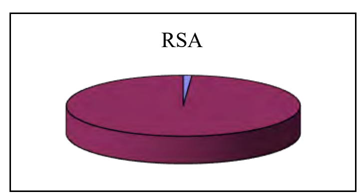
Unique species observed:
Lophozia liverwort (*Lophozia ventricosa*)

Provincially listed species observed:
None

Ecosite Supply

Areas occupied by the RF2-D ecosite comprised 219.0 ha (5.3%) of the LSA and 474.3 ha (1.2%) of the RSA.

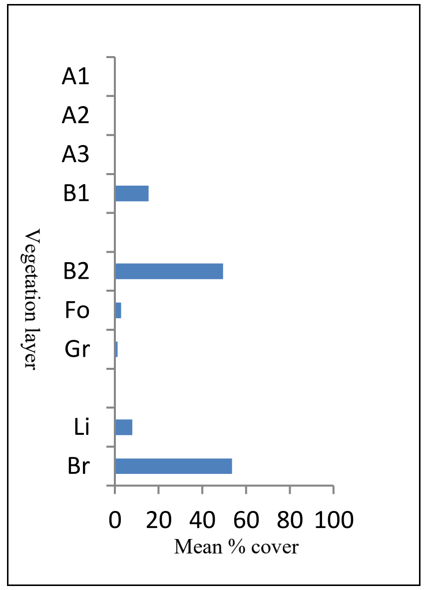




Ecological Interpretation

RF2-Deciduous ecosites are poor to moderate in vascular species diversity. However, lichen diversity is relatively high. They closely resemble the RF1 ecosite but are generally younger. As the case is for RF3, this is a commonly encountered ecosite on the Boreal Shield. They are associated with the hills of eskers and drumlins as well as level plains. The RF2 ecosite succeeds the RF3 ecosite, and will continue to succeed towards RF1 in absence of fire.

RF2 - B **Regenerating forest bog – tall shrub dominated** (n=4)



Ecosite Description

This regeneration stage is usually dominated jack pine and black spruce tall shrubs. The low shrub layer is dominated by Labrador tea. The dominant ground cover is rusty peat moss and litter. The average age of this phase is 20-35 years in the study area.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 24 (17, 27)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=0):						
A2 (n=0):						
A3 (n=0):						

Lower Vegetation Layer info:

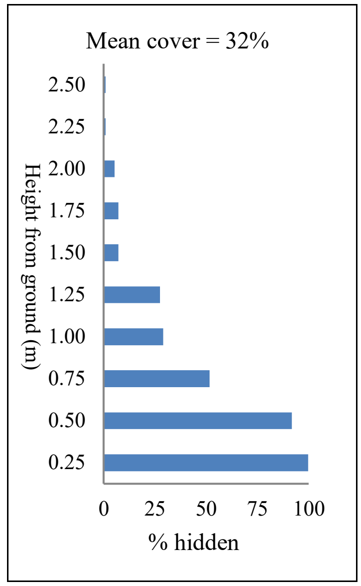
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	4	16%	Pinemar5 Pinuban5
B2	10	50%	Ledugro5 Chamcal1 Oxycmic1 Picemar1 Vaccvit1
Forb	3	3%	Rubucha8 Smiltri2
Graminoid	2	1%	Eriovag10
Lichen	16	8%	Cladmit2 Cladcor1 Claddef1 Cladgra1 Icmaeri1 Parmamb1 Parmhyp1 Peltneo1 Vulppin1
Bryophyte	6	54%	Sphafus8 Sphaang1 Polyjun1

*Only including species that constitute 10% or more by composition.

RF2 - B Regenerating forest bog– tall shrub dominated (n=4)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.0	Low
	Mean snag diameter (cm)		
	Mean snag height (m)		
	Mean snag decay Class		
Course Woody Debris >10cm	Mean frequency of CWD	0.0	Low
	Mean CWD diameter (cm)		
	Mean CWD decay class		
Mean Percent Ground Cover	Litter Cover	35.4	Moderate
	Litter Depth (cm)	0.7	Low
	Bare Soil	2.8	Moderate
	Bare Rock	0.0	Low
	CWD <10cm	0.0	Low
	Sand	0.0	Low
	Open Water	0.0	Low



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

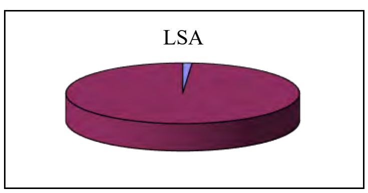
Attribute	**Value**	**Rating**
Structural diversity	1.1	Moderate
Species richness	24	High
Unique species	2	Low
Provincially listed species	1	Low

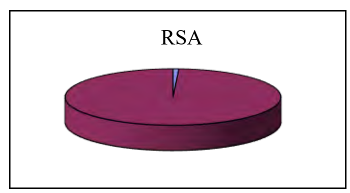
Unique species observed:
Common powderhorn (*Cladonia coniocraea*), Candy lichen (*Icmadophila ericetorum*)

Provincially listed species observed:
None

Ecosite Supply

Areas occupied by the RF2-B ecosite comprised 52.6 ha (1.3%) of the LSA and 343.5 ha (0.9%) of the RSA.

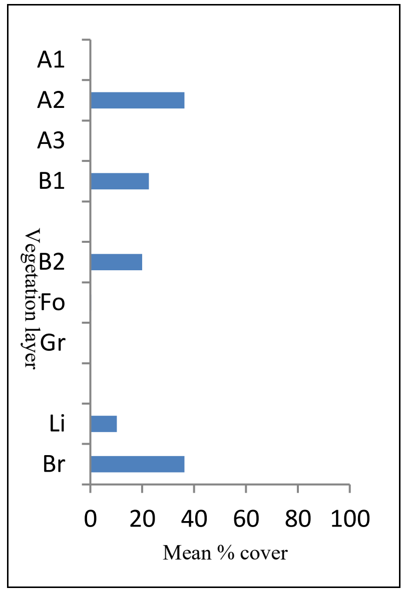




Ecological Interpretation

RF2-Bog ecosites are moderate in vascular species diversity. However, lichen diversity is relatively high. They closely resemble the RF1 ecosite but are generally younger. As the case is for RF3, this is a commonly encountered ecosite on the Boreal Shield. They are associated with the hills of eskers and drumlins as well as level plains. The RF2 ecosite succeeds the RF3 ecosite, and will continue to succeed towards RF1 in absence of fire.

RF1 - C **Regenerating forest coniferous – tree dominated** (n=4)



Ecosite Description

RF1-Coniferous regeneration stage is usually jack pine dominated. Blueberry and bog cranberry shrubs can be found beneath the tree canopy, along with jack pine and the occasional black spruce and Labrador tea. Bryophytes are sporadically distributed and the dominant ground cover is reindeer lichen. This phase is on average 25-40 years old in the study area.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 19 (17, 22)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=0):						
A2 (n=4):	1	36%	6.7 m	6.9 cm	Pj10	1980
A3 (n=0):						

Lower Vegetation Layer info:

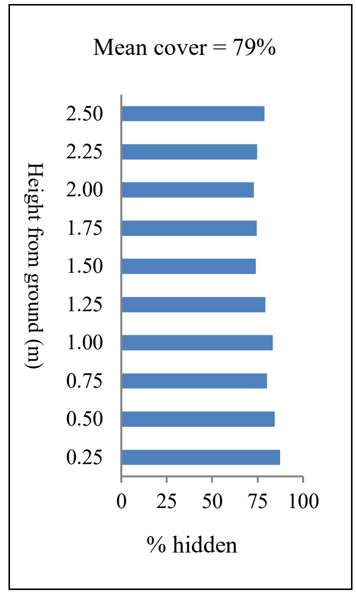
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	3	23%	Pinuban5 Alnucri5
B2	5	20%	Vaccmyr5 Vaccvit3 Ledugro2
Forb	1	<1%	Corncan10
Graminoid			
Lichen	14	10%	Cladmit5 Cladcor1 Cladgra1 Clagunc1 Parmamb1
Bryophyte	6	36%	Pleusch9

*Only including species that constitute 10% or more by composition.

RF1 - C **Regenerating forest coniferous– tree dominated** (n=4)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.0	Low
	Mean snag diameter (cm)		
	Mean snag height (m)		
	Mean snag decay Class		
Course Woody Debris >10cm	Mean frequency of CWD	1.25	High
	Mean CWD diameter (cm)	12.6	
	Mean CWD decay class	4.0	
Mean Percent Ground Cover	Litter Cover	53.8	Moderate
	Litter Depth (cm)	1.8	Moderate
	Bare Soil	0.0	Low
	Bare Rock	0.0	Low
	CWD <10cm	0.0	Low
	Sand	0.0	Low
	Open Water	0.0	Low

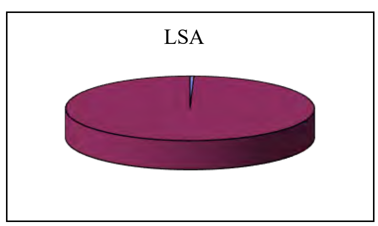


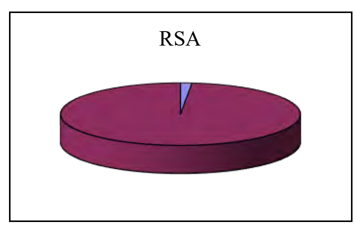
Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

Attribute	Value	Rating
Structural diversity	1.3	Moderate
Species richness	19	High
Unique species	0	Low
Provincially listed species	0	Low
Unique species observed: None		
Provincially listed species observed: None		

Ecosite Supply

Areas occupied by RF1-C comprised 20.6 ha (0.5%) of the LSA and 612.9 ha (1.5%) of the RSA.

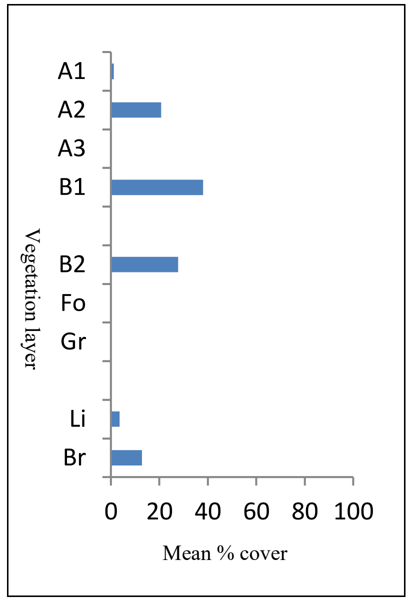




Ecological Interpretation

RF1-Coniferous ecosites have a moderate structural diversity. They have relatively low vascular plant diversity but relatively high lichen species diversity. They closely resemble the RF2 ecosite but RF1 sites have a greater structural diversity and canopy closure. RF1 can be considered to be in a more advanced successional stage than RF2, and will (if wild fires are absent) succeed towards a BP2 over time.

RF1 - D **Regenerating forest deciduous – tree dominated** (n=4)



Ecosite Description

RF1-Deciduous regeneration stage is usually white birch dominated. Alder and Labrador tea shrubs can be found beneath the tree canopy. Bryophytes are sporadically distributed and litter cover is high. This phase is on average 25-40 years old in the study area.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 16 (12, 20)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=4):	3	1%	10.7 m	16.9 cm	Bw6 Sw2 Pj2	1967
A2 (n=7):	3	21%	6.1 m	5.9 cm	Bw8 Pj2	1982
A3 (n=0):						

Lower Vegetation Layer info:

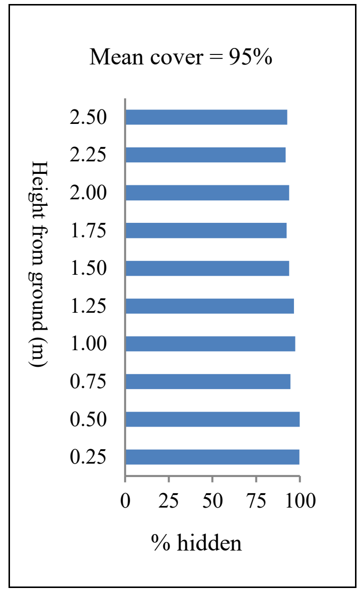
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	5	38%	Betupap4 Alnucri4 Pinuban1
B2	6	28%	Ledugro5 Vaccmyr3 Vaccvit1
Forb	1	<1%	Epilang10
Graminoid			
Lichen	10	4%	Cladgra3 Cladmit2 Cladcor1 Claddef1 Parmhyp1 Vulppin1
Bryophyte	7	13%	Pleusch9 Dicrpol1

*Only including species that constitute 10% or more by composition.

RF1 - D	**Regenerating forest deciduous – tree dominated** (n=4)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.0	Low
	Mean snag diameter (cm)		
	Mean snag height (m)		
	Mean snag decay Class		
Course Woody Debris >10cm	Mean frequency of CWD	0.75	Moderate
	Mean CWD diameter (cm)	11.0	
	Mean CWD decay class	4.0	
Mean Percent Ground Cover	Litter Cover	80.7	High
	Litter Depth (cm)	3.4	High
	Bare Soil	0.0	Low
	Bare Rock	0.0	Low
	CWD <10cm	3.0	Moderate
	Sand	0.0	Low
	Open Water	0.0	Low

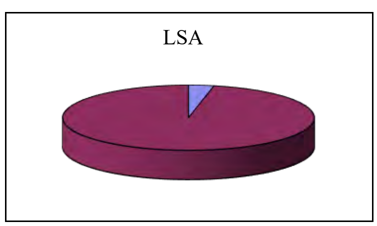


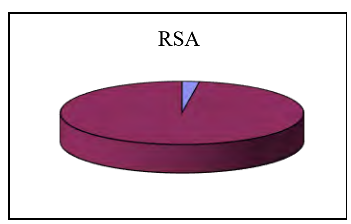
Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

Attribute	**Value**	**Rating**
Structural diversity	1.4	High
Species richness	16	Moderate
Unique species	0	Low
Provincially listed species	0	Low
Unique species observed: None		
Provincially listed species observed: None		

Ecosite Supply

Areas occupied by RF1-D comprised 133.7 ha (3.3%) of the LSA and 919.8 ha (2.3%) of the RSA.

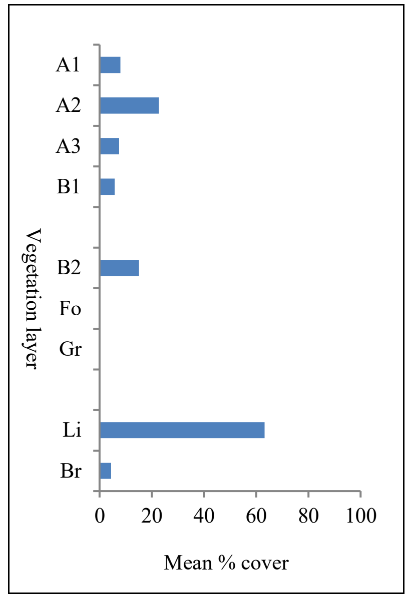




Ecological Interpretation

RF1-D ecosites have a high structural diversity and moderate species richness. They closely resemble the RF2 ecosite but RF1 sites have a greater structural diversity and canopy closure. RF1 can be considered to be in a more advanced successional stage than RF2, and will (if wild fires are absent) succeed towards a BS14 over time.

BP2 **Jack pine/lichen: Moderately fresh sand** (n=4)



Ecosite Description

BP2 ecosites have a characteristically pure canopy of jack pine, a scattered ericaceous shrub understory, a near-continuous carpet of green reindeer and other lichens, and a significant cover of needle litter. The average age of this ecosite is 60 years in the study area. Similar to BS3 jack pine/blueberry/lichen ecosite in the Boreal Shield.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 21 (17, 24)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=4):	2	8%	12.0 m	14.5 cm	Pj10	1950
A2 (n=5):	2	23%	8.7 m	9.5 cm	Pj10	1957
A3 (n=3):	1	8%	5.8 m	6.7 cm	Pj10	1952

Lower Vegetation Layer info:

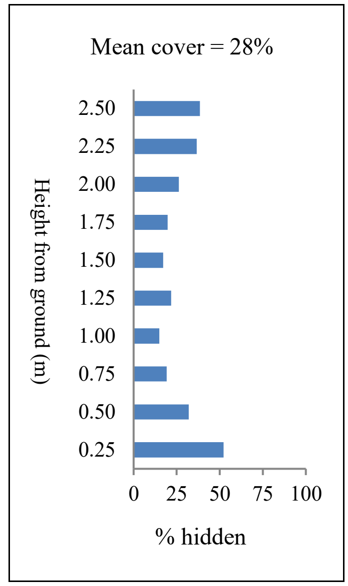
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	5	6%	Alnucri5 Pinuban3 Picemar1
B2	4	15%	Vaccvit5 Vaccmyr4 Arctuva1
Forb			
Graminoid			
Lichen	21	63%	Cladmit7 Cladunc1 Cladgra1
Bryophyte	5	4%	Pleusch7 Dicrpol2 Ptilcil1

*Only including species that constitute 10% or more by composition.

BP2 Jack pine/lichen: Moderately fresh sand (n=4)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.25	Low
	Mean snag diameter (cm)	10.4	
	Mean snag height (m)	4.2	
	Mean snag decay Class	2.0	
Course Woody Debris >10cm	Mean frequency of CWD	0.25	Low
	Mean CWD diameter (cm)	11.0	
	Mean CWD decay class	2.0	
Mean Percent Ground Cover	Litter Cover	30.9	Moderate
	Litter Depth (cm)	0.8	Moderate
	Bare Soil	0.0	Low
	Bare Rock	0.2	Low
	CWD <10cm	0.0	Low
	Sand	0.4	Low
	Open Water	0.0	Low



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

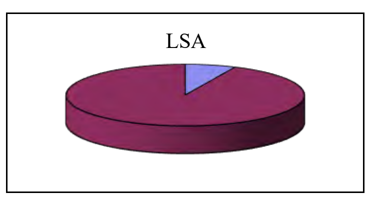
Attribute	**Value**	**Rating**
Structural diversity	1.4	High
Species richness	21	High
Unique species	4	Moderate
Provincially listed species	0	Low

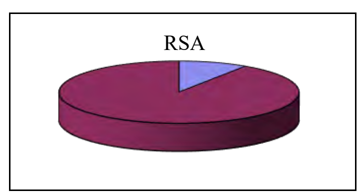
Unique species observed:
Concentric ring lichen (*Arctoparmelia centrifuga*), Apple Pelt (*Peltigera malacea*), Green Map Lichen (*Rhizocarpon geographicum*), Wolly foam lichen (*Stereocaulon tomentosum*)

Provincially listed species observed:
None

Ecosite Supply

Areas occupied by Jack pine /lichen forests comprised 282.3 ha (6.9%) of the LSA and 3729.2 ha (9.3%) of the RSA. It is the most common ecosite in the area.

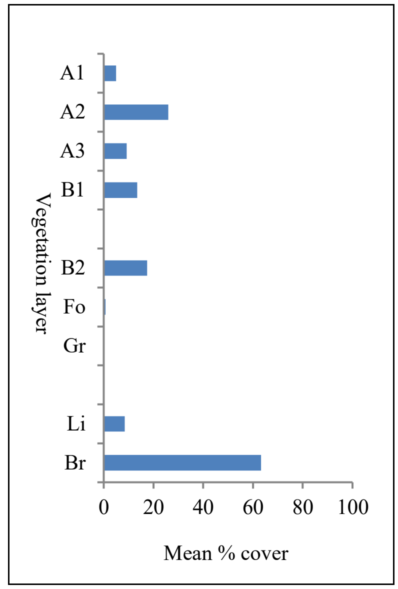




Ecological Interpretation

BP2 ecosites have the lowest species richness and lowest tree productivity (as measured by site index) of all the jack pine or conifer ecosites in the Boreal Plain ecozone. Following disturbance, these ecosites will usually return to their former condition. In the absence of disturbance, these ecosites may still resemble their former species composition but the canopy closure will likely decrease and shrub species may become more prominent.

BP3 **Jack pine/feathermoss: Moderately fresh loamy sand** (n=4)



Ecosite Description

BP3 ecosites are dominated by a relatively consistent canopy of jack pine. Approximately 75% of the sites encountered are pure jack pine. The remainder may have up to 10% inclusion of trembling aspen, however spruce is also possible. The understory of BP3 ecosite consists mainly of ericaceous shrubs and green alder. The forest floor is predominantly feathermoss (Schreber's moss). The age of this ecosite is approximately 70 years old. Similar to BS4 jack pine/ black spruce/ feathermoss ecosite in the Boreal Shield.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 18 (14, 21)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=5):	2	5%	13.3 m	15.9 cm	Pj9 Sb1	1941
A2 (n=6):	2	26%	9.7 m	11.0 cm	Pj9 Sb1	1950
A3 (n=5):	3	9%	8.5 m	9.1 cm	Pj4 Sb3 Bw3	1941

Lower Vegetation Layer info:

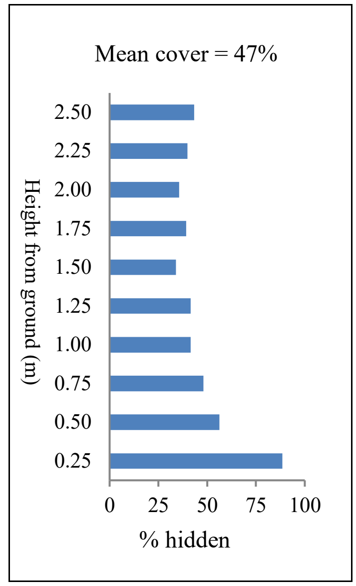
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	3	14%	Alnucri8 Betupap2
B2	5	17%	Vaccmyr5 Vaccvit5
Forb	2	<1%	Geocliv10
Graminoid			
Lichen	11	9%	Cladmit5 Cladgra2 Claddef1 Cladcor1
Bryophyte	8	63%	Pleusch9

*Only including species that constitute 10% or more by composition.

BP3 Jack pine/feathermoss: Moderately fresh loamy sand (n=4)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	1.5	Moderate
	Mean snag diameter (cm)	13.3	
	Mean snag height (m)	7.2	
	Mean snag decay Class	4.3	
Course Woody Debris >10cm	Mean frequency of CWD	0.25	Low
	Mean CWD diameter (cm)	10.0	
	Mean CWD decay class	1.0	
Mean Percent Ground Cover	Litter Cover	28.2	Moderate
	Litter Depth (cm)	0.7	Low
	Bare Soil	0.0	Low
	Bare Rock	0.0	Low
	CWD <10cm	0.0	Low
	Sand	0.0	Low
	Open Water	0.0	Low



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

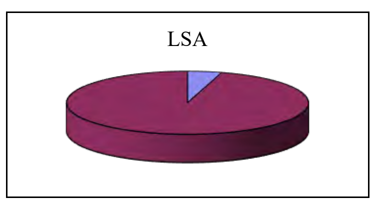
Attribute	Value	Rating
Structural diversity	1.5	High
Species richness	18	High
Unique species	2	Low
Provincially listed species	0	Low

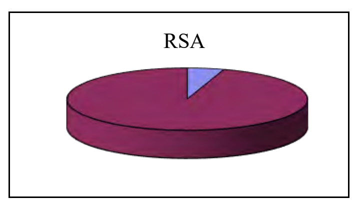
Unique species observed:
Naugehyde liverwort (*Ptilidium pulcherrimum*), Greater sulphur-cup (*Cladonia sulfurina*)

Provincially listed species observed:
None

Ecosite Supply

Areas occupied by jack pine/feathermoss comprised 187.8 ha (4.6%) of the LSA and 1972.4 ha (4.9%) of the RSA.

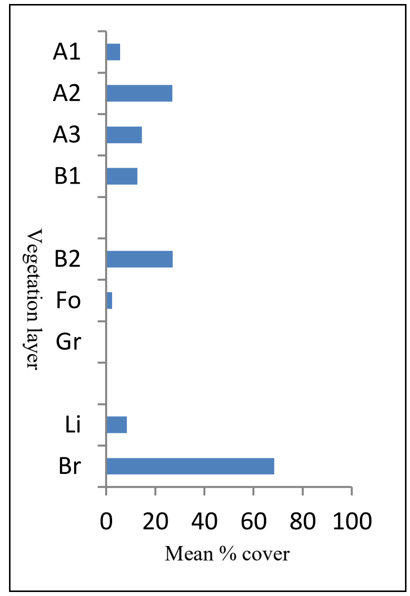




Ecological Interpretation

BP3 ecosites have high structural diversity. They have relatively low vascular plant richness but relatively high non-vascular species richness. They may occasionally have trembling aspen present but not to the extent seen in BP4. Following disturbance, these sites may more closely resemble the composition of BP4 or even BP5. In the absence of disturbance, stand openings will likely become more common and shrub layer development may become more pronounced but the ecosite will likely remain the same.

BP14 **Black spruce/Labrador tea/feathermoss: Very moist sandy clay loam** (n=4)



Ecosite Description

BP14 ecosite canopies are predominantly black spruce but may contain jack pine, white spruce, or trembling aspen. Over 80% of the sites will be conifer. The understory is generally limited to ericaceous shrubs but low-bush cranberry and green alder may occasionally be found. While a great variety of herbs is associated with this ecosite, only a few species occur with constancy. The forest floor generally has a continuous carpet of feathermoss mixed with abundant needle and leaf litter. While moist mineral soils are associated with this ecosite, the occurrence of an organic soil is possible, but not common. The average age of this ecosite in the study area is 90 years. Similar to BS9 black spruce/ jack pine/ feathermoss in the Boreal Shield.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 17 (14, 20)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=4):	2	6%	14.6 m	20.5 cm	Sb8 Pj2	1920
A2 (n=5):	2	27%	9.8 m	11.4 cm	Sb9 Pj1	1927
A3 (n=9):	3	15%	6.3 m	6.7 cm	Sb8 Bw2	1964

Lower Vegetation Layer info:

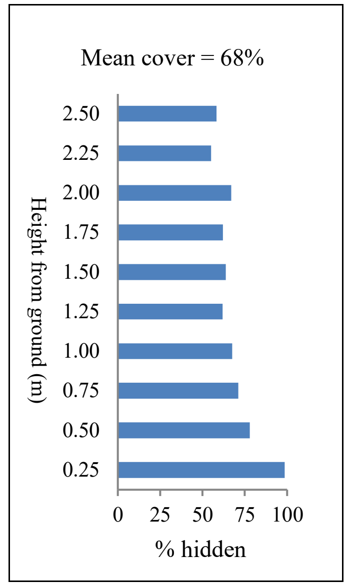
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	5	13%	Picemar4 Betupap2 Alnurug2 Alnucri1 Saliser1
B2	5	27%	Ledugro6 Vaccvit3
Forb	6	3%	Corncan6 Equisyl2 Geocliv1
Graminoid			
Lichen	12	8%	Cladste6 Cladmit2 Peltneo1
Bryophyte	4	69%	Pleusch9

*Only including species that constitute 10% or more by composition.

BP14 Black spruce/Labrador tea/feathermoss: Very moist sandy clay loam (n=4)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	5.0	High
	Mean snag diameter (cm)	14.4	
	Mean snag height (m)	8.0	
	Mean snag decay Class	3.7	
Course Woody Debris >10cm	Mean frequency of CWD	0.5	Low
	Mean CWD diameter (cm)	12.5	
	Mean CWD decay class	4.0	
Mean Percent Ground Cover	Litter Cover	20.7	Moderate
	Litter Depth (cm)	0.6	Low
	Bare Soil	0.0	Low
	Bare Rock	0.0	Low
	CWD <10cm	0.0	Low
	Sand	0.0	Low
	Open Water	0.0	Low

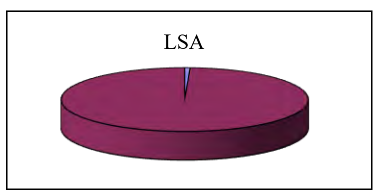


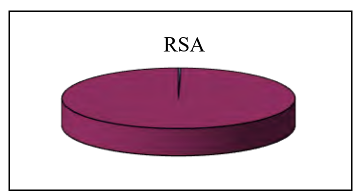
Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

Attribute	Value	Rating
Structural diversity	1.5	High
Species richness	17	Moderate
Unique species	1	Low
Provincially listed species	0	Low
Unique species observed: Stiff clubmoss (*Lycopodium annotinum*)		
Provincially listed species observed: None		

Ecosite Supply

Areas occupied by black spruce/ Labrador tea/ feathermoss forests comprised 28.8 ha (0.7%) of the LSA and 132.2 ha (0.3%) of the RSA.

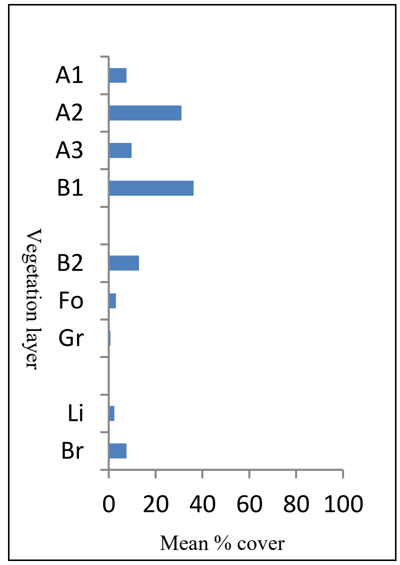




Ecological Interpretation

BP14 ecosites have a high structural diversity and a moderate species richness. They tend to be rather moist. It is not unusual to find them adjacent to treed bogs (BP19). Following disturbance, these sites may retain their pre-disturbance tree composition provided they were in a pure conifer condition or they may move toward a BP19 ecosite condition if the site's moisture regime was affected. For BP14 ecosites with a hardwood component they may exhibit similarities to the BP6 or BP7 ecosites if the aspen component was high; however, the moisture regime may lessen the likelihood of this shift. In the absence of disturbance, the BP14 ecosite may not change dramatically in condition or composition, though the jack pine component will eventually decrease.

BS14 **White birch/lingonberry/Labrador tea: Moderately dry sand** (n=4)



Ecosite Description

BS14 ecosites are readily recognized by the pure or nearly pure white birch canopy. This ecosite may also contain black spruce, white spruce, jack pine, or trembling aspen in the canopy but always with white birch as the leading and dominant species. The understory of BS14 ecosites is mostly ericaceous shrubs and scattered green alder and sometimes willow, rose, or pin cherry. A moderate herbaceous layer can usually be observed in combination with patches of Schreber's moss and scattered lichens. The abundance of birch contributes considerably to the high leaf litter cover in the ground. The average age of this ecosite type is 50 years in the study area. Similar to BP11 white birch/white spruce/ balsam fir ecosite in the Boreal Plain.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 17 (15, 20)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=4):	2	8%	11.1 m	14.8 cm	Bw8 Sb2	1944
A2 (n=10):	5	31%	8.1 m	8.6 cm	Bw8 Sb2	1969
A3 (n=5):	4	10%	7.0 m	6.4 cm	Bw4 Salisco4 Sb1 Alnurug1	1978

Lower Vegetation Layer info:

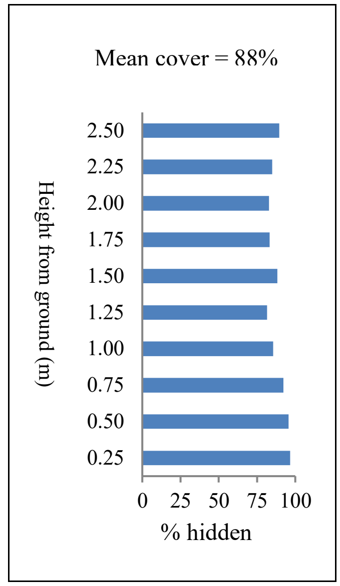
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	7	36%	Alnurug3 Betupap2 Salisco2 Picemar1 Saliser1
B2	6	13%	Ledugro7 Picemar1 Vaccvit1
Forb	8	3%	Corncan3 Equisyl3 Geocliv1 Pyrosec1 Rubupub1
Graminoid	3	<1%	Careros6 Calacan3
Lichen	6	2%	Peltaph4 Cladgra4 Claddef1 Cladcor1
Bryophyte	7	8%	Pleusch4 Hylospl3 Tomenit2 Ptilcil1

*Only including species that constitute 10% or more by composition.

BS14 White birch/lingonberry/Labrador tea: Moderately dry sand (n=4)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.75	Low
	Mean snag diameter (cm)	12.3	
	Mean snag height (m)	5.9	
	Mean snag decay Class	4.0	
Course Woody Debris >10cm	Mean frequency of CWD	0.25	Low
	Mean CWD diameter (cm)	13.0	
	Mean CWD decay class	6.0	
Mean Percent Ground Cover	Litter Cover	90.5	High
	Litter Depth (cm)	3.7	High
	Bare Soil	0.0	Low
	Bare Rock	0.0	Low
	CWD <10cm	0.0	Low
	Sand	0.0	Low
	Open Water	0.0	Low



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

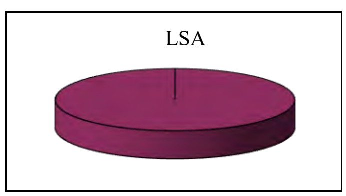
Attribute	Value	Rating
Structural diversity	1.7	High
Species richness	17	Moderate
Unique species	5	Moderate
Provincially listed species	0	Low

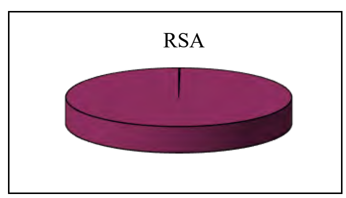
Unique species observed:
Golden moss (*Tomenthypnum nitens*), Wild sarsaparilla (*Aralia nudicaulis*), One-sided pyrola (*Pyrola secunda*), Beaked sedge (*Carex rostrate*), Common freckle pelt (*Peltigera aphthosa*)

Provincially listed species observed:
None

Ecosite Supply

Areas occupied by BS14 comprised 0.8 ha (0.02%) of the LSA and 74.6 ha (0.2%) of the RSA.

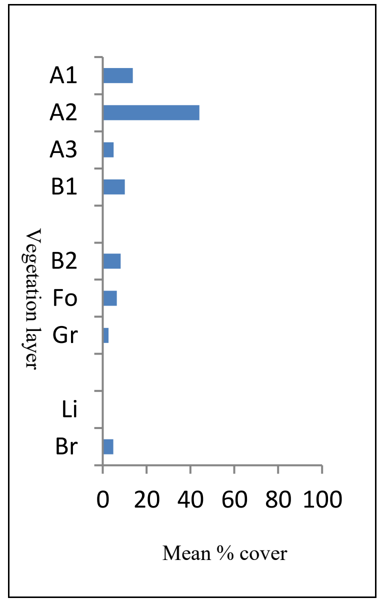




Ecological Interpretation

BS14 ecosites have high structural diversity and a high richness of plant and tree species. These ecosites usually consist of a closed canopy of white birch on rapidly drained soils. In the absence of disturbance this ecosite may transition towards the BS10 ecosite condition. Following disturbance this ecosite may return to its former composition.

BP15 **Balsam poplar/white spruce/feathermoss: Very moist silty loam** (n=4)



Ecosite Description

BP15 ecosites generally have a canopy that has balsam poplar leading in combination with white and/or black spruce. Trembling aspen, white birch, and/or balsam fir may occasionally also occur in the canopy. Both the shrub and herb layers tend to be diverse and a conspicuous layer of feathermosses is apparent above the layer of leaf litter. The average age of this ecosite is 30 years old. Similar to BS16 black spruce/ balsam poplar river alder swamp ecosite in the Boreal Shield.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 12 (9, 14)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=5):	3	14%	9.8 m	12.8 cm	Pb9 Bw1	1989
A2 (n=8):	6	44%	7.7 m	8.2 cm	Alnurug4 Bw3 Alnucri2 Salisco1	1986
A3 (n=1):	1	5%	5.8 m	4.8 cm	Bw10	1997

Lower Vegetation Layer info:

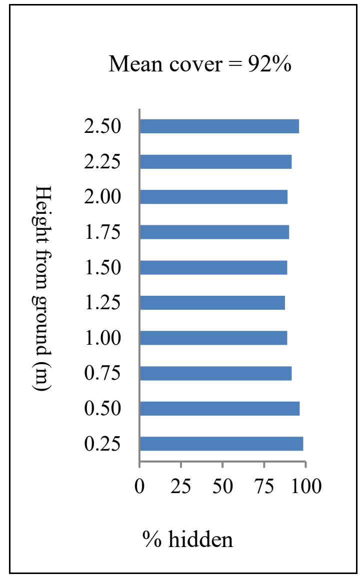
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	9	10%	Salisco7 Alnurug1 Betupap1 Saliser1
B2	10	8%	Ribeoxy6 Ribehud2 Picemar1 Ledugro1
Forb	10	6%	Athyfil4 Corncan3 Galitri1
Graminoid	1	3%	Calacan10
Lichen			
Bryophyte	7	5%	Plagell3 Scorrev2 Drepadu2 Cincsty1 Hypnrev1

*Only including species that constitute 10% or more by composition.

BP15 **Balsam poplar/white spruce/feathermoss: Very moist silty loam** (n=4)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.5	Low
	Mean snag diameter (cm)	17.5	
	Mean snag height (m)	9.5	
	Mean snag decay Class	4.0	
Course Woody Debris >10cm	Mean frequency of CWD	1.5	High
	Mean CWD diameter (cm)	12.8	
	Mean CWD decay class	6.0	
Mean Percent Ground Cover	Litter Cover	88.4	High
	Litter Depth (cm)	6.5	High
	Bare Soil	0.0	Low
	Bare Rock	2.0	Moderate
	CWD <10cm	0.0	Low
	Sand	0.0	Low
	Open Water	4.9	Moderate



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

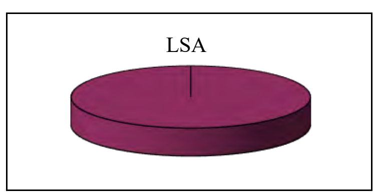
Attribute	**Value**	**Rating**
Structural diversity	1.7	High
Species richness	12	Low
Unique species	16	High
Provincially listed species	1	Low

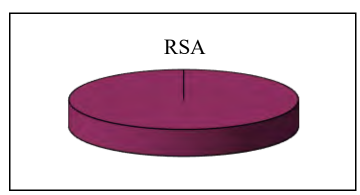
Unique species observed: Lurid cupola moss (*Cinclidium stygium*), Drepanocladus moss (*Drepanocladus aduncus*), Revolute hypnum moss (*Hypnum revolutum*), Elliptic plagiomnium moss (Plagiomnium ellipticum), Sickle-leaved Hook Moss (*Sanionia uncinate*), Limprichtia Moss (*Scorpidium revolvens*), Subarctic ladyfern (*Athyrium filix-femina ssp. angustatum*), Woodland strawberry (*Fragaria vesca*), Wild strawberry (*Fragaria virginiana*), Marsh skullcap (*Scutellaria galericulata*), Kidney-leaved violet (*Viola renifolia*), Balsam poplar (*Populus balsamifera*), Skunk currant (*Ribes glandulosum*), Northern black currant (*Ribes hudsonianum*), Wild gooseberry (*Ribes oxyacanthoides*), Raspberry (*Rubus idaeus*)

Provincially listed species observed:
Subarctic ladyfern (*Athyrium filix-femina ssp. angustatum*)

Ecosite Supply

Areas occupied by balsam poplar/ white spruce/ feathermoss ecosite comprised 0.6 ha (<0.1%) of the LSA, and 33.2 ha (0.1%) of the RSA.

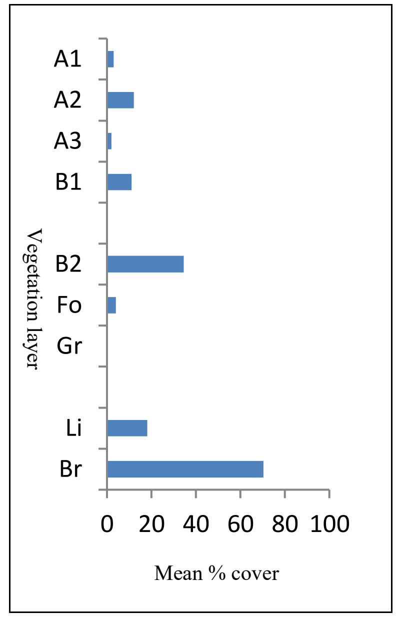




Ecological Interpretation

This ecosite has a consistently high diversity of shrub and herb species and will also support a wide variety of tree species. Richness of graminoid and lichen species is generally low. Following disturbance, these ecosites may return to their former condition though they may also resemble BP6 or BP7 if their previous stand condition had sufficient aspen. In the absence of disturbance, these ecosites may more closely resemble BP9 or BP13 as succession unfolds.

BP19 Black spruce treed bog: Moderately wet fibric organic (n=4)



Ecosite Description

BP19 ecosites consistently have a somewhat open canopy of all-aged black spruce. Tamarack also occurs on about half of the sites but with relatively little cover. The understory is largely ericaceous shrub (mostly Labrador tea) and the ground cover is represented by an even distribution of *Sphagnum* moss interspersed with the occasional stair-step moss. The average age of this ecosite in the study area is 80 years. Synonymous to BS17 black spruce treed bog ecosite in the Boreal Shield.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 21 (18, 24)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=3):	1	3%	9.5 m	11.4 cm	Sb10	1881
A2 (n=4):	1	12%	6.6 m	9.3 cm	Sb10	1936
A3 (n=1):	1	2%	5.8 m	6.1 cm	Sb10	1936

Lower Vegetation Layer info:

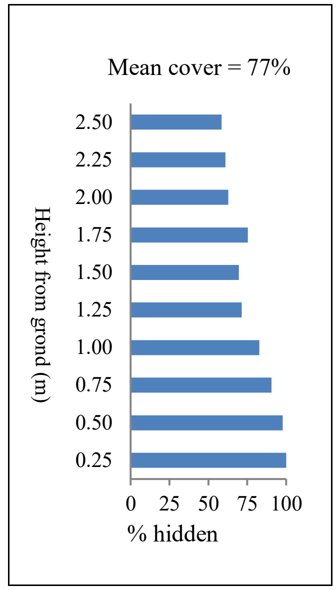
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	2	11%	Picemar10
B2	7	35%	Ledugro6 Chamcal2 Picemar1 Vaccvit1
Forb	3	4%	Rubucha8 Drosrot1 Smiltri1
Graminoid	1	<1%	Eriovag10
Lichen	12	18%	Cladmit7 Cladran2
Bryophyte	12	70%	Sphafus6 Pleusch2 Sphaang1 Sphacap1

*Only including species that constitute 10% or more by composition.

BP19 Black spruce treed bog: Moderately wet fibric organic (n=4)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.0	Low
	Mean snag diameter (cm)		
	Mean snag height (m)		
	Mean snag decay Class		
Course Woody Debris >10cm	Mean frequency of CWD	0.0	Low
	Mean CWD diameter (cm)		
	Mean CWD decay class		
Mean Percent Ground Cover	Litter Cover	11.9	Low
	Litter Depth (cm)	0.6	Low
	Bare Soil	0.0	Low
	Bare Rock	0.0	Low
	CWD <10cm	0.0	Low
	Sand	0.0	Low
	Open Water	0.0	Low



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

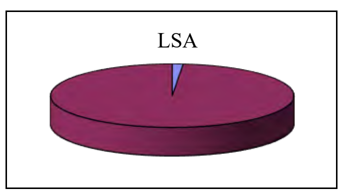
Attribute	**Value**	**Rating**
Structural diversity	1.3	Moderate
Species richness	21	High
Unique species	1	Low
Provincially listed species	1	Low

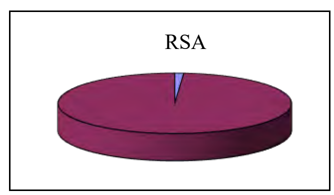
Unique species observed:
Jensen's sphagnum (*Sphagnum jensenii*)

Provincially listed species observed:
None

Ecosite Supply

Areas occupied by black spruce treed bog comprised 59.4 ha (1.4%) of the LSA and 499.1 ha (1.2%) of the RSA.

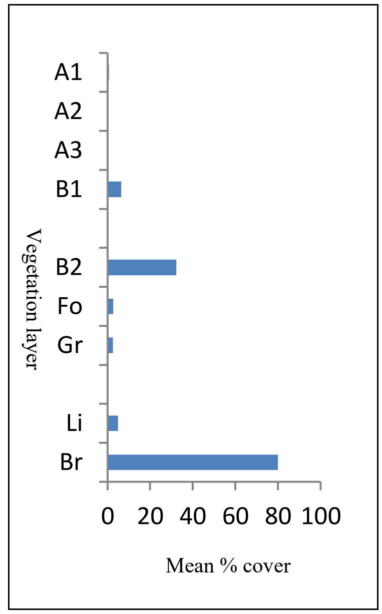




Ecological Interpretation

BP19 ecosites have low tree and shrub species richness, but often contain a high diversity of moss and lichen species. Overall structural diversity is moderate. The black spruce on these sites usually represents all ages as the *Sphagnum* moss on the site encourages vegetative reproduction by branch layering. *Sphagnum* is also a suitable seed bed for spruce germination provided that the moss isn't Girgensohn's or another fast-growing peat moss which can outcompete and smother black spruce germinants. Despite the wet conditions, black spruce can remain free from rot for long periods. In the absence of disturbance these sites will likely remain as a treed bog. Following disturbance these sites may more closely resemble BP20 or BP22.

BP20 **Labrador tea shrubby bog: Wet fibric organic** (n=3)



Ecosite Description

BP20 is dominated by ericaceous shrubs, notably leatherleaf and Labrador tea. Occasionally black spruce and/or tamarack may occur in tree form (i.e., >2 m) but the cover is usually low (i.e., <10%). Aside from the expected absence of trees, shrubby bogs tend to have a greater proportion of Sphagnum moss than would be found on treed bogs (BP19). Synonymous with BS18 Labrador tea shrubby bog ecosite in the Boreal Shield.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 19 (16, 21)

Tree Vegetation Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=2):	1	<1%	5.4 m	7.5 cm	Sb10	1963
A2 (n=0):						
A3 (n=0):						

Lower Layer info:

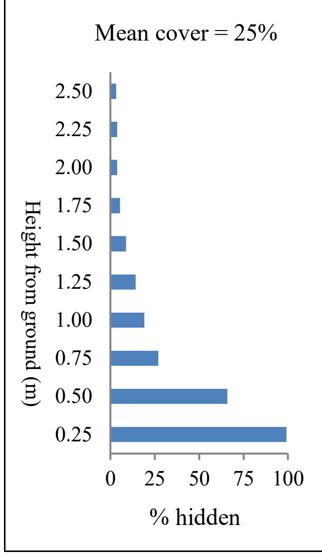
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	3	6%	Picemar9
B2	8	32%	Picemar3 Ledugro3 Oxycmic1 Rhodtom1 Kalmpol1 Chamcal1
Forb	3	3%	Smiltri8 Drosrot2
Graminoid	2	3%	Eriovag6 Eriosch4
Lichen	10	5%	Cladmit6 Cladgra2
Bryophyte	7	80%	Sphafus9

*Only including species that constitute 10% or more by composition.

BP20 **Labrador tea shrubby bog: Wet fibric organic** (n=3)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.0	Low
	Mean snag diameter (cm)		
	Mean snag height (m)		
	Mean snag decay Class		
Course Woody Debris >10cm	Mean frequency of CWD	0.0	Low
	Mean CWD diameter (cm)		
	Mean CWD decay class		
Mean Percent Ground Cover	Litter Cover	15.1	Low
	Litter Depth (cm)	0.7	Low
	Bare Soil	0.0	Low
	Bare Rock	0.0	Low
	CWD <10cm	0.0	Low
	Sand	0.0	Low
	Open Water	0.0	Low



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

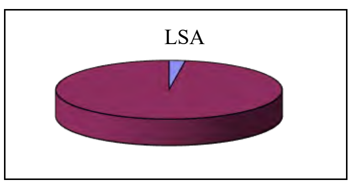
Attribute	Value	Rating
Structural diversity	1.0	Low
Species richness	19	High
Unique species	2	Low
Provincially listed species	1	Moderate

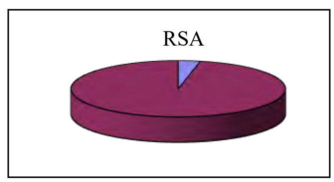
Unique species observed:
Split-peg lichen (*Cladonia cariosa*), Dwarf raspberry (*Rubus acaulis*)

Provincially listed species observed:
White cotton grass (*Eriophorum scheuchzeri*)

Ecosite Supply

Areas occupied by Labrador tea shrubby bog comprised 95.6 ha (2.3%) of the LSA and 1321.2 ha (3.3%) of the RSA.

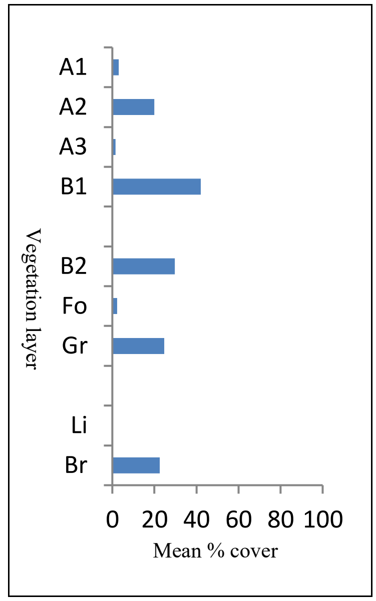




Ecological Interpretation

Shrubby bogs are relatively common in the Boreal Plain ecozone but less so than in other ecozones. They possess a low structural diversity but contain high shrub and moss species richness. Being wetter than treed bogs, they tend to be associated with Fibrisol and Mesisol organic soils orders. Like the other forms of bogs, most of the moisture they receive is the result of precipitation. Shrubby bogs, unlike treed bogs, are more likely to be found on level sites. Since the water table associated with shrubby bogs is usually below the site surface, they are also susceptible to disturbance from fire. Fires with a long enough duration or intensity may kill shrub species and the bog may transition into an open (BP22) or graminoid dominated (BP21) condition.

BP23 Tamarack treed fen: Wet fibric organic (n=2)



Ecosite Description

BP23 ecosite has tamarack as the dominant tree species, though black spruce may also occur. Many of the shrub and herb species encountered in fens are commonly associated with wet conditions. It is not uncommon for treed fens to have a water table at or near the surface. Treed fens are usually associated with an organic substrate but mineral soil substrates may also be encountered. Synonymous with BS21 tamarack treed fen ecosite in the Boreal Shield.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 15 (11, 18)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=1):	1	3%	11.0 m	11.2 cm	Lt10	1966
A2 (n=2):	1	20%	7.0 m	6.8 cm	Lt10	1974
A3 (n=2):	2	2%	6.0 m	6.4 cm	Sb7 Bw3	1980

Lower Vegetation Layer info:

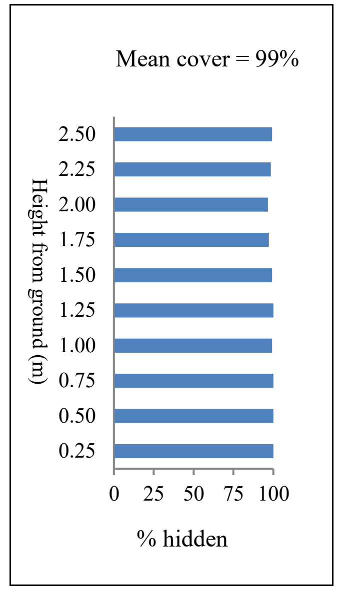
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	7	42%	Saliser5 Larilar2 Salisp.1
B2	7	30%	Chamcal9 Vaccvit1
Forb	3	2%	Potepal7 Smiltri2 Rubupub1
Graminoid	2	25%	Calacan6 Careaqu4
Lichen			
Bryophyte	5	23%	Sphaang9 Meeslon1

*Only including species that constitute 10% or more by composition.

BP23 **Tamarack treed fen: Wet fibric organic** (n=2)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.0	Low
	Mean snag diameter (cm)		
	Mean snag height (m)		
	Mean snag decay Class		
Course Woody Debris >10cm	Mean frequency of CWD	0.0	Low
	Mean CWD diameter (cm)		
	Mean CWD decay class		
Mean Percent Ground Cover	Litter Cover	63.4	Moderate
	Litter Depth (cm)	4.4	High
	Bare Soil	0.0	Low
	Bare Rock	0.0	Low
	CWD <10cm	0.0	Low
	Sand	0.0	Low
	Open Water	7.0	Moderate



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

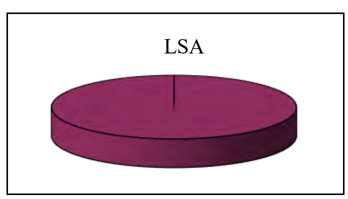
Attribute	**Value**	**Rating**
Structural diversity	1.7	High
Species richness	15	Moderate
Unique species	0	Low
Provincially listed species	0	Low

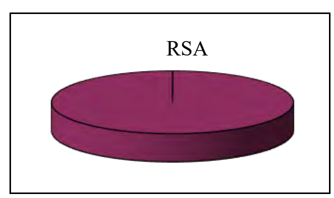
Unique species observed:
None

Provincially listed species observed:
None

Ecosite Supply

Areas occupied by Tamarack treed fen comprised <0.1% of the LSA and 21.1 ha (0.1%) of the RSA.

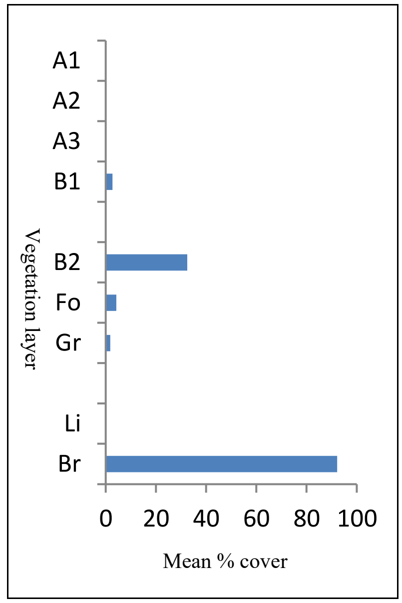




Ecological Interpretation

BP23 ecosites have high structural diversity and moderate species richness. They are typically not as common as black spruce treed bogs (BP19). They tend to occur in association with shrubby fens (BP24) and resemble ribbons in the landscape along drainage ways. Following disturbance, these ecosites could be expected to become a shrubby fen (BS22). In the absence of disturbance these ecosites will likely remain in their current condition.

BP24	**Leatherleaf shrubby poor fen: Wet fibric organic** (n=3)



Ecosite Description

Leatherleaf, dwarf birch, and dwarf bog-rosemary are the dominant shrub species on this ecosite. Scattered tamarack or black spruce may also occur. Many of the shrub and herb species encountered in fens are commonly associated with wetter conditions than those found in bogs. Shrubby poor fens frequently have a water table that is at or near the surface. The substrate for these ecosites is usually organic. Synonymous with BS22 leatherleaf shrubby poor fen in the Boreal Shield.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 11 (8, 14)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=0):						
A2 (n=0):						
A3 (n=0):						

Lower Vegetation Layer info:

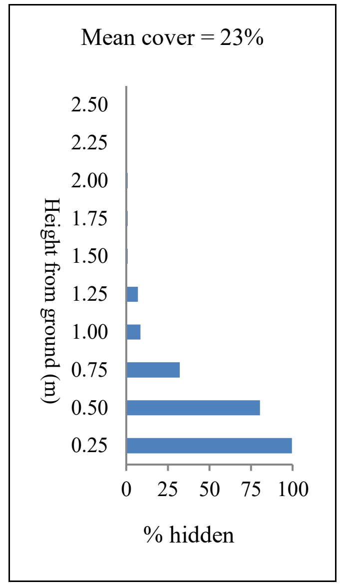
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	3	3%	Picemar4 Betugla4 Larilar2
B2	6	33%	Chamcal8 Kalmpol1
Forb	3	4%	Smiltri9 Schepal1
Graminoid	4	2%	Eriosch6 Carelim1 Careaqu1 Calacan1
Lichen			
Bryophyte	7	92%	Spharip3 Sphamag3 Sphafus2 Sphaang2

*Only including species that constitute 10% or more by composition.

BP24 Leatherleaf shrubby poor fen: Wet fibric organic (n=3)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.0	Low
	Mean snag diameter (cm)		
	Mean snag height (m)		
	Mean snag decay Class		
Course Woody Debris >10cm	Mean frequency of CWD	0.0	Low
	Mean CWD diameter (cm)		
	Mean CWD decay class		
Mean Percent Ground Cover	Litter Cover	8.0	Low
	Litter Depth (cm)	0.5	Low
	Bare Soil	0.0	Low
	Bare Rock	0.0	Low
	CWD <10cm	0.0	Low
	Sand	0.0	Low
	Open Water	0.0	Low



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

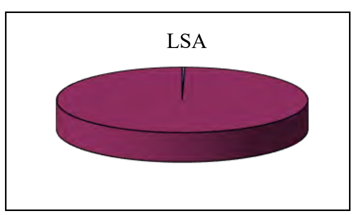
Attribute	Value	Rating
Structural diversity	0.8	Low
Species richness	11	Low
Unique species	1	Low
Provincially listed species	1	Low

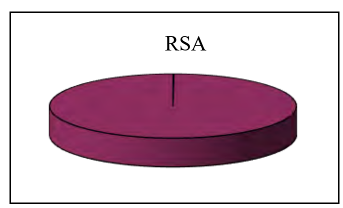
Unique species observed:
Straw-coloured Water Moss (*Straminergon stramineum*)

Provincially listed species observed:
White cotton grass (*Eriophorum scheuchzeri*)

Ecosite Supply

Areas occupied by leatherleaf shrubby poor fen comprised 12.9 ha (0.3%) of the LSA and 54.1 ha (0.1%) of the RSA.

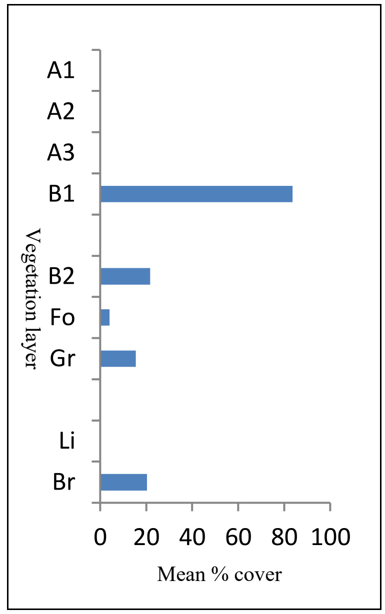




Ecological Interpretation

Shrubby poor fens are relatively low in both species richness and diversity. They are similar to tamarack treed fen (BP23) conditions and frequently occur adjacent to them. However, leatherleaf shrubby poor fens tend to be wetter than treed fens, and as such, will have lesser amounts of lingonberry and Schreber's moss but a higher proportion of swamp horsetail. Following disturbance, these ecosites could be expected to return to a shrubby fen condition or possibly to a BP26 or BP27 condition. As with all fens, the water on these sites is largely of ground water origin and relatively mineral-rich.

BP25 **Willow shrubby rich fen: Wet humic organic** (n=3)



Ecosite Description

BP25 has high cover values of willows. The typical willows associated with this site are pussy willow and flat-leaved willow. Other shrubs that could be found include dwarf birch, northern gooseberry, northern red current and alder-leaved buckthorn. Shrubby rich fens also tend to have more open water at the surface than shrubby poor fens (BP24). In the Boreal Plain ecozone, willow shrubby rich fens commonly occur on organic soils. Synonymous with BS23 willow shrubby rich fen ecosite in the Boreal Shield.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 18 (16, 22)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=1):	1	<1%	6.2 m	7.2 cm	Bw10	1991
A2 (n=0):						
A3 (n=0):						

Lower Vegetation Layer info:

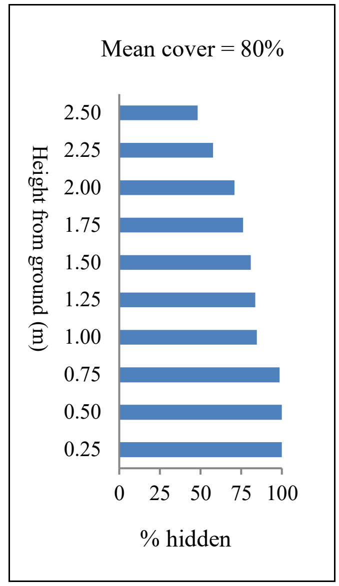
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	10	84%	Betupum3 Myrigal2 Saliser2 Saliped1 Salipla1
B2	9	22%	Chamcal4 Myrigal3 Betupum1 Saliser1
Forb	15	4%	Potepal2 Rubuarc1 Hippvul1 Caltpal1 Callpal1
Graminoid	3	16%	Calacan5 Caredis3 Careaqu2
Lichen	2	<1%	Parmamb5 Vulppin5
Bryophyte	9	20%	Sphaang9 Marcpol1

*Only including species that constitute 10% or more by composition.

BP25 **Willow shrubby rich fen: Wet humic organic** (n=3)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.0	Low
	Mean snag diameter (cm)		
	Mean snag height (m)		
	Mean snag decay Class		
Course Woody Debris >10cm	Mean frequency of CWD	0.0	Low
	Mean CWD diameter (cm)		
	Mean CWD decay class		
Mean Percent Ground Cover	Litter Cover	59.1	Moderate
	Litter Depth (cm)	4.3	High
	Bare Soil	0.0	Low
	Bare Rock	0.0	Low
	CWD <10cm	0.0	Low
	Sand	0.0	Low
	Open Water	19.2	High



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

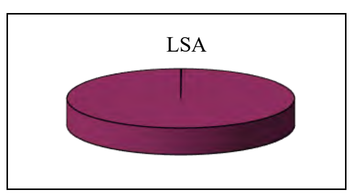
Attribute	Value	Rating
Structural diversity	1.2	Moderate
Species richness	18	High
Unique species	9	High
Provincially listed species	1	Low

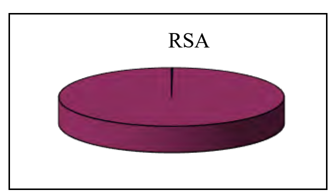
Unique species observed:
Green-tongue Liverwort (*Marchantia polymorpha*), Thin-leafed peat moss (*Sphagnum teres*), Glaucus willowherb (*Epilobium glaberrimum*), Water horsetail (*Equisetum fluviatile*), Common mare's-tail (*Hippuris vulgaris*), Lesser duckweed (*Lemna minor*), Dwarf raspberry (*Rubus arcticus ssp. acaulis*), Two-seeded sedge (*Carex disperma*), Bog willow (*Salix pedicellaris*)

Provincially listed species observed:
Lesser duckweed (*Lemna minor*)

Ecosite Supply

Areas occupied by willow shrubby rich fen comprised 4.8 ha (0.1%) of the LSA and 68.9 ha (0.2%) of the RSA.

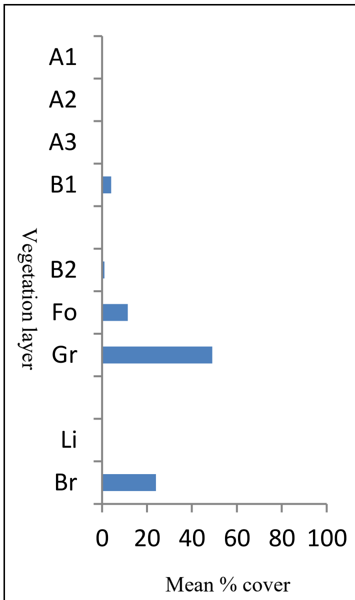




Ecological Interpretation

BP25 ecosites have a moderate structural diversity and a high species richness, particularly of shrubs and herbs. They differ considerably from leatherleaf shrubby poor fens (BP24). Rich fen ecosites often occur adjacent to streams and lakes. They may also occur as part of a swale or draw. In the absence of disturbance these ecosites are self-sustaining. Following disturbance they will likely return to their former composition or may more closely resemble an open fen (BP27) condition.

BP26 **Graminoid fen: Wet humic organic** (n=3)



Ecosite Description

Graminoid fens often have various sedge species and sometimes marsh reed grass. They generally lack trees and shrubs. Graminoid fens usually have water at or near the surface which accounts for the presence of water smartweed, yellow marsh marigold, and marsh skullcap. While graminoid fen ecosites are usually associated with organic soils, they may also occur with mineral substrates. Synonymous with BS24 graminoid fen in the Boreal Shield.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 11 (10, 14)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=0):						
A2 (n=0):						
A3 (n=0):						

Lower Vegetation Layer info:

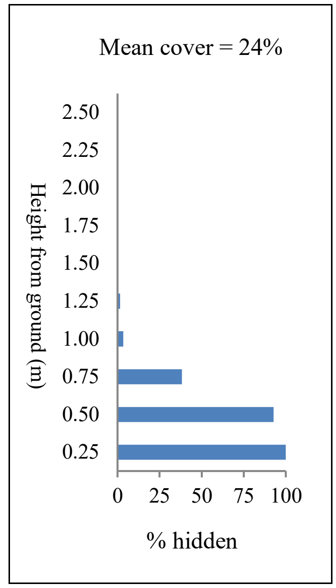
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	4	4%	Betugla4 Salisp.2 Betupum2 Larilar2
B2	2	1%	Myrigal9 Salisp.1
Forb	9	12%	Potepal8 Utriint1
Graminoid	5	49%	Careaqu6 Careutr4
Lichen			
Bryophyte	5	24%	Sphaang7 Spharip2 Callgig1

*Only including species that constitute 10% or more by composition.

BP26 Graminoid fen: Very wet humic organic (n=3)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.0	Low
	Mean snag diameter (cm)		
	Mean snag height (m)		
	Mean snag decay Class		
Course Woody Debris >10cm	Mean frequency of CWD	0.0	Low
	Mean CWD diameter (cm)		
	Mean CWD decay class		
Mean Percent Ground Cover	Litter Cover	68.1	Moderate
	Litter Depth (cm)	6.9	High
	Bare Soil	0.0	Low
	Bare Rock	0.0	Low
	CWD <10cm	0.0	Low
	Sand	0.0	Low
	Open Water	6.8	Moderate



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

Attribute	Value	Rating
Structural diversity	1.1	Moderate
Species richness	11	Low
Unique species	6	Moderate
Provincially listed species	0	Low

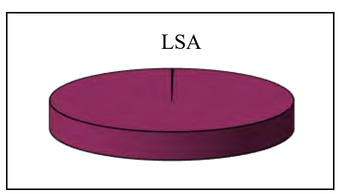
Unique species observed:

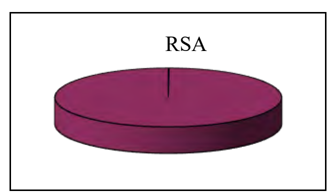
Giant calliergon moss (*Calliergon giganteum*), Peat moss (*Sphagnum girgensohnii*), Marsh willowherb (*Epilobium palustre*), Water dock (*Rumex orbiculatus*), Northwest territory sedge (*Carex utriculata*), Common Great Bulrush (*Scirpus lacustris*)

Provincially listed species observed:
None

Ecosite Supply

Areas occupied by graminoid fen comprised 7.7 ha (0.2%) of the LSA and 45.1 ha (0.1%) of the RSA.



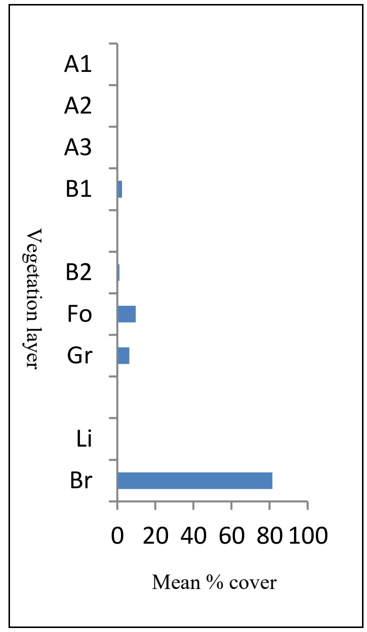


Ecological Interpretation

BP26 ecosites have an overall low species richness, primarily composed of forbs and grasses. Structural diversity is low to moderate. They are occasionally found across the Boreal Plain ecozone. They are often in close proximity to lake shorelines but can also form a relatively continuous wet meadow. These sites deviate little from their original condition either in the presence of or absence from disturbance.

BP27

Open fen: Wet fibric organic (n=2)



Ecosite Description

BP27 is conspicuous by the lack of any dominant form of vegetation with the exception of mosses. It is not uncommon for open fens to exhibit many of the vegetation species found in adjacent ecosites. However, while the diversity of species may be relatively high, the cover values are low. In terms of substrate, open fens can either have a mineral or organic substrate. Synonymous with BS25 open fen ecosite in the Boreal Shield.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 15 (14, 16)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=0):						
A2 (n=0):						
A3 (n=0):						

Lower Vegetation Layer info:

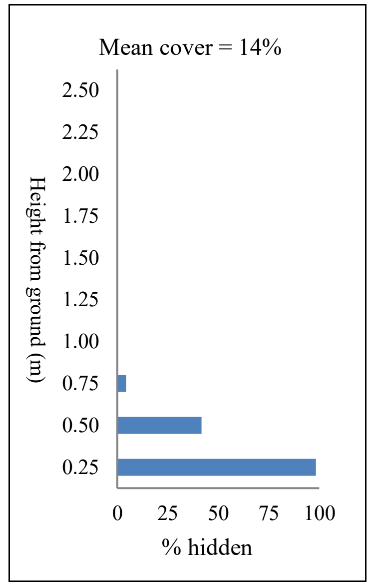
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	1	3%	Picemar10
B2	3	1%	Andrpol6 Kalmpol3 Oxycmic1
Forb	5	10%	Schepal4 Menytri4 Drosang2
Graminoid	2	6%	Juncnod7 Carelim3
Lichen			
Bryophyte	5	82%	Sphang6 Sphamag3 Dicrfus1

*Only including species that constitute 10% or more by composition.

BP27 Open fen: Wet fibric organic (n=2)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.0	Low
	Mean snag diameter (cm)		
	Mean snag height (m)		
	Mean snag decay Class		
Course Woody Debris >10cm	Mean frequency of CWD	0.0	Low
	Mean CWD diameter (cm)		
	Mean CWD decay class		
Mean Percent Ground Cover	Litter Cover	0.0	Low
	Litter Depth (cm)	N/A	Low
	Bare Soil	0.0	Low
	Bare Rock	0.0	Low
	CWD <10cm	0.0	Low
	Sand	0.0	Low
	Open Water	18.3	High



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

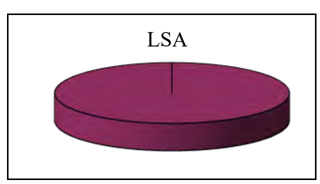
Attribute	Value	Rating
Structural diversity	0.7	Low
Species richness	15	Moderate
Unique species	4	Moderate
Provincially listed species	1	Low

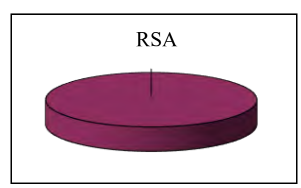
Unique species observed:
Dicranum moss (*Dicranum fuscum*), Brown moss (*Drepanocladus unciatus*), Buckbean (*Menyanthes trifoliata*), Knotted Rush (*Juncus nodosus var. nodosus*)

Provincially listed species observed:
English sundew (*Drosera anglica*)

Ecosite Supply

No areas with the BP27 ecosite were located in the LSA, however 55.6 ha (0.1%) of the RSA were occupied by this ecosite.

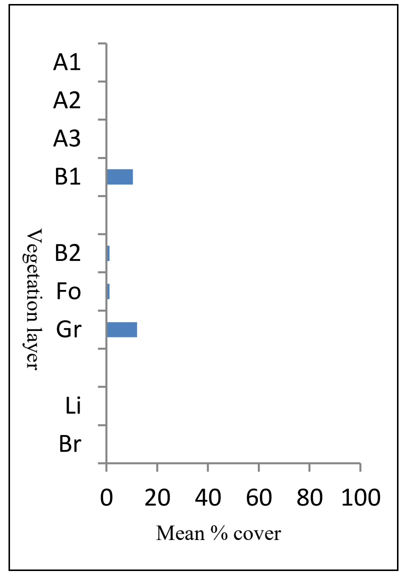




Ecological Interpretation

BP27 ecosites have low structural diversity and moderate species richness. While open fens appear uncommon across the Boreal Plain ecozone, this is an artifact of their existence as small pockets nested within other fen ecosites. Rarely do open fens exist as large expanses. Following disturbance these ecosites could be expected to return to open fens, but over time it is likely that they would become part of the more extensive adjacent fen ecosite types.

BS26 Rush Sandy Shore: very moist sand (n=2)



Ecosite Description

BS26 ecosites are characterized by having a relatively low cover of rushes, grasses, and sedges and little else. The ground cover is mostly exposed soil; usually just sand.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 7 (3, 11)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=0):						
A2 (n=0):						
A3 (n=0):						

Lower Vegetation Layer info:

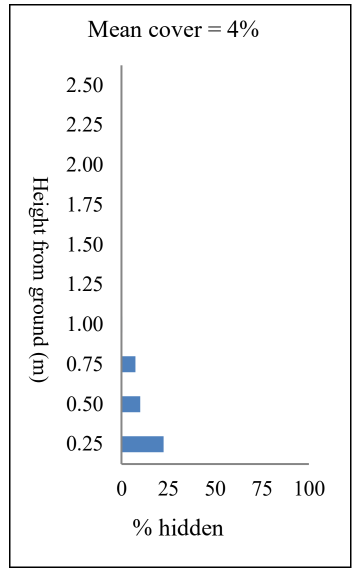
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	2	11%	Alnurug7 Betupap3
B2	3	1%	Salibeb6 Myrigal3 Vaccmyr1
Forb	2	1%	Potenor9 Epilang1
Graminoid	4	12%	Agrosca6 Festrub2 Calacan1
Lichen			
Bryophyte			

*Only including species that constitute 10% or more by composition.

BS26 Rush Sandy Shore: very moist sand (n=2)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.0	Low
	Mean snag diameter (cm)		
	Mean snag height (m)		
	Mean snag decay Class		
Course Woody Debris >10cm	Mean frequency of CWD	0.0	Low
	Mean CWD diameter (cm)		
	Mean CWD decay class		
Mean Percent Ground Cover	Litter Cover	1.7	Low
	Litter Depth (cm)	0.5	Low
	Bare Soil	0.0	Low
	Bare Rock	0.0	Low
	CWD <10cm	0.0	Low
	Sand	83.3	High
	Open Water	0.0	Low



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

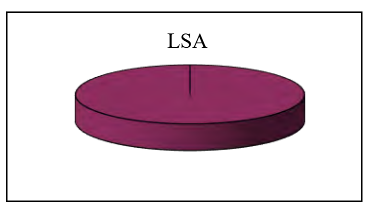
Attribute	Value	Rating
Structural diversity	1.0	Low
Species richness	7	Low
Unique species	2	Low
Provincially listed species	0	Low

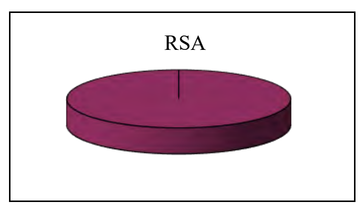
Unique species observed:
Rough cinquefoil (*Potentilla norvegica),* Short sedge (*Carex brunnescens*)

Provincially listed species observed:
None

Ecosite Supply

Areas occupied by rush sandy shores comprised <0.1% of the LSA and 16.9 ha (<0.1%) of the RSA.

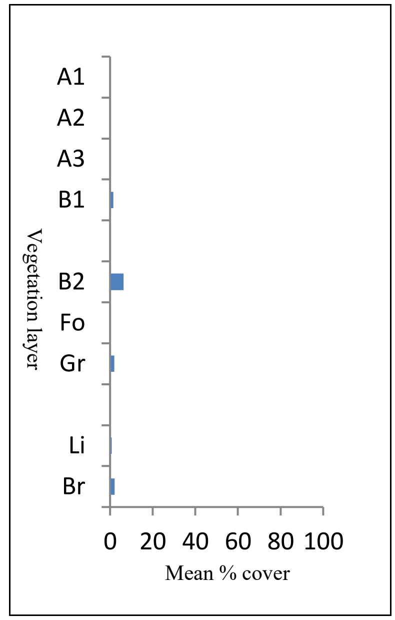




Ecological Interpretation

Rush sandy shores are low in both species richness and diversity. They are almost always narrow linear features adjacent to lakes or ponds. This particular ecosite was defined based on data almost exclusively from the Athabasca Dunes ecodistrict.

DL1 **Disturbed lands - vegetated** (n=3)



Ecosite Description

DL1 ecosite type is characterized by previous removal of naturally occurring vegetation (and in some cases soil) and the absence of a tree layer. Some sites include an open shrub layer including by willows, green alder, and jack pine. Graminoids and forbs are also present, however, mainly consisting of planted or invasive species. A cover of mosses can also be found on the ground, but bare soil is a predominant feature in this ecosite type.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 9 (6, 12)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=0):						
A2 (n=0):						
A3 (n=0):						

Lower Vegetation Layer info:

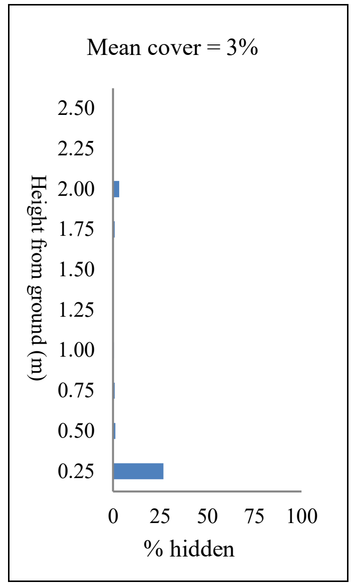
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1	3	2%	Alnucri4 Pinuban4 Salipla1
B2	5	6%	Vaccmyr5 Arctuva4
Forb	1	<1%	Rubucha10
Graminoid	3	2%	Agrosca6 Festrub2 Carehoo1
Lichen	4	<1%	Claddef4 Cladmit3 Cladgra2
Bryophyte	2	2%	Polyjun9 Polypil1

*Only including species that constitute 10% or more by composition.

DL1 **Disturbed lands - vegetated** (n=3)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.0	Low
	Mean snag diameter (cm)		
	Mean snag height (m)		
	Mean snag decay Class		
Course Woody Debris >10cm	Mean frequency of CWD	0.0	Low
	Mean CWD diameter (cm)		
	Mean CWD decay class		
Mean Percent Ground Cover	Litter Cover	39.9	Moderate
	Litter Depth (cm)	0.6	Low
	Bare Soil	19.7	High
	Bare Rock	3.7	Moderate
	CWD <10cm	0.0	Low
	Sand	30.7	High
	Open Water	0.0	Low



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

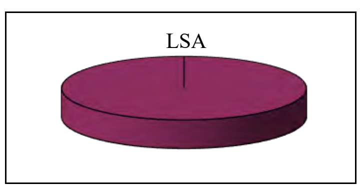
Attribute	**Value**	**Rating**
Structural diversity	1.2	Moderate
Species richness	9	Low
Unique species	1	Low
Provincially listed species	0	Low

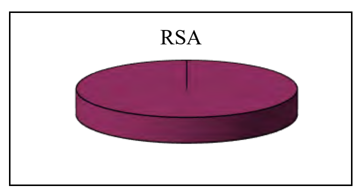
Unique species observed:
Hooker's Sedge (*Carex hookerana*)

Provincially listed species observed:
None

Ecosite Supply

Areas occupied by disturbed land - vegetated were absent from the LSA and comprised <0.1% of the RSA.

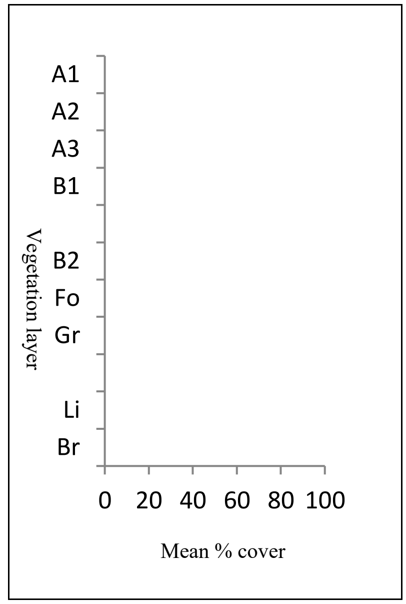




Ecological Interpretation

DL1 ecosites are poor in species diversity and richness. They do have a moderate number of unique species, however, these species are generally actively seeded (such as red fescue) or invasive (such as narrow-leaved hawk's beard and dandelion). The ecosites are the result of previously cleared developed sites (e.g. road right-of-ways and airstrips) where some kind of natural revegetation has taken place, as well as areas where active reclamation has occurred.

DL2 **Disturbed lands – non-vegetated** (n=2)



Ecosite Description

DL2 ecosite type is characterized by previous removal of naturally occurring vegetation (and in some cases soil) and the absence of a tree layer. Shrubs, forbs, and lichen/mosses are virtually absent. Bare rock and sand cover are high.

Species and Vegetation Layer Info

Average number plant and lichen species per plot (min, max): 0 (0, 0)

Tree Layer Info:

Tree Layer	Total # Species	Crown Closure	Mean Height	Mean DBH	Species Composition	Year of Origin
A1 (n=0):						
A2 (n=0):						
A3 (n=0):						

Lower Vegetation Layer info:

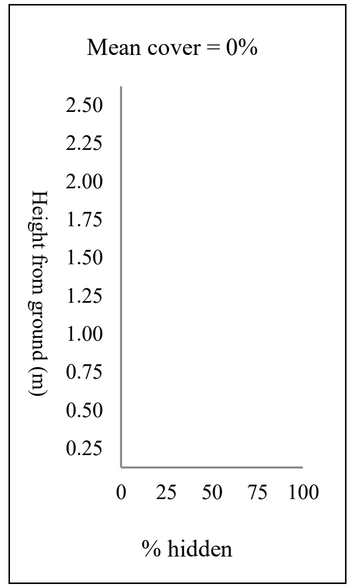
Vegetation Layer	Total # Species	Percentage Cover	Species Composition*
B1			
B2			
Forb			
Graminoid			
Lichen			
Bryophyte			

*Only including species that constitute 10% or more by composition.

DL2 **Disturbed lands – non-vegetated** (n=2)

Structural Attributes and Relative Rating

Structural Component	Attribute	Value	Rating
Snags	Mean # of snags/plot	0.0	Low
	Mean snag diameter (cm)		
	Mean snag height (m)		
	Mean snag decay Class		
Course Woody Debris >10cm	Mean frequency of CWD	0.0	Low
	Mean CWD diameter (cm)		
	Mean CWD decay class		
Mean Percent Ground Cover	Litter Cover	1.4	Low
	Litter Depth (cm)	0.3	Low
	Bare Soil	0.0	Low
	Bare Rock	21.5	High
	CWD <10cm	0.0	Low
	Sand	76.1	High
	Open Water	0.0	Low



Structural Diversity, Species Richness, and Unique and Rare Species Occurrence Evaluation

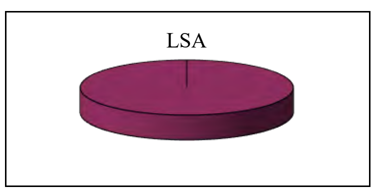
Attribute	Value	Rating
Structural diversity	0.0	Low
Species richness	4	Low
Unique species	0	Low
Provincially listed species	0	Low

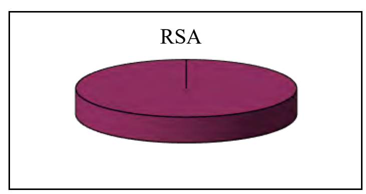
Unique species observed:
None

Provincially listed species observed:
None

Ecosite Supply

Areas occupied by disturbed land – non-vegetated comprised <0.1% of the LSA and <0.1% of the RSA.





Ecological Interpretation

DL2 ecosites are poor in species diversity and richness. The ecosites are the result of previously cleared developed sites (e.g. road right-of-ways and airstrips) where natural regeneration has not taken place.

7.0 LINEAR FEATURE NATURAL REGENERATION ASSESSMENT

Environment Canada (EC) (2012b) assessed the capacities of caribou ranges to maintain self-sustaining local populations of boreal caribou across Canada, and utilized a methodology that linked calf recruitment to levels of disturbance within specific ranges. The objective was to identify range-specific disturbance based on management thresholds. For the Boreal Shield of Saskatchewan (SK1), in 2018, ECCC indicated that to ensure sustainable caribou populations, total buffered anthropogenic disturbance should not exceed five percent and that total disturbance (natural + buffered anthropogenic) should not exceed 40%. Currently, under this scheme, there is approximately 82% buffered anthropogenic disturbance in the LSA and approximately 49% in the RSA (Section 3.3). Linear disturbances, in the form of seismic/exploration lines, trails, and roads, were most common.

The increase in linear disturbances has the potential to increase the hunting opportunities and efficiencies of wolves (James et al. 2004; Dickie et al. 2017) and black bears (Latham et al. 2011a; Tigner et al. 2014; DeMars and Boutin 2017). Dickie et al. (2017) demonstrated that wolves move faster and farther on right-of-ways (ROW), especially wider ROWs, than in interior forests. Latham et al. (2011b) observed that legacy seismic lines in Alberta were the most important movement corridors for wolves during the snow-free season, and Tigner et al. (2014) also found that black bears used linear features more frequently than undisturbed forest interior. This increased carnivore use of linear features could lead to higher levels of woodland caribou mortality.

Additive footprint from the proposed Project would result in an increase to baseline disturbance levels and prolong the natural recovery timeline of the Project-related and existing disturbances. However, not all mapped existing anthropogenic disturbances should still be considered disturbed because natural succession has likely begun on many older features.

Visual or physical obstruction by vegetation is thought to be an important functional habitat attribute for wildlife, either as hiding cover, or as a factor affecting movement. Ungulate flight responses are likely governed by several factors and the amount of hiding cover is likely one important factor (Nudds 1977). This section presents two approaches used to investigate current visual and physical obstruction as well as one approach to investigate potential future visual and physical obstruction on linear features. The approaches for current visual obstruction included measurements of hiding cover (percentage hidden) and vegetation regrowth (percent cover or stem count by vegetation layer). The approach for examining potential future visual obstruction involved investigating regeneration of ericaceous shrub and tree species. Ericaceous shrubs, such as blueberry, Labrador tea, and leatherleaf will generally not grow taller than 1 m and will not contribute considerably in terms of line blocking, neither physical blocking or visual (line of sight) (McLaughlan et al. 2010). Tree species (such as jack pine and black spruce) conversely will, given there are no fires or human traffic, grow tall enough to block line of sight. The abundance of tree species regeneration on a linear feature, even if currently less than 1 m tall, would be an important predictor of future regrowth and visual obstruction potential on a linear feature.

7.1 Study Objectives

The objectives of linear feature natural regeneration assessment field surveys were to:

- identify levels of natural vegetation recovery in anthropogenic features of different types, in different habitats, and with varying level of human use; and
- use this data to inform future potential reclamation efforts.

7.2 Methods

7.2.1 Sample Site Selection

Field sampling was conducted between 21 and 28 August 2019 at a time of full vegetation green-up. Sampling sites were stratified by lowland or upland sites and then by mature or regenerating forest classes. Sample sites were stratified randomly using a 1:20,000 anthropogenic feature and vegetation cover type map (see Figures 3.3-1 and 5.3-1). In addition, due to the relatively homogeneous vegetative characteristics of the study area, specific sites with higher levels of linear feature regeneration were intentionally selected to provide adequate representation. All sample sites chosen were accessed safely by all-terrain vehicle (ATV). Sampled disturbance types included hand cut exploration lines (1 m to 2 m wide), machine cut lines (2.5 m to 10 m wide), temporary trails (1.5 m to 8 m wide) and roads (5 m to 10 m wide).

Paired reference transects were run along the same bearing and parallel to linear feature transects in suitable interior (undisturbed) habitat 30 m away. A total of 60 sites were sampled. The locations of the transects are provided in Figure 7.2-1. Transect details are provided in Appendix B.

7.2.2 Sample Site Layout and Sampling Design

Each sampling site consisted of a 30 m transect along which five 20 cm x 50 cm sub-plots, five 1 m x 1 m sub-plots, and three 2 m x 5 m sub-plots were systematically distributed at 5 m intervals (Figure 7.2-2). A series of vegetative and structural attributes were estimated or measured. Visual estimates along a continuous scale to the nearest percent were made at each sub-plot as described in British Columbia Ministry of Forests (1998). The percent cover of bare soil, rock/stones, litter, mulch, terrestrial lichen, feather moss, and sphagnum moss were recorded in the five 20 cm x 50 cm sub-plots. The depth of litter and mulch were also recorded. In each of the 1 m x 1 m sub-plots, the 10 most abundant low shrubs (<1 m in height) were recorded and given a rank order from 1 (most abundant) to 10 (least abundant). Forbs, grasses, and sedges/rushes were grouped together and recorded and ranked in the same manner. Total percent cover and median height of low shrubs, forbs, grasses, sedges/rushes, and standing water was recorded for each sub-plot. Tall shrub saplings were surveyed in the 2 m x 5 m sub-plot. Saplings were divided into two groups: 1 m to <3-m and ≥3 m to 5-m heights. Species and height was recorded for each sapling. Structural data included frequency of occurrence of coarse woody debris and hiding cover. Coarse woody debris was recorded along the length of the 30 m transect. The total number of intercepts, the diameter, and the decay class (1-7) of all pieces >10 cm were measured or estimated (Lee et al. 1995).

Horizontal and vertical visual obstruction from vegetation was estimated in both east and west directions from the transect centre and along each disturbance and corresponding reference transects adapting methods by Nudds (1977). A red and white colour-coded cloth measuring 2.5 m in height was held upright 15 m from the observer at the transect centre (Figure 6.2-4). The observer viewed the cloth from both caribou and wolf eye levels (1.7 m and 1.2 m above ground respectively, as per Kansas et al. 2016). An estimate of percent obstructed/hidden (by vegetation) was recorded for each of the ten 25 cm x 25 cm squares.

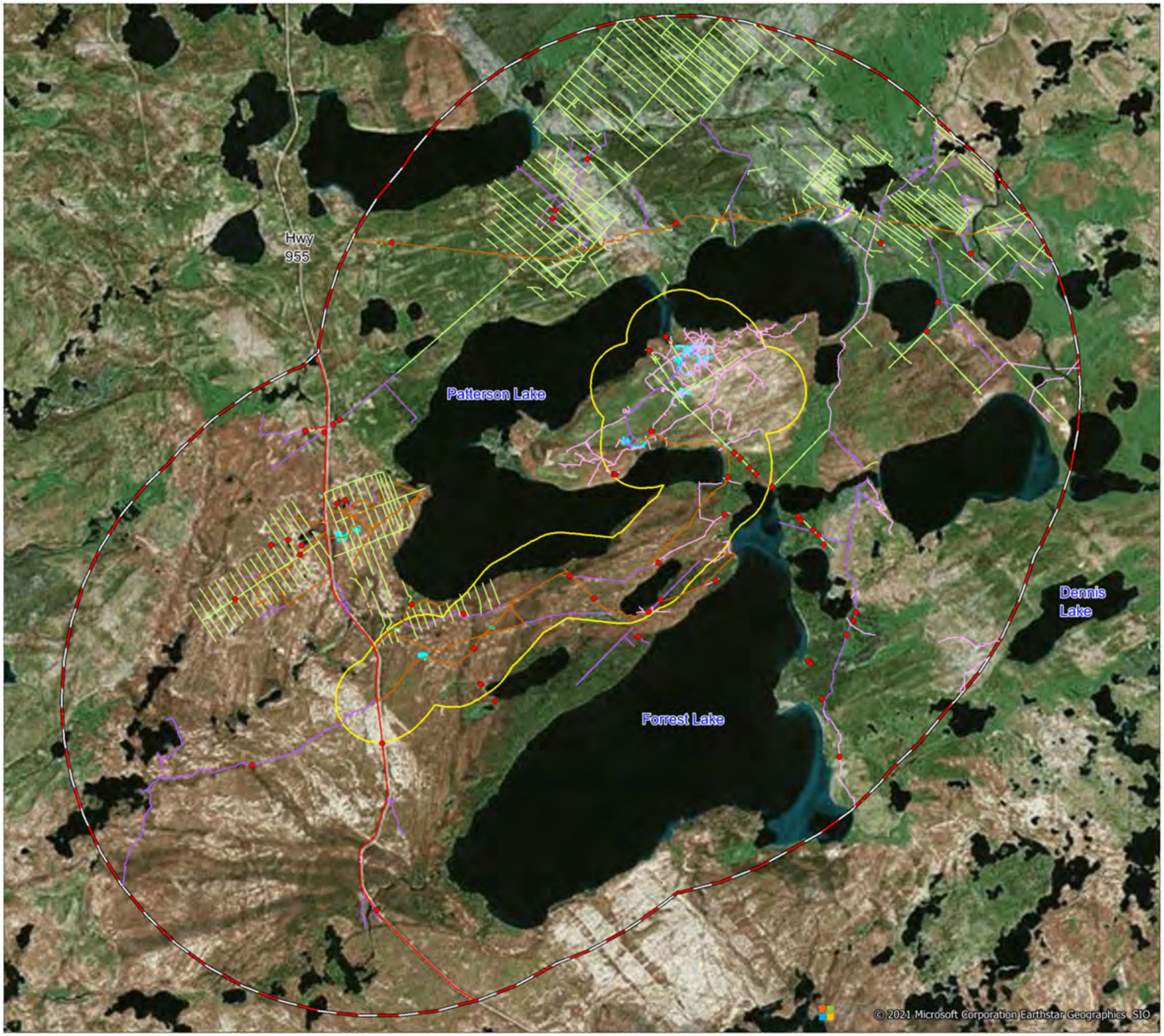


Figure 7.2-1 Linear Feature Natural Regeneration Transect Locations

Legend

Assessment Transect Location

Disturbance Type - Width

Cutline (1.75m)

ROW (2.5m)

Trail (4m)

Rough Road (5.5m)

Road (12m)

Clearing

Regional Study Area (RSA)

Local Study Area (LSA)

0 5 10

kilometers

Scale = 1 : 90,000

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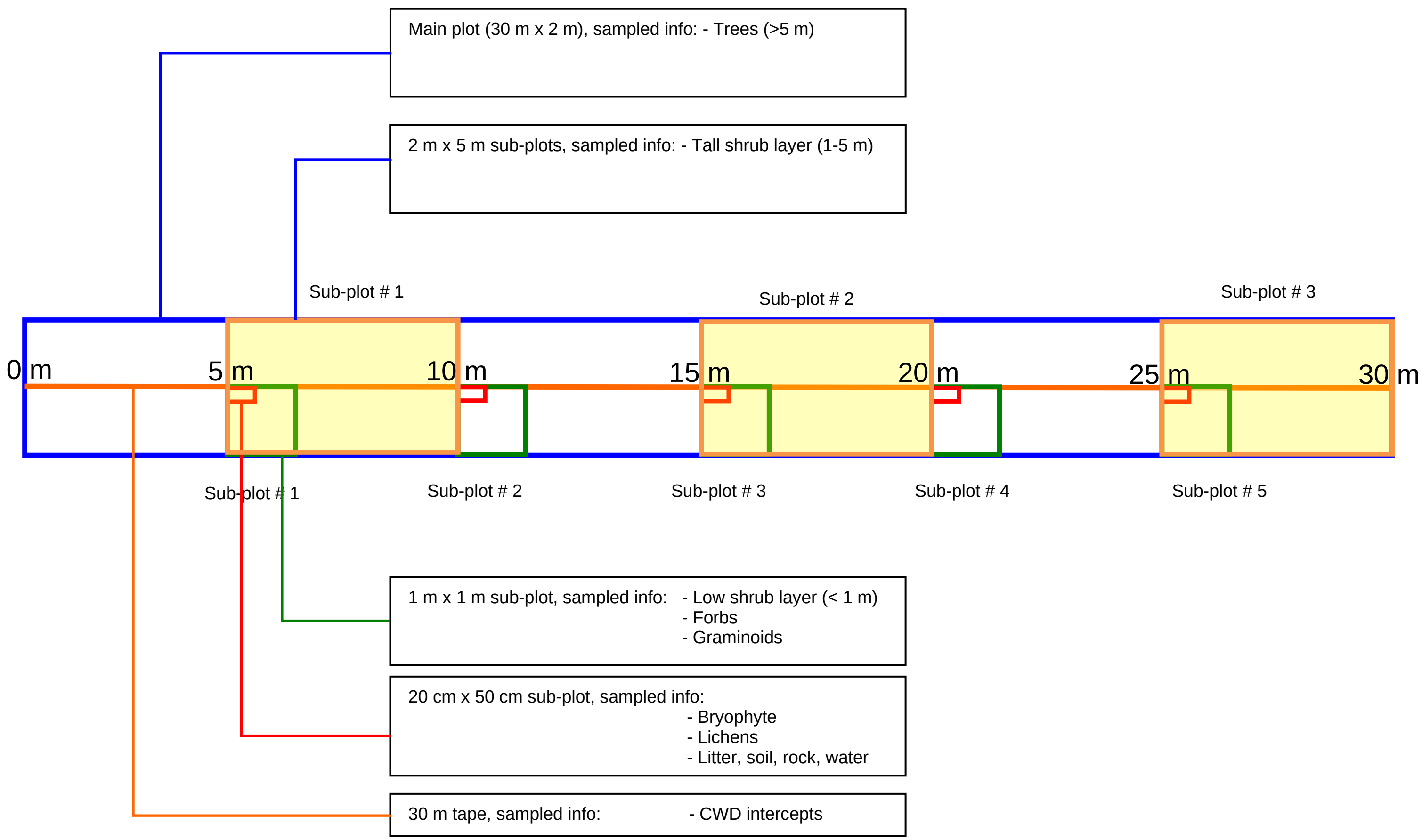
Figure 7.2-2 Linear Feature Natural Regeneration Assessment Ground Sampling Plot Layout



7.2.3 Analysis

Three types of analyses were completed to assess natural regeneration of disturbed linear features and paired reference transects, including:

1) level of visual obstruction provided by vegetation on linear features;
2) level of vegetation regrowth (percentage cover or stem counts); and
3) analysis of low shrub cover focusing on dominant species type (ericaceous shrub or tree) to determine the percentage of species that has the potential to reach caribou eye level and beyond (to predict whether a line is likely to be naturally revegetated over time).

For each of these three analyses, four classes of features were investigated, including features:

1) that have burned after creation (Appendix C, Photograph 7.2-1) versus those that have not burned since creation (Appendix C, Photograph 7.2-2);
2) in upland (e.g., jack pine forest) (Appendix C, Photograph 7.2-3) versus lowland (e.g., bogs and fens) (Appendix C, Photograph 7.2-4) areas;
3) in old (> 40 years since fire) (Appendix C, Photograph 7.2-3) versus young forest (<= 40 years since fire) (Appendix C, Photograph 7.2-2); and
4) with varying degree of human use, ranging from none (Appendix C, Photograph 7.2-5), low (Appendix C, Photograph 7.2-6), low/moderate (Appendix C, Photograph 7.2-7), moderate (Appendix C, Photograph 7.2-8), moderate/high (Appendix C, Photograph 7.2-9), and high (Appendix C, Photograph 7.2-10). Level of use was based on observations in the field including flattened vegetation, percentage of bare soil, presence and extent of tire tracks, etc.

Seven different vegetation cover/stem density metrics (lichens, mosses, forbs, graminoids, shrubs < 1 m, shrubs 1 m to 2 m, and shrubs 3 m to 5 m) and two vegetation structure metrics (wolf hiding cover and caribou hiding cover) were analyzed. The average values for all vegetation layers as well as the average values for visual obstruction up to 2 m height from both caribou and wolf eye levels for the sampling by stratified sites were calculated in both the linear feature transects (treatment) and the paired adjacent natural transects (reference).

For the low shrub layer, the 10 most abundant shrub species (<1 m in height) were recorded and given a rank order from 1 (most abundant) to 10 (least abundant) for each sub-plot. The ranks were converted to a numerical value (1 = 100, 2 = 90, 3 = 80, …, 10 = 10), and the values from each sub-plot were added to provide a total amount for each transect, thereby taking into consideration both ranking and occupancy for the sub-plots. This value was then normalized so each species received a value between 0 (not observed in any sub-plot) to 100 (overall highest ranking and most commonly recorded in sub-plots).

Using this information, two levels of analysis were undertaken. First, a comparison between disturbance and reference for each site type (e.g., upland – disturbed vs. upland - reference) was analysed. Second, a comparison of the level of natural regeneration between disturbed areas in different site types (e.g., upland – disturbed vs. lowland – disturbed) was analysed. To investigate the variation between reference and disturbance transects (rather than the variation within each of these groups), the precision of the mean value was quantified by calculating standard error of the mean.

For the first level analysis, paired t-tests were run to verify if differences in mean values between compared variables were statistically significant (probability [P] <0.05). For the second level analysis, two-sample t-tests, not assuming equal variance, were run to verify if differences in mean values between compared variables were statistically significant (P<0.05). All data was analyzed using Minitab v. 17.3.1 (Minitab Inc., State College, PA, USA).

7.2.4 Assumptions and Limitations

Natural vegetation recovery, at any given site, will depend on a variety of factors. No information has been made available as for when linear features were created, how they were created, how they were used and for how long they may have been used, among other factors. Therefore, the analyses did not take age of disturbance into consideration. For each of the four classes of features analysed, several additional assumptions and limitations were identified:

1) Burned before or after creation of linear disturbance.
    - Since there was no information available on when linear features were created, the designation of burned before or after line creation was based on evidence observed during the field trip, such as presence of stumps and/or deadfall from tree felling.
    - It is likely that, overall, lines created after fire may tend to be younger than lines created before fire (e.g., in any given fire polygon, a line cut after the fire will always be younger than a line cut before the fire). As we do not have information on when lines were created, we can not control for this. Nevertheless, being adapted to a fire driven environment, jack pine has serotinous cones (protected by a waxy coating) that require the heat of fire to release their seeds, and fire also produces favourable conditions for the seeds of these pines to germinate. Nutrients are released in the soil, mineral soil is exposed, competing species are eliminated and the amount of sunlight on the forest floor is increased. As such, jack pine therefore depends on fire to regenerate, and fires initiate natural regeneration. This will not happen, to the same extent, when a line is cut, and it is therefore expected that recovery on lines burned after creation will recover faster than lines burned before creation.
    - Transects included in this analysis are all:
        i. no/low human use (to investigate effect of fire only);
        ii. trail, handcut, or cutline (as roads had minimal natural recovery irrespective of fire age); and
        iii. in young upland regenerating forest (to compare similar ages of fire).

2) Upland versus lowland comparisons include transects that:
    - have no/low human use (to investigate effect of moisture only);
    - are trail, handcut, or cutline (as roads have minimal recovery irrespective of moisture regime); and
    - represent areas of between 30 to 100 years since fire, since there is most overlap for these ages).

3) Old versus young comparisons include transects that:
    - are upland areas only (very limited young lowland transects);
    - have not burned since the line was cut;
    - are divided into young (<=40 years since fire) and old (>40 years since fire);
    - have no/low human use (to investigate effect of age only); and
    - are trail, handcut, or cutline (as roads had minimal recovery irrespective of fire age).

4) Levels of human use, transects that include:
    - all landcover types (uplands and lowlands);
    - all ages;
    - all types of features; and
    - all categories of human use.

7.3 Results

The key findings and trends for each of the three analyses, including *Visual Obstruction, Vegetation Recovery and Ericaceous shrubs vs. Tree Species* are provided in Table 7.3-1. Detailed results for each analysis are described below.

7.3.1 Visual Obstruction

Line Cut Before versus After Fire

No significant differences in visual obstruction in any layers were observed between disturbed versus reference transects for areas that had burned after the line was cut (Figure 7.3-1A). In situations where lines were cut after fires, wolf visual obstruction was significantly higher for reference transects for all layers except 0.25 m to 0.75 m (P<0.05), and caribou visual obstruction was significantly higher for reference transects for all layers except 0.25 m and 0.50 m (P<0.05), indicating poor vegetation regrowth in areas cut after fire (Figure 7.3-1B). The differences in observed visual obstruction between disturbances created before and after fire indicate that, for trails and hand cuts and in absence of continued human use, wildfires substantially accelerate natural recovery processes such that vegetation conditions are more similar on and off disturbance than on disturbances that have not burned.

Upland versus Lowland

Lowlands generally had a slightly higher visual obstruction in the lower height layers compared with uplands. In lowlands, there were no significant differences between disturbed areas and reference areas in any of the layers (Figure 7.3-2A). In uplands, both caribou and wolf visual obstruction was significantly lower in disturbed areas compared to reference areas for all layers, except 0.25 m above ground (P<0.05) (Figure 7.3-2B). With respect to disturbed areas for lowlands versus uplands, a higher visual obstruction in the lowest height layer occurred in lowlands compared to uplands, as both wolf and caribou visual obstruction were significantly higher for lowlands than uplands in the 0.25 m layer, but displayed no significant difference between lowlands and uplands in any of the higher layers (Figure 7.3-2C).

Young Forest versus Old Forest

For young forests, overall hiding cover (all layers combined) was significantly different between disturbed and reference for both wolf and caribou. Caribou hiding cover was significantly different in all height layers except the 0.25 m layer (P<0.05), and wolf hiding cover was significantly different in all layers except for layers 0.25 m to 0.75 m (Figure 7.3-3A). Although old forests had lower hiding cover overall (both in disturbed areas and reference areas), the difference between disturbed and reference areas were similar to young forests. Both wolf and caribou hiding cover were significantly different in all height layers except the 0.25 m layer (P<0.25) (Figure 7.3-3B). There was a strong trend (statistically significant in the 0.25 m and 0.5 m layer for caribou, and 0.5 m and 1.0 m for wolf) towards higher recovery in young forests compared to old forests (Figure 7.3-3C), suggesting young forests are likely to recover faster, when compared to reference sites, than old forests post disturbance.

Level of Human Use

Human use significantly affected vegetation regrowth (based on visual obstruction) (Figures 7.3-4A to 7.3-4D). There was no significant difference between no use, low use, and moderate use for the 0.25 m layer; however, areas in these use categories had significantly higher visual obstruction than areas with high human for this layer (Figure 7.3-4E). For all other layers (0.50 - 2.00 m) there was significantly higher visual obstruction in areas with no vs. low/moderate/high human use. As such, it appears that any level of human use of features has a substantial impact on natural vegetation recovery.

Table 7.3-1 Key Findings and Trends for Each Analysis of Disturbed Areas.

Variable	Main Findings/Trends for Disturbed Areas
Visual Obstruction	
Line Cut Before vs. After Fire	Areas burned after line cutting: No significant differences in visual obstruction in any layers were observed between disturbed versus reference transects. Areas burned before line was cut: Wolf visual obstruction significantly higher for reference transects for all layers except 0.25 m to 0.75 m (P<0.05); caribou visual obstruction significantly higher for reference transects for all layers except 0.25 m and 0.50 m (P<0.05), indicating poor vegetation regrowth in areas cut after fire.
Upland vs. Lowland	Significantly higher visual obstruction in lowlands vs. uplands for the 0.25 m layer.
Young Forest vs. Old Forest	Significantly higher visual obstruction in young forest vs. old forest for the 0.25 m to 0.50 m layer (caribou) and the 0.50 m to 1.00 m (wolf).
Level of Human Use	No significant difference between no, low and moderate use for the 0.25 m layer, and these are all significantly different from high use. For all other layers, significantly higher visual obstruction in areas with no vs. low/moderate/high human use.
Vegetation Recovery	
Line cut before vs. after fire	Significantly higher stem counts of Shrubs (3 m to 5 m) and strong trend towards higher stem counts of shrubs (1 m to 3 m) in areas burned after vs. before line creation. No difference between disturbed and reference in areas burned after line creation.
Upland vs. Lowland	Significantly higher forb and moss cover, and lower lichen cover in lowlands vs. uplands.
Young forest vs. Old Forest	Strong trends toward higher lichen cover in old vs. young forest (p=0.06), as well as higher stem counts of shrubs (1 m to 3 m) in young vs. old forest (p=0.055).
Level of Human Use	Significantly higher vegetation recovery in areas with no/low vs. moderate/high human use.
Tree Species Abundance	
Line cut before vs. after fire	Higher tree species occurrence in areas burned after vs. before line creation.
Upland vs. Lowland	Similar relative abundance of tree species in lowlands and uplands.
Young forest vs. Old Forest	Similar relative abundance of tree species in young and old forest.
Level of Human Use	Higher tree species occurrence in areas with no/low/moderate vs. high human use.

Figure 7.3-1A Visual Obstruction in Areas Burned *After* Line was Cut

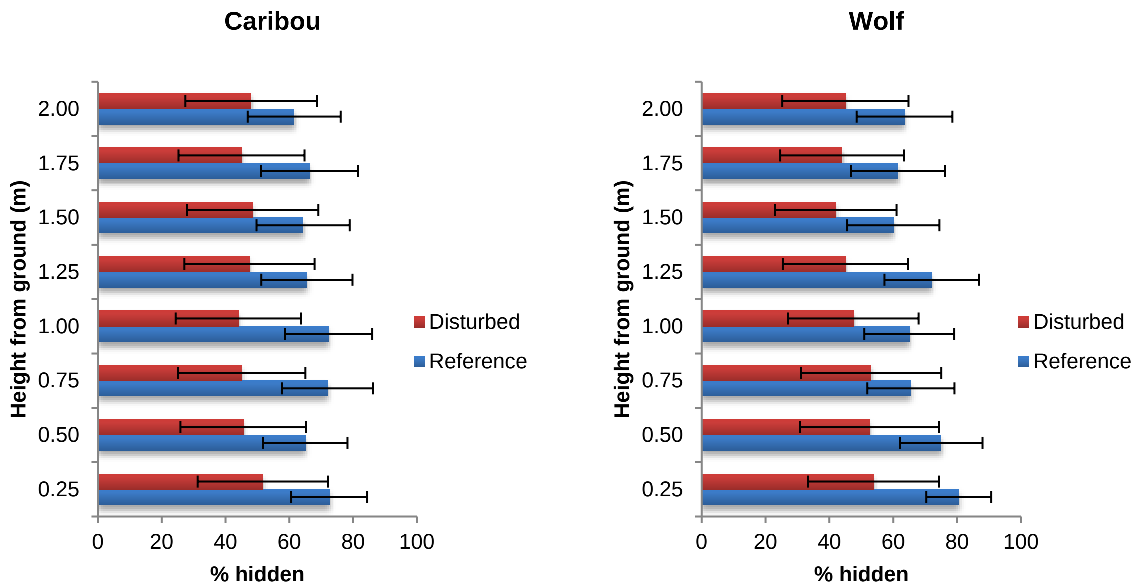
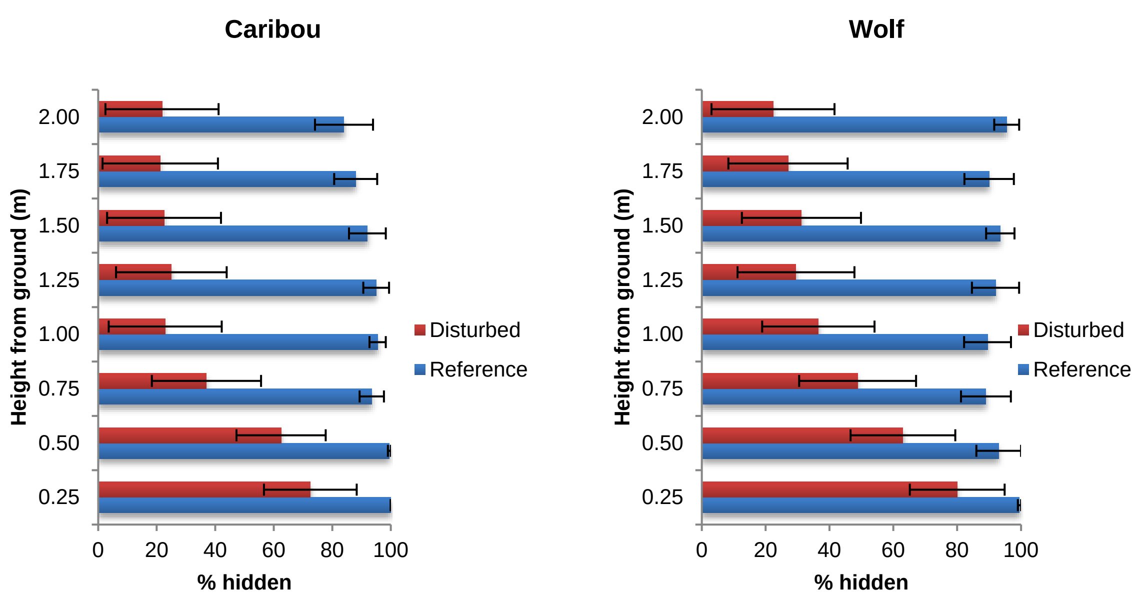


Figure 7.3-1B Visual Obstruction in Areas Burned B*efore* Line was Cut



Note: The error bars are standard errors around the means; fire occurred 2 to 29 years ago.

Figure 7.3-2A Visual Obstruction in Lowland (Bogs/Fens)

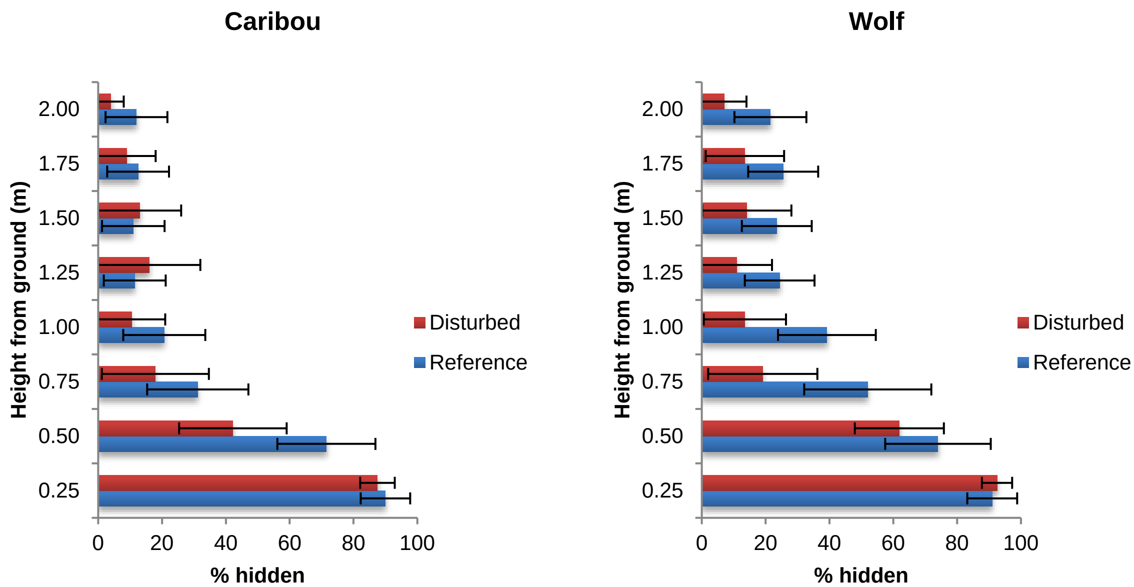


Figure 7.3-2B Visual Obstruction in Upland

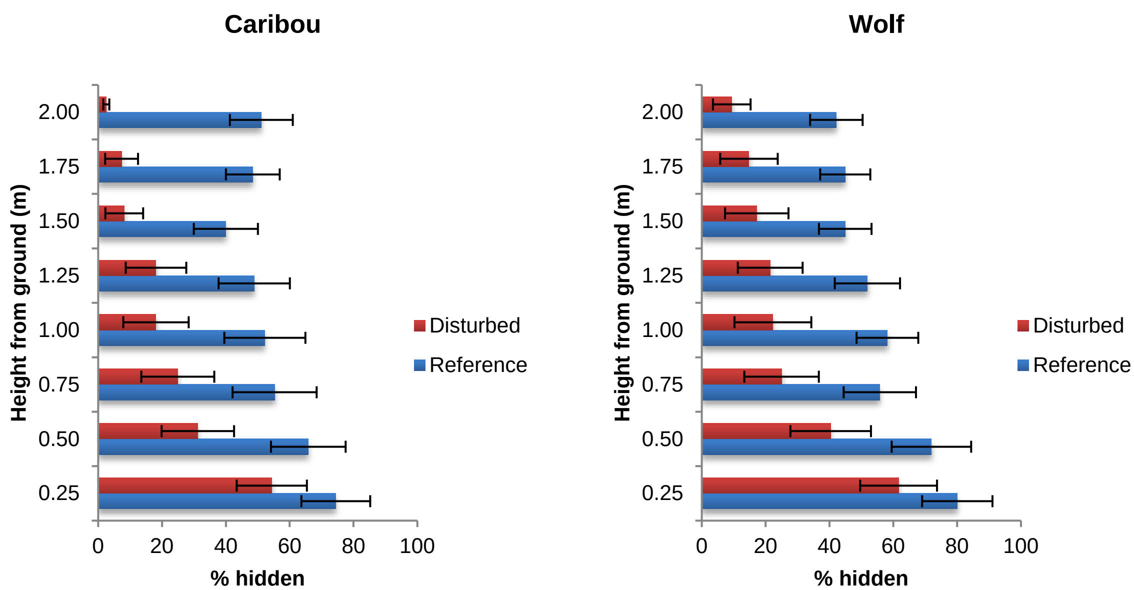
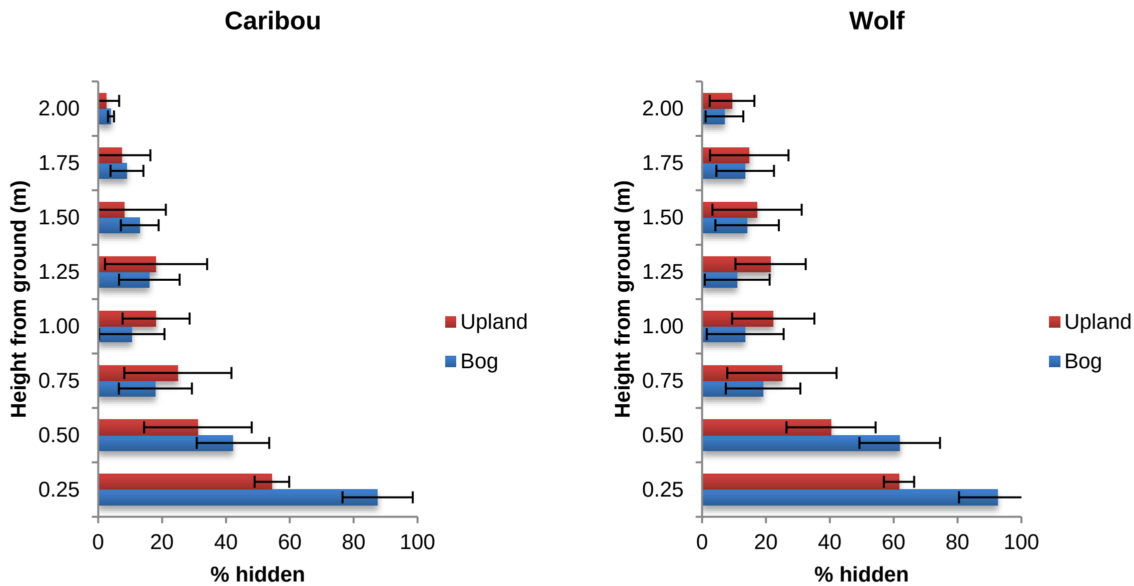


Figure 7.3-2C Visual Obstruction: Lowland (Bogs/Fens) versus Upland in Disturbed Areas



Note: The error bars are standard errors around the means.

Figure 7.3-3A Visual Obstruction in Young Forest (< 40 Years Old)

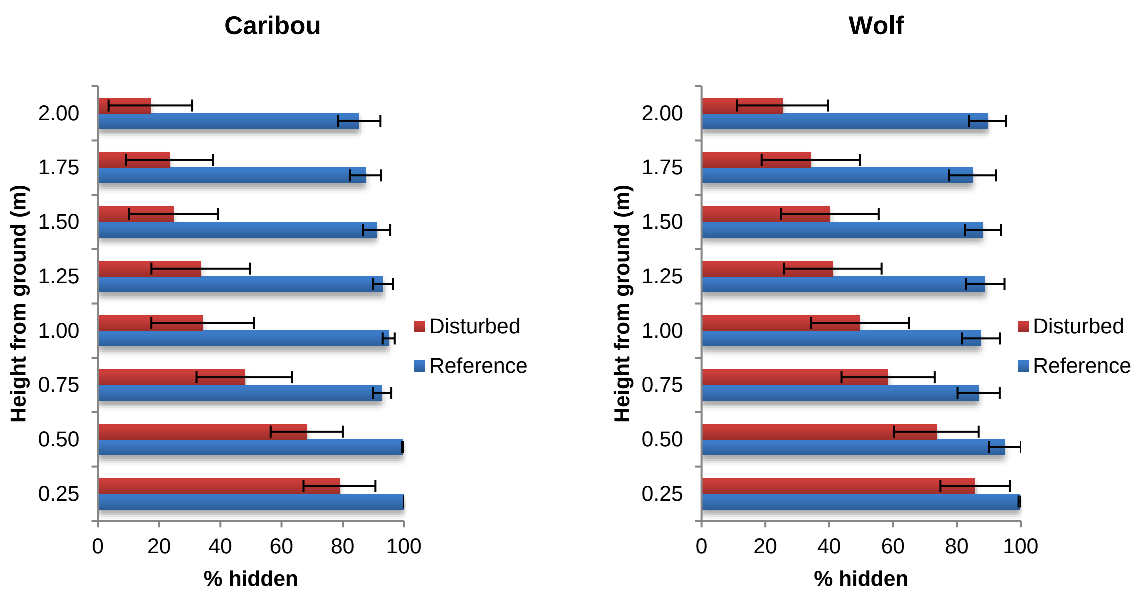


Figure 7.3-3B Visual Obstruction in Old Forest (> 40 Years Old)

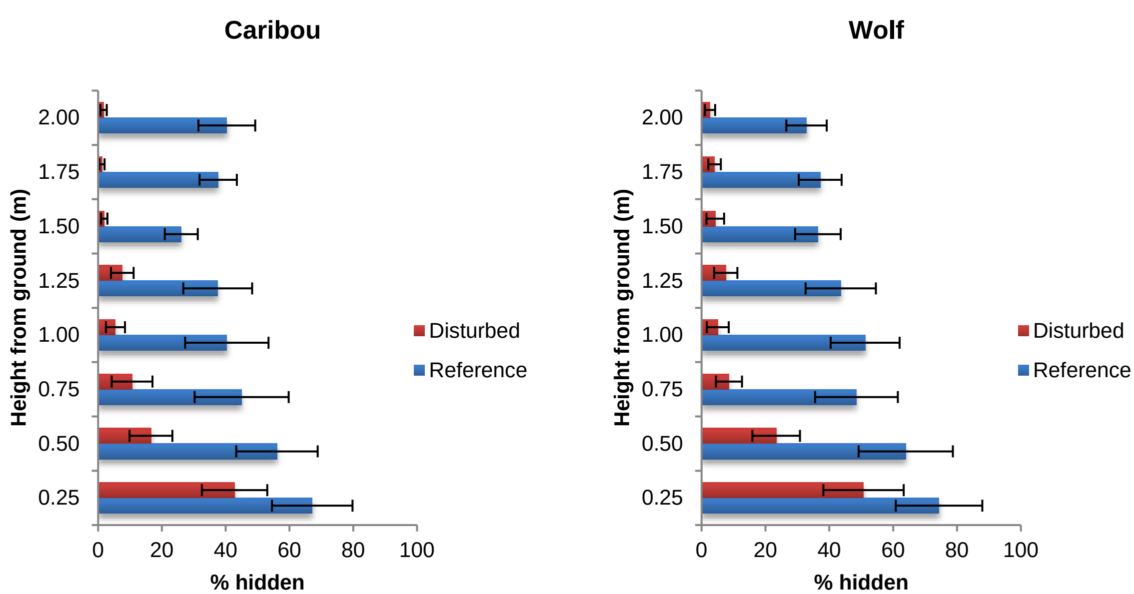


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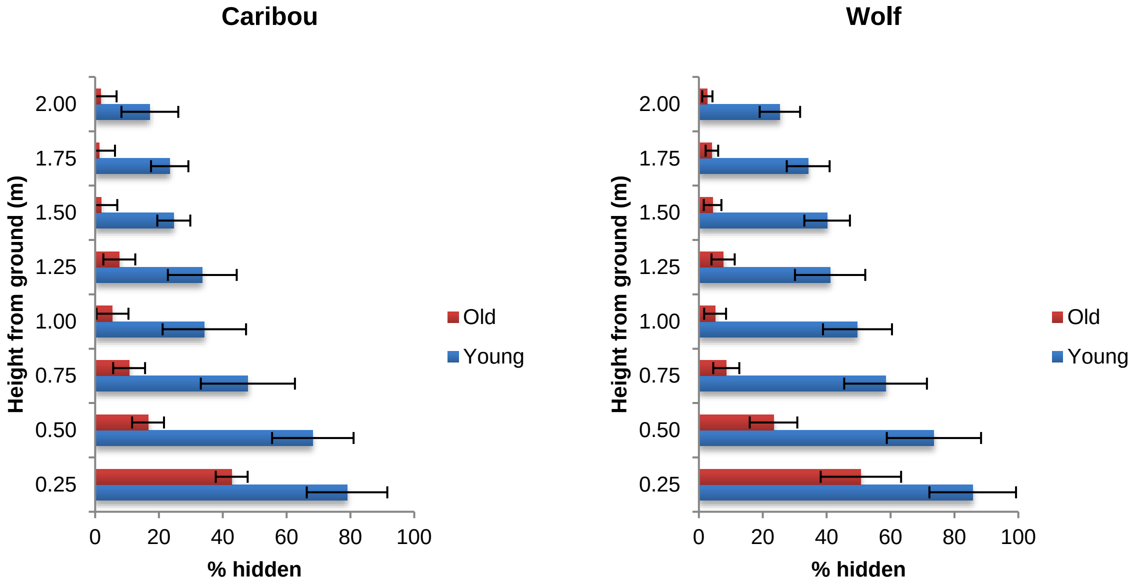
Figure 7.3-3C Visual Obstruction: Old versus Young Forest in Disturbed Areas



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Note: The error bars are standard errors around the means.

Figure 7.3-4A Visual Obstruction in Areas with No Human Use

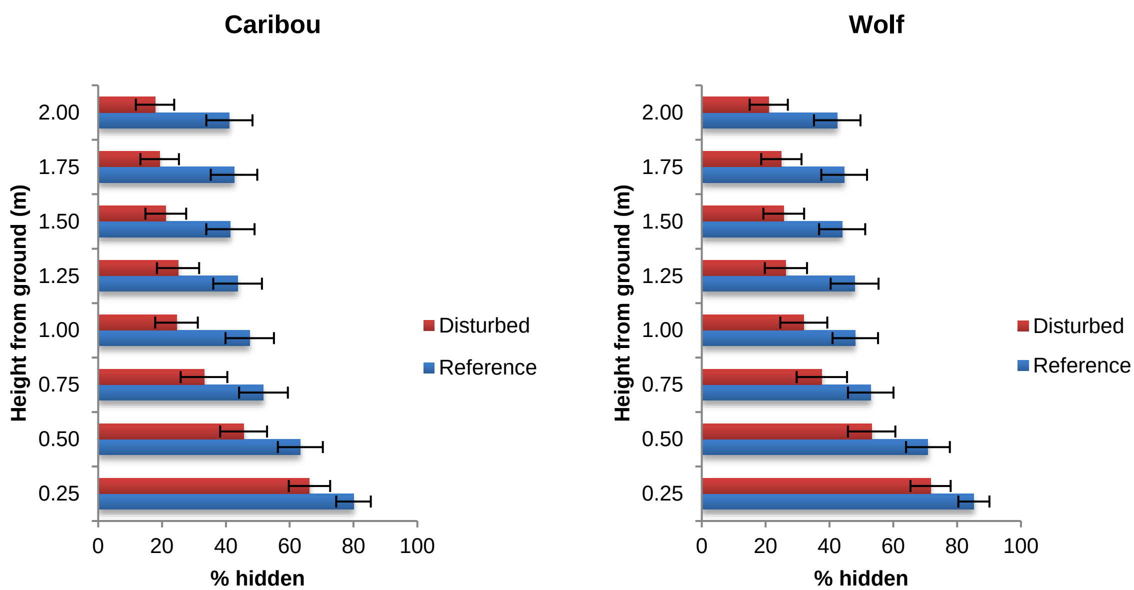

Figure 7.3-4B Visual Obstruction in Areas with Low Human Use

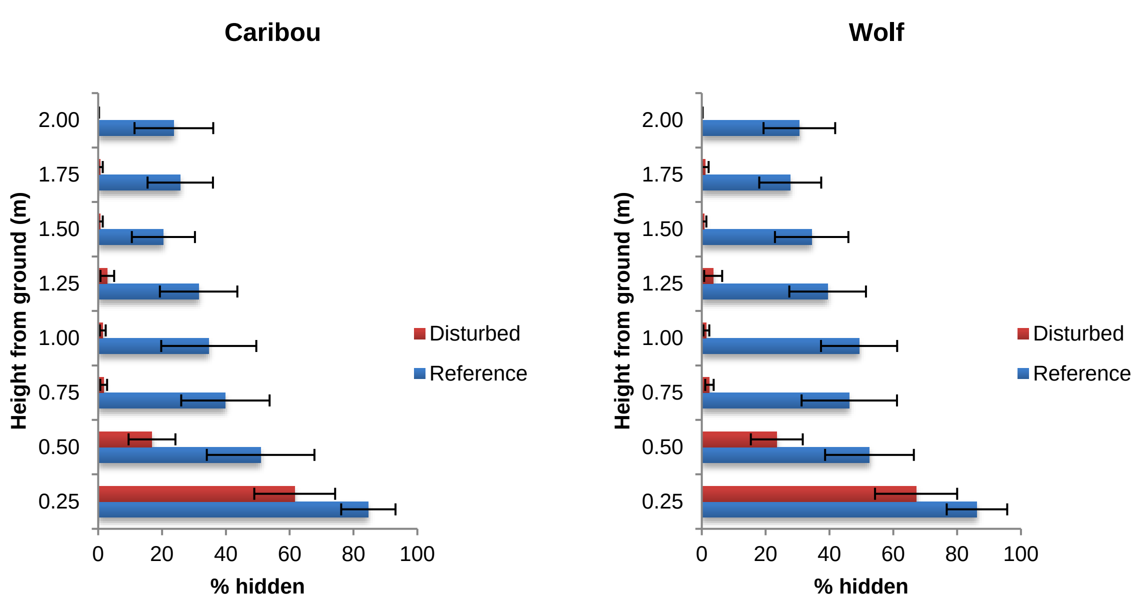

Figure 7.3-4C Visual Obstruction in Areas with Moderate Human Use

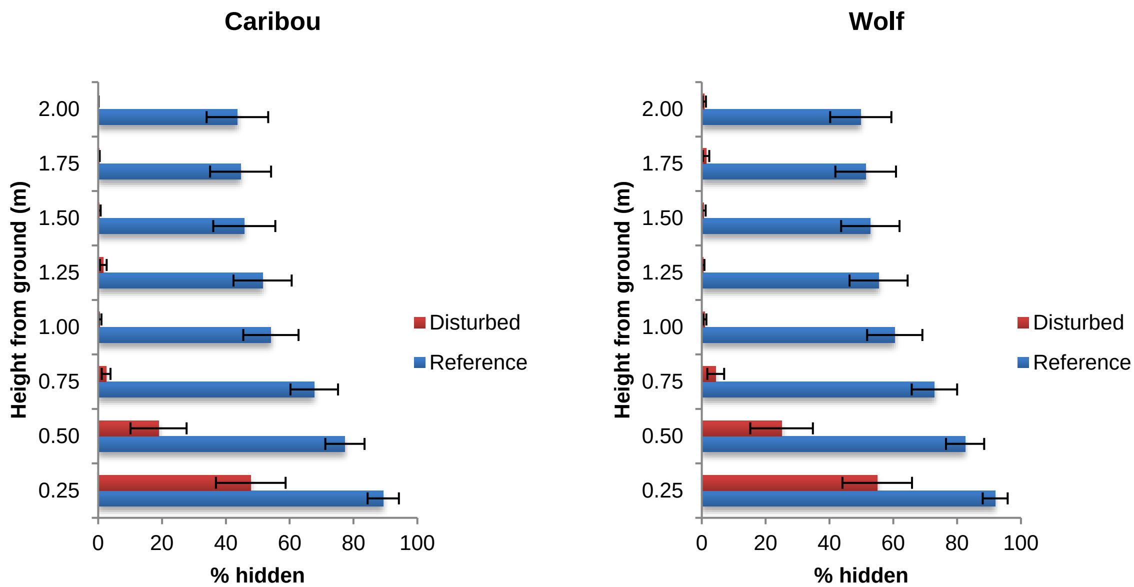

Figure 7.3-4D Visual Obstruction in Areas with High Human Use

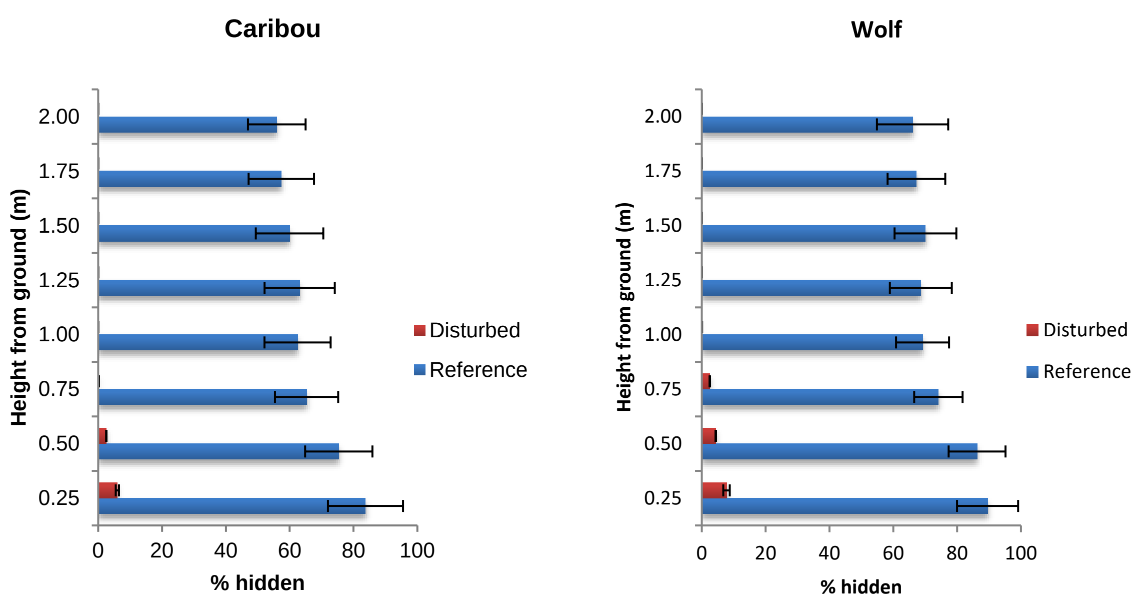

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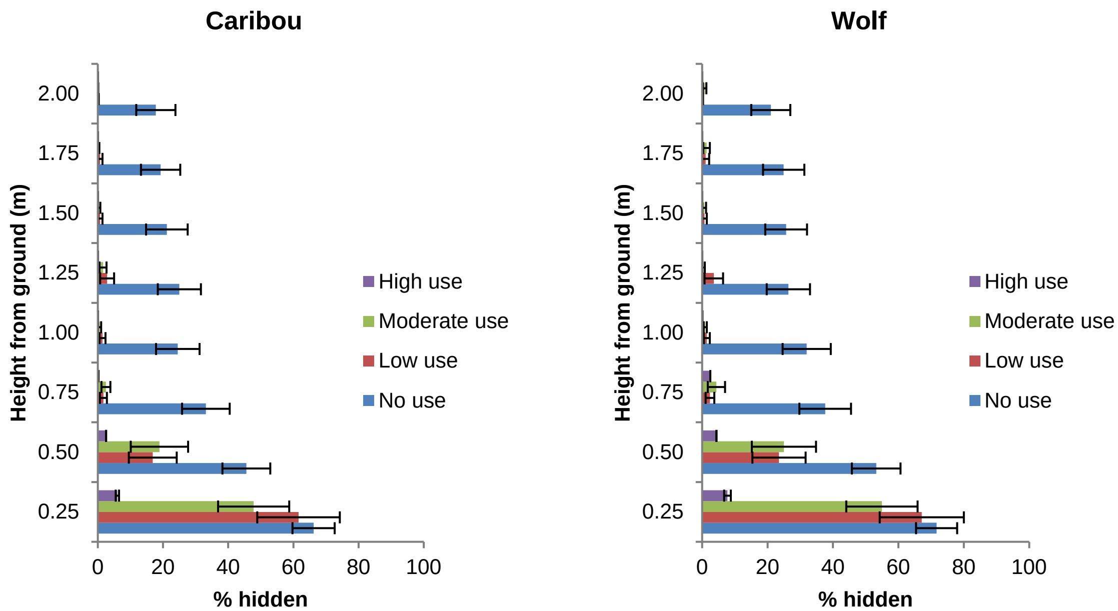
Figure 7.3-4E Visual Obstruction in Areas of Varying Degrees of Human Use



Note: The error bars are standard errors around the means.

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7.3.2 Vegetation Recovery

Line Cut Before Versus After Fire

Areas burned before line creation had significantly higher shrub (3 m to 5 m) cover (P=0.02) and a strong trend towards higher shrub (1 m to 3 m) cover (P=0.17) in the reference compared to disturbed areas (Figure 7.3-5A). However, the average cover of lichens, mosses, and low shrubs were similar in reference and disturbed areas for areas burned before and after line creation. Also, areas that had burned after line creation had no significant difference in disturbed versus reference areas (Figure 7.3-5B), emphasizing the importance of fires for initiating regrowth on disturbed linear features.

Upland versus Lowland

Lowlands generally had higher moss and forb cover, and a lower lichen cover than uplands (Figure 7.3-6). This is likely due to site conditions (e.g., soil moisture) rather than as a result of disturbance since there were no significant differences between reference and disturbed areas for either the lowland or upland transects.

Young Forest versus Old Forest

There was a trend (P=0.062) towards higher cover of lichen in old forests compared to young forests regardless of disturbance levels (Figure 7.3-7). There was also a strong trend (P=0.055) for higher shrub cover (1 m to 3 m) in young forests, an indication that young forests are likely to recover faster than old forests post disturbance.

Figure 7.3-5A Vegetation Cover/ Stem Counts in Areas Burned Before Line was Created

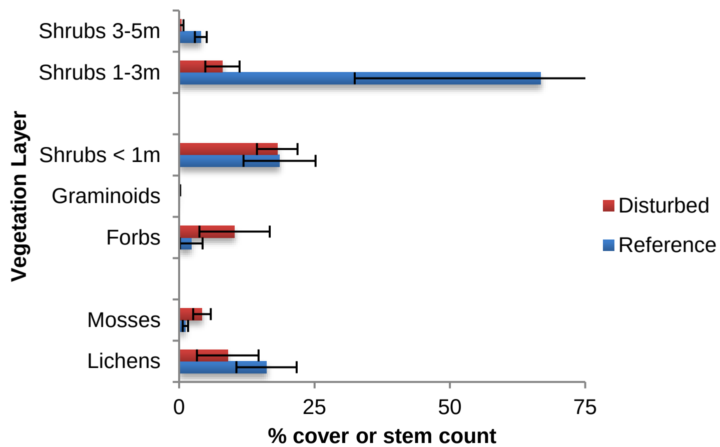
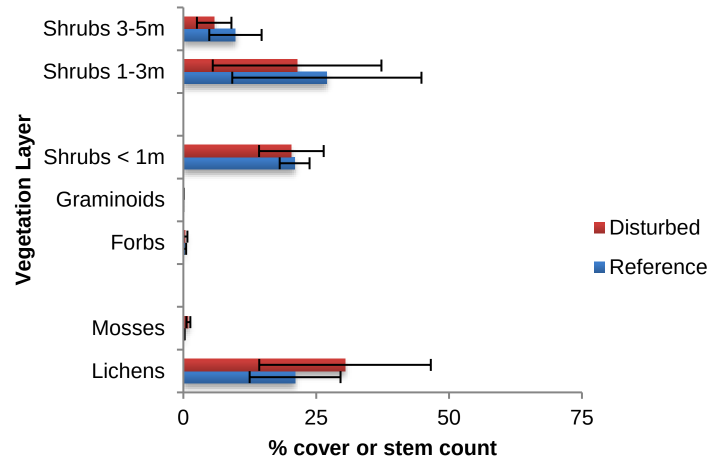


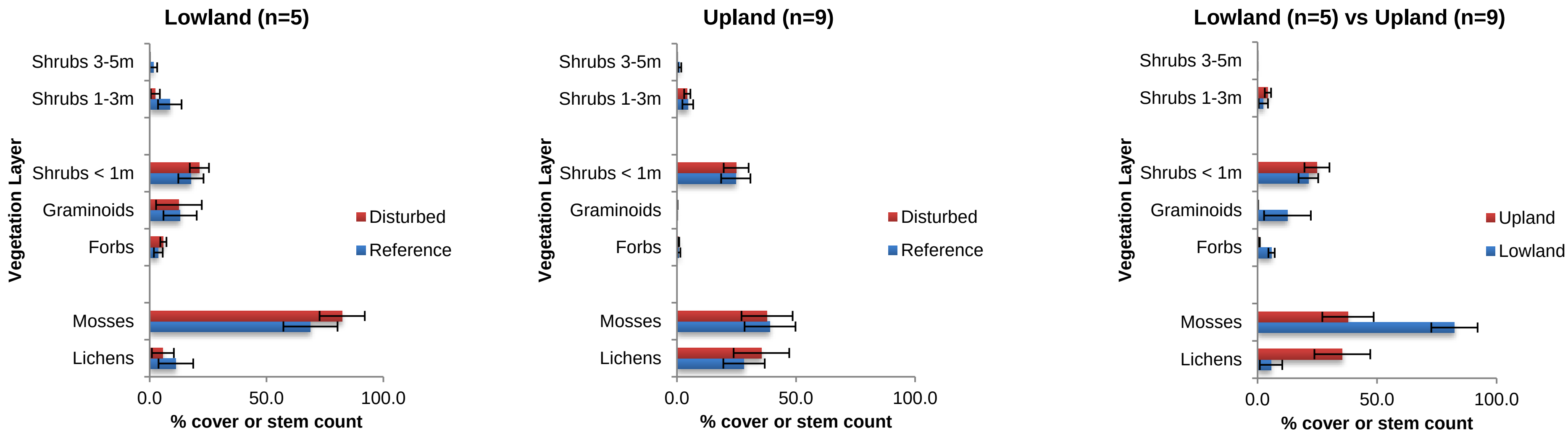
Figure 7.3-5B Vegetation Cover/ Stem Counts in Areas Burned After Line was Created



Note: 2-29 years since fire (n=5). Error bars are standard errors around the means.

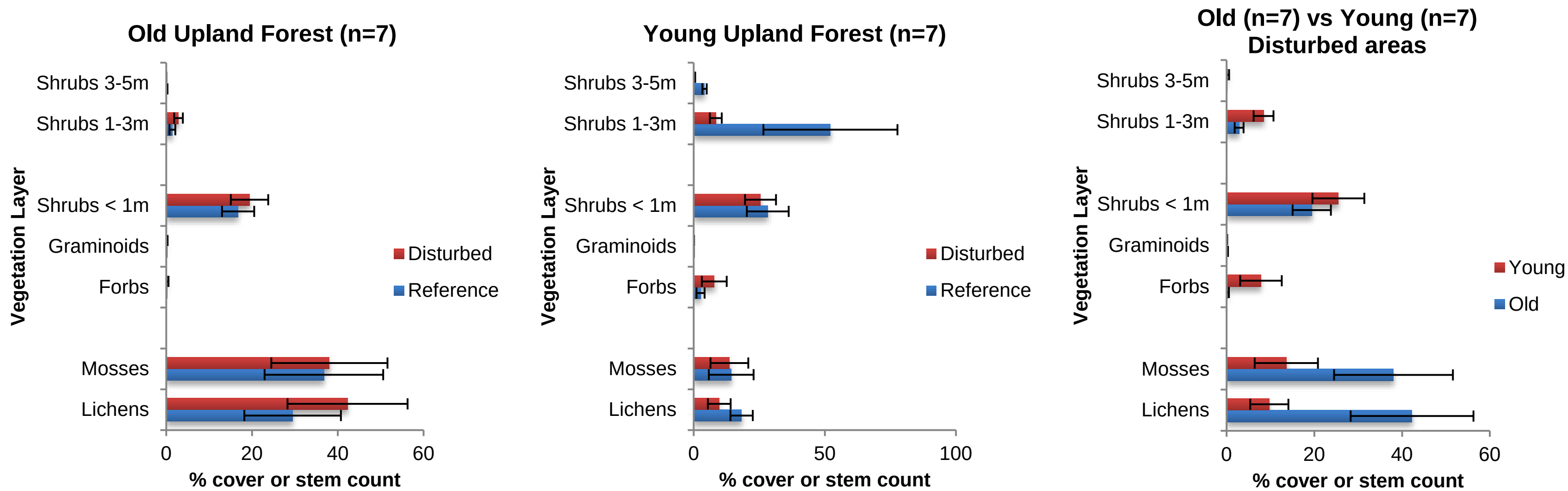
Figure 7.3-6 Vegetation Recovery: Lowland (Bogs/Fens) versus Upland

Note: Error bars are



standard errors around the means.

Figure 7.3-7 Vegetation Recovery: Old Forest versus Young Forest



Note: Error bars are standard errors around the means.

Level of Human Use

Similar to the analysis of visual obstruction, human use significantly affected vegetation regrowth. There was no significant difference between reference and disturbance for the no use areas. Moderate use areas had some regrowth in the shrub layers, and high use areas had minimal regrowth (Figure 7.3-8). This highlights the harmful effects on natural regrowth resulting from continued human use of disturbance features.

7.3.3 Tree Species Composition

Line Cut Before versus After Fire

Features that had burned after the line was created showed a higher abundance of jack pine (22[2]) than areas that had not burned after line creation (15), despite opposite abundance values for control areas (Table 7.3-2). This supports the findings of visual obstruction and vegetation regrowth that wildfire effects on trails and hand cuts, in absence of continued human use, substantially accelerate natural recovery. Further, this indicates that recovery post fire is similar on and off disturbances.

Upland versus Lowland

Both Lowland and Upland areas had a low abundance of tree species in disturbed areas (Table 7.3-3) indicating that, at the time of sampling, there was minimal natural recovery where no fire disturbance has occurred.

Young Forest versus Old Forest

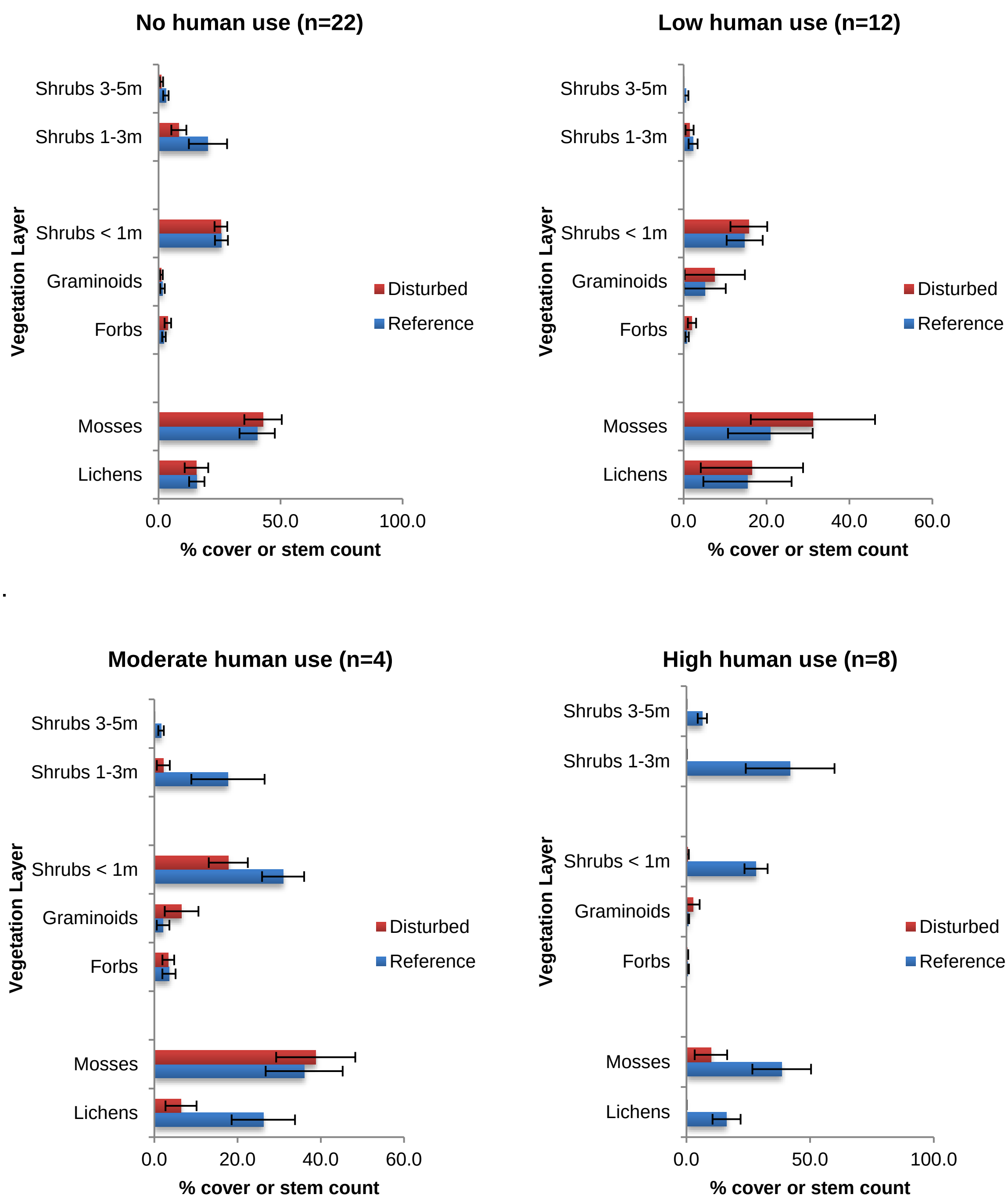
Both Old and Young areas had a low abundance of tree species in disturbed areas (Table 7.3-4) indicating that, at the time of sampling, there is minimal natural recovery in areas where no fire disturbance has occurred. Given the reproductive nature of the dominant upland conifer species (jack pine) and the necessity for disturbance by fire for serotinous cones, this result is not a surprise.

Level of Human Use

Areas with no, low, and moderate human had a much higher abundance of tree species regeneration compared to high use areas (Table 7.3-5). This highlights the deleterious effects of continued human use of disturbance features on natural regrowth.

[2] This is not a percent cover value, but a normalized relative abundance of each species compared to other species (values: 0-100).

Figure 7.3-8 Vegetation Recovery: Level of Human Use



Note: Error bars are standard errors around the means.

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Table 7.3-2 Species (< 1 m tall) Ranking and Compositional Information: Areas Burned Before and After Line was Cut.

	Area burned before line was created 2-29 years since fire (n=5)	
Rank	Reference	Disturbed
1	Vaccmyr (83)	Vaccmyr (75)
2	Vaccvit (31)	Vaccvit (60)
3	Pinuban (30)	Rhodgro (29)
4	Alnucri (19)	Pinuban (15)
5	Rhodgro (16)	Vibuedu (11)
6	Betupap (4)	Alnucri (11)
7	Arctuva (3)	Rosaaci (10)
8		Betupap (7)
9		Ribegla (4)
10		Poputre (4)

Area burned after line was created 2-29 years since fire (n=5)	
Reference	Disturbed
Vaccmyr (100)	Vaccmyr (83)
Vaccvit (31)	Vaccvit (34)
Rhodgro (26)	Pinuban (22)
Arctuva (23)	Junihor (21)
Chamcal (17)	Chamcal (15)
Pinuban (15)	Rhodgro (15)
Alnucri (12)	Arctuva (6)

Coniferous tree species
Ericaceous shrub species
Deciduous shrub species

Note: Values in brackets show abundance of each species. This is not a percentage cover value, but a normalized relative abundance of each species compared to other species (values: 0-100). Species code details can be found in Appendix A.

Table 7.3-3 Species (< 1 m tall) Ranking and Compositional Information: Lowland & Upland.

	Lowland (n=5)	
Rank	Reference	Disturbed
1	Rhodgro (68)	Chamcal (75)
2	Chamcal (63)	Rhodgro (60)
3	Kalmpol (49)	Kalmpol (52)
4	Picemar (40)	Oxycmic (36)
5	Oxycmic (36)	Vaccvit (24)
6	Andrpol (20)	Picemar (20)
7	Vaccvit (18)	Andrpol (16)
8	Rhodtom (10)	Betupum (16)
9	Myriga (5)	Myriga (13)
10	Betupum (5)	Salibeb (8)

Upland (n=9)	
Reference	Disturbed
Vaccmyr (100)	Vaccmyr (91)
Vaccvit (87)	Vaccvit (87)
Rhodgro (54)	Rhodgro (52)
Alnucri (23)	Alnucri (20)
Arctuva (12)	Pinuban (9)
Kalmpol (11)	Picemar (8)
Chamcal (9)	Arctuva (5)
Picemar (2)	Salisco (5)
	Kalmpol (2)

Coniferous tree species
Ericaceous shrub species
Deciduous shrub species

Note: Values in brackets show abundance of each species. This is not a percentage cover value, but a normalized relative abundance of each species compared to other species (values: 0-100). Species code details can be found in Appendix A.

Table 7.3-4 Species (< 1 m tall) Ranking and Compositional Information: Old and Young Forest.

	Old Upland Forest (n=7)		Young Upland Forest (n=7)	
Rank	Reference	Disturbed	Reference	Disturbed
1	Vaccmyr (100)	Vaccvit (93)	Vaccmyr (98)	Vaccmyr (91)
2	Vaccvit (99)	Vaccmyr (88)	Rhodgro (42)	Vaccvit (87)
3	Rhodgro (42)	Rhodgro (53)	Vaccvit (40)	Rhodgro (52)
4	Arctuva (15)	Alnucri (13)	Alnucri (30)	Alnucri (20)
5	Alnucri (15)	Picemar (10)	Pinuban (24)	Pinuban (9)
6	Picemar (3)	Pinuban (9)	Kalmpol (15)	Vibuedu (8)
7		Arctuva (6)	Chamcal (12)	Rosaaci (5)
8		Salisco (6)	Betupap (3)	Betupap (5)
9			Arctuva (3)	Ribegla (2)
10				

Coniferous tree species
Ericaceous shrub species
Deciduous shrub species

Note: Values in brackets show abundance of each species. This is not a percentage cover value, but a normalized relative abundance of each species compared to other species (values: 0-100). Species code details can be found in Appendix A.

Table 7.3-5 Species (< 1 m tall) Ranking and Compositional Information: Level of Human Use.

Rank	No Human Use (n=28)		Low Human Use (n=7)		Moderate Human Use (n=13)		High Human Use (n=12)	
	Reference	Disturbed	Reference	Disturbed	Reference	Disturbed	Reference	Disturbed
1	Vaccmyr (76)	Vaccmyr (70)	Rhodgro (100)	Rhodgro (88)	Rhodgro (79)	Chamcal (70)	Vaccmyr (91)	Chamcal (12)
2	Rhodgro (64)	Vaccvit (63)	Vaccmyr (51)	Chamcal (52)	Chamcal (58)	Rhodgro (61)	Vaccvit (89)	Rhodgro (10)
3	Vaccvit (56)	Rhodgro (62)	Vaccvit (51)	Vaccvit (48)	Vaccvit (46)	Picemar (52)	Pinuban (44)	Salibeb (5)
4	Chamcal (54)	Chamcal (46)	Chamcal (45)	Kalmpol (41)	Vaccmyr (42)	Kalmpol (36)	Rhodgro (43)	Vaccvit (4)
5	Kalmpol (30)	Kalmpol (26)	Kalmpol (26)	Vaccmyr (41)	Oxycmic (40)	Oxycmic (31)	Chamcal (29)	Vaccmyr (3)
6	Oxycmic (26)	Oxycmic (26)	Oxycmic (13)	Picemar (24)	Picemar (39)	Vaccmyr (26)	Arctuva (23)	Betupap (3)
7	Picemar (20)	Picemar (17)	Picemar (13)	Oxycmic (20)	Pinuban (17)	Vaccvit (18)	Oxycmic (22)	Kalmpol (2)
8	Rhodtom (16)	Pinuban (14)	Arctuva (12)	Myriga (12)	Arctuva (15)	Andrpol (16)	Picemar (15)	Oxycmic (2)
9	Alnucri (16)	Rhodtom (13)	Alnucri (7)	Betupum (8)	Betupum (13)	Salibeb (12)	Kalmpol (12)	Andrpol (0)
10	Andrpol (14)	Andrpol (12)	Myriga (4)	Salibeb (8)	Kalmpol (9)	Betupap (11)	Alnucri (9)	Arctuva (0)

Coniferous tree species
Ericaceous shrub species
Deciduous shrub species

Note: Values in brackets show abundance of each species. This is not a percentage cover value, but a normalized relative abundance of each species compared to other species (values: 0-100). Species code details can be found in Appendix A.

7.3.4 Key Findings

- Wildfires (in absence of continued human use), can substantially accelerate natural regeneration of trails and hand cuts, and instigate a post fire recovery that is more similar on and off disturbance features than in the absence of fire.
- Natural vegetation recovery of tree/shrub height and abundance on disturbed features is somewhat greater in lowland habitats.
- Human use is an important factor affecting natural vegetation regrowth. Eliminating Access to trails could enhance natural recovery.
- Results indicate that natural vegetation recovery on disturbances is lower in mature upland habitats.

8.0 SUMMARY

The Rook I Project (Project) is a proposed new uranium mining and milling operation that is 100% owned by NexGen Energy Ltd. (NexGen). The Project is located in northwestern Saskatchewan, approximately 40 km east of the Alberta-Saskatchewan border, 130 km north of the town of La Loche, and 640 km northwest of the city of Saskatoon.

Omnia Ecological Services collected terrestrial (wildlife and vegetation resources) baseline data in support of the proposed development of the Project.

The objectives of the Omnia terrestrial baseline surveys were to, using available peer reviewed research and applicable professional protocols:

- characterize the existing terrestrial environment in the region (natural and anthropogenic elements);
- inform environmental effects and technical assessments;
- ensure the baseline studies meet all provincial and federal regulatory requirements for the effects assessment;
- capture information from community engagements and stakeholder considerations;
- establish a framework to facilitate future environmental effects monitoring; and
- support the development of project specific mitigation strategies.

This report documents and summarizes baseline (current) anthropogenic and natural disturbance, ecosite characterization, and a linear feature natural regeneration assessment based on data obtained during field programs completed in 2018 and 2019.

The Omnia terrestrial baseline surveys were established using three nested study areas to guide effects assessments of Project-specific and cumulative impacts on potential wildlife valued components (VC) including: a local study area (LSA); a regional study area (RSA); and a caribou regional study area (CRSA).

Using the refined anthropogenic disturbance map product (unbuffered), the total amount of anthropogenic disturbance was 0.8 km^2 (2.0%) in the LSA and 2.1 km^2 (0.5%) in the RSA. Industrial clearings, rough roads, and right-of-ways (ROW) were the most common anthropogenic disturbance types in the LSA. A comparison of the refined anthropogenic disturbance mapping versus the unbuffered EC (2012a) linear feature data set found the refined LSA map had a linear feature density 8.3 times higher than the EC (2012a) data set. Comparatively, the refined RSA anthropogenic map had a linear feature density that was 7.6 times greater than EC (2012a). Refined anthropogenic mapping indicated five linear feature types (road, rough road, trail, cutline, and ROW) in the LSA and RSA, while the EC (2012a) data set only detected one type (road). This difference was as a result of the approach and scale (1:30,000) of the mapping completed by EC (2012a).

Based on Saskatchewan Ministry of Environment mapping, a total of 19 fires have occurred in the Project CRSA since 1945. The age of these fires ranges from recent (2018) to 51 years. In the terrestrial part of the LSA, RSA, and CRSA, 85.9%, 90.4%, and 94.3%, respectively, has burned in the last 40 years.

Predictive Ecosite Mapping data was obtained from the Saskatchewan Technical Branch, however the mapping does not describe land cover types less than 40 years old. Therefore, an Interpreted ecosite Map was created. The accuracy of the resulting ecosite map, taking into consideration the newly created regenerating forest ecosite types, was 80.2%, and included 27 different ecosite classifications.

A detailed description of each sampled ecosite type is provided in the form of a two-page fact sheet. The first page of the fact sheet contains information about species composition and vegetation layers. The second page provides information about structural attributes and ratings as well as biodiversity information and ecosite supply in the RSA.

For the linear feature natural regeneration assessment program, the key findings were:

- Wildfires (in absence of continued human use), can substantially accelerate natural regeneration of trails and hand cuts, and instigate a post fire recovery that is more similar on and off disturbance features than in the absence of fire. Natural vegetation recovery of tree/shrub height and abundance on disturbed features is somewhat greater in lowland habitats.
- Human use is an important factor affecting natural vegetation regrowth. Access to trails limits natural recovery in some areas.
- Results indicate that natural vegetation recovery on disturbances is lower in mature upland habitats.

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10.0 APPENDICES

Appendix A

Appendix A. Species Observations during Plant Structural Diversity, Species Richness Assessment and Ecosite Characterization Survey.

Scientific Name	Common Name	Species Code	SKCDC Rank
Trees			
Betula papyrifera	Paper birch	Betupap	
Larix laricina	Tamarack	Larilar	
Picea glauca	White spruce	Picegla	
Picea mariana	Black spruce	Picemar	
Pinus banksiana	Jack pine	Pinuban	
Populus balsamifera	Balsam poplar	Popubal	
Populus tremoloides	Trembling aspen	Popultre	
Shrubs			
Alnus crispa	Green alder	Alnucri	
Alnus rugosa	River alder	Alnurug	
Andromeda polifolia	Bog rosemary	Andrpol	
Arctostaphylos uva-ursi	Common bearberry	Arctuva	
Betula glandulosa	Bog birch	Betugla	
Betula pumila	Dwarf birch	Betupum	
Chamaedaphne calycaluta	Leatherleaf	Chamcal	
Kalmia polifolia	Bog laurel	Kalmpol	
Linnea borealis	Twinflower	Linnbor	
Myrica gale	Sweet gale	Myrigal	
Oxycoccus microcarpus	Small bog cranberry	Oxycmic	
Rhododendron tomentosum	Northern Labrador tea	Rhodtom	
Rhododendron groenlandicum	Labrador tea	Rhodgro	
Ribes glandulosum	Skunk currant	Ribegla	
Ribes hudsonianum	Northern black currant	Ribehud	
Ribes oxyacanthoides	Wild gooseberry	Ribeoxy	
Ribes triste	Wild red currant	Ribetri	
Rubus acaulis	Dwarf raspberry	Rubuaca	
Rubus idaeus	Raspberry	Rubuida	
Salix bebbiana	Bebb's willow	Salibeb	
Salix candida	Hoary willow	Salican	
Salix myrtillifolia	Billberry willow	Salimyr	
Salix pedicellaris	Bog willow	Saliped	
Salix planifolia	Diamondleaf willow	Salipla	
Salix scouleriana	Scouler's willow	Salisco	
Salix serissima	Autumn willow	Saliser	
Salix sp.	Unknown willow	Sali sp.	
Vaccinium myrtilloides	Blueberry	Vaccmyr	
Vaccinium vitis-idaea	Bog cranberry	Vaccvit	

Appendix A cont.

Forbs			
Aralia nudicaulis	Wild sarsaparilla	Aralnud	
Athyrium filix-femina ssp. angustatum	Subarctic ladyfern	Athyang	S3
Calla palustris	Wild calla lilly	Callpal	
Caltha palustris	Marsh marigold	Caltpal	
Cerastium sp.	-	Cera sp.	
Cornus canadensis	Bunchberry	Corncan	
Drosera anglica	Angle-leaved sundew	Drosang	S3
Drosera rotundifolia	Round-leaved sundew	Drosrot	
Epilobium angustiflorum	Fireweed	Epilang	
Epilobium glaberrimum	Glaucus willowherb	Epilgla	
Epilobium palustre	Marsh willowherb	Epilpal	
Epilobium sp.	-	Epil sp.	
Equisetum fluviatile	Water horsetail	Equiflu	
Equisetum sylvaticum	Woodland horsetail	Equisyl	
Fragaria vesca	Woodland strawberry	Fragves	
Fragaria virginiana	Wild strawberry	Fragvir	
Galium trifidum	Threepetal bedstraw	Galitri	
Geocaulon lividum	Bastard toadflax	Geocliv	
Hippuris vulgaris	Common mare's-tail	Hippvul	
Lemna minor	Lesser duckweed	Lemnmin	S1
Lycopodium annotinum	Stiff clubmoss	Lycoann	
Lycopodium complanatum	Ground cedar	Lycocom	
Maianthemum canadense	Wild lily-of-the-valley	Maiacan	
Melampyrum lineare	Cow wheat	Melalin	
Menyanthes trifoliata	Buckbean	Menytri	
Potentilla norvegica	Rough cinquefoil	Potenor	
Potentilla palustris	Swamp cinquefoil	Potepal	
Potentilla tridentata	Three-toothed cinquefoil	Potetri	
Pyrola secunda	One-sided pyrola	Pyrosec	
Rubus arcticus ssp. acaulis	Dwarf raspberry	Rubuaca	
Rubus chamaemorus	Cloudberry	Rubucha	
Rubus pubescens	Running raspberry	Rubupub	
Rumex orbiculatus	Water dock	Rumeorb	

Appendix A cont.

Forbs cont.			
Scheuchzeria palustris	Scheuchzeria	Schepal	
Scutellaria galericulata	Marsh skullcap	Scutgal	
Smilacina trifolia	Three-leaved Solomon's seal	Smiltri	
Symphyotrichum sp.	-	Symp sp.	
Unknown forb	Unknown forb	Unk forb	
Utricularia intermedia	Flatleaf bladderwort	Utriint	
Viola renifolia	Kidney-leaved violet	Violren	
Viola sp	Violet sp.	Viol sp.	
Graminoids			
Agrostis scabra	Rough bentgrass	Agrosca	
Calamagrostis canadensis	Blue-joint grass	Calacan	
Carex aquatilis	Water sedge	Careaqu	
Carex brunnescens	Short sedge	Carebru	
Carex concinna	Low northern sedge	Carecon	S3
Carex disperma	Two-seeded sedge	Caredis	
Carex foenea	Hay Sedge	Carefoe	
Carex hookerana	Hooker's Sedge	Carehoo	
Carex limosa	Mud sedge	Carelim	
Carex rostrata	Beaked sedge	Careros	
Carex sp.	Sedge sp.	Care sp.	
Carex utriculata	Northwest territory sedge	Careutr	
Eriophorum scheuchzeri	White cotton grass	Eriosch	S2
Eriophorum vaginatum	Sheated cottongrass	Eriovag	
Festuca rubra	Red fescue	Festrub	
Juncus nodosus var. nodosus	Knotted Rush	Juncnod	
Oryzopsis pungens	Northern rice grass	Oryzpun	
Scirpus lacustris	Common Great Bulrush	Scrilac	
Unknown graminoid	Unknown graminoid	Unk gram	
Mosses			
Calliergon giganteum	Giant calliergon moss	Callgig	
Cinclidium stygium	Lurid cupola moss	Cincsty	
Dicranum fuscum	Dicranum moss	Dicrfus	
Dicranum polysetum	Cushion moss	Dicrpol	
Dicranum scoparium	Broom fork moss	Dicrsco	
Dicranum sp.	Broom moss	Dicr sp.	
Drepanocladus aduncus	Drepanocladus moss	Drepadu	
Drepanocladus unciatus	Brown moss	Drepunc	

Appendix A cont.

Mosses cont.			
Hylocomium splendens	Stair-step moss	Hylospl	
Hypnum revolutum	Revolute hypnum moss	Hypnrev	
Jamesoniella autumnalis	Waldo Lake liverwort	Jameaut	S3
Jungermannia sp.	-	Jung sp.	
Lepidozia reptans	Creeping Fingerwort	Lepirep	S3
Leptodictyum sp.	-	Lept sp.	
Lophozia ventricosa	Lophozia liverwort	Lophven	S3
Marchantia polymorpha	Green-tongue Liverwort	Marcpol	
Meesia longiseta	Meesia moss	Meeslon	
Meesia triquetra	Three-ranked humpmoss	Meestri	
Mylia anomala	Anomalous flapwort	Myliano	S3
Plagiomnium ellipticum	Elliptic plagiomnium moss	Plagell	
Plagiomnium sp.	Leafy moss	Plag sp.	
Pleurozium schreberi	Schreber's moss	Pleusch	
Polytrichum juniperinum	Juniper hair-cap	Polyjun	
Polytrichum piliferum	Hair-cap moss	Polypil	
Ptilidium ciliare	Ptilidium liverwort	Ptilcil	
Ptilidium pulcherrimum	Naugehyde liverwort	Ptilpul	S3
Ptilium crista castrensis	Knight's plume moss	Ptilcas	
Sanionia uncinata	Sickle-leaved Hook Moss	Saniunc	
Scorpidium revolvens	Limprichtia Moss	Scorrev	
Sphagnum angustifolium	Poor Fen Peat Moss	Sphaang	
Sphagnum capillifolium	Acute-leaved Peat Moss	Sphacap	
Sphagnum fuscum	Rusty Peat Moss	Sphafus	
Sphagnum girgensohnii	Girgensohn's Peat Moss	Sphagir	
Sphagnum jensenii	Jensen's sphagnum	Sphajen	
Sphagnum magellanicum	Midway Peat Moss	Sphamag	
Sphagnum riparium	Shore-growing Peat Moss	Spharip	
Sphagnum teres	Thin-leafed peat moss	Sphater	
Straminergon stramineum	Straw-coloured Water Moss	Strastr	
Tomenthypnum nitens	Golden moss	Tomenit	
Unknown moss	Unknown moss	Unk moss	

Appendix A cont.

Lichens			
Arctoparmelia centrifuga	Concentric ring lichen	Arctcen	S2
Cetraria ericetorum	Iceland lichen	Cetreri	S3
Cetraria islandica	True Iceland lichen	Cetrisl	S3
Cladina mitis	Green reindeer lichen	Cladmit	
Cladina rangiferina	Gray reindeer lichen	Cladran	
Cladina stellaris	Star-tipped reindeer lichen	Cladste	
Cladonia sp.	Cladonia lichen	Clad sp.	
Cladonia borealis	Boreal pixie-cup	Cladbor	S3
Cladonia botrytes	Wooden soldiers	Cladbot	
Cladonia cariosa	Split-peg lichen	Cladcar	
Cladonia cenotea	Powdered funnel lichen	Cladcen	S3
Cladonia coniocraea	Common powderhorn	Cladcon	S2
Cladonia cornuta	Bighorn cladonia	Cladcor	
Cladonia crispata	Organ-pipe lichen	Cladcrisp	S3
Cladonia cristatella	British soldiers	Cladcrist	S3
Cladonia deformis	Lesser sulphur-cup	Claddef	S3
Cladonia gracilis spp. turbinata	Smooth cladonia	Cladtur	
Cladonia pleurota	Red-fruited pixie-cup	Cladple	S2
Cladonia sulfurina	Greater sulphur-cup	Cladsul	S2
Cladonia uncialis	Thorn cladonia	Caldunc	
Flavocetraria nivalis	Crinkled snow lichen	Flavniv	S3
Icmadophila ericetorum	Candy lichen	Icmaeri	
Parmeliopsis ambigua	Green starburst lichen	Parmamb	S3
Parmeliopsis hyperopta	Gray starburst lichen	Parmhyp	S3
Peltigera aphthosa	Common freckle pelt	Peltaph	S2
Peltigera malacea	Apple Pelt	Peltmal	S3
Peltigera neopolydactyla	Carpet pelt	Peltneo	
Rhizocarpon geographicum	Green Map Lichen	Rhizgeo	S2
Stereocaulon tomentosum	Woolly foam lichen	Stertom	
Vulpicida pinastri	Powdered sunshine lichen	Vulppin	

Appendix B

Appendix B. Transect Details for the Linear Feature Natural Regeneration Assessment

Transect #	Easting	Northing	Feature Type	Ecosite	Landcover Type	Age (years since fire)	Age Group	Burned after line was cut?	Human Use Class
1	605004	6388177	Trail	BP3	Upland	61-70	old	no	0
2	603690	6387686	Cutline	BP14	Upland	71-80	old	no	1
3	603419	6387392	Cutline	RF2-C	Upland	21-30	young	yes	0
4	603181	6386798	Cutline	BP2	Upland	71-80	old	no	0
5	602087	6387691	Trail	RF2-C	Upland	21-30	young	no	4
6	601496	6388211	Road	BP3	Upland	81-90	old	no	5
7	610926	6396181	Trail	RF4	Upland	1-10	young	yes	2
8	610162	6395003	Cutline	RF4-bog	Lowland	1-10	young	yes	1
9	609922	6394297	Cutline	RF4-bog	Lowland	1-10	young	yes	1
10	608758	6396381	Handcut	RF4-upland	Upland	1-10	young	yes	0
11	603826	6396722	Road	BP3	Upland	101-110	old	no	4
12	600867	6396763	Handcut	RF1-C	Upland	31-40	young	no	0
13	597033	6396087	Road	RF1-C	Upland	31-40	young	no	5
14	595517	6391514	Trail	BP2	Upland	31-40	young	no	3
15	595030	6388782	Handcut	RF2-C	Upland	21-30	young	no	0
16	594999	6388559	Trail	RF2-C	Upland	21-30	young	no	4
17	594699	6388909	Handcut	BP24	Lowland	N/A	-	no	0
18	594303	6388776	Handcut	BP20	Lowland	N/A	-	no	0
19	593464	6387462	Handcut	RF1-D	Upland	21-30	young	no	0
20	597709	6387422	Handcut	RF2-B	Lowland	21-30	young	yes	0
21	608401	6387516	Trail	BP26	Lowland	41-50	old	yes	2
22	608349	6387319	Trail	BP23	Lowland	81-90	old	no	2
23	608182	6386969	Trail	BP19	Lowland	91-100	old	no	2
24	608097	6384029	Trail	RF2-C	Upland	31-40	young	no	3
25	607642	6385417	Handcut	BP19	Lowland	61-70	old	no	0
26	607278	6386327	Handcut	BP21	Lowland	61-70	old	no	0
27	607337	6386271	Handcut	RF4-treed bog	Lowland	1-10	young	yes	0
28	607340	6386261	Trail	RF4-treed bog	Lowland	1-10	young	yes	1
29	595862	6389815	Handcut	BP20	Lowland	N/A	-	no	0
30	596048	6389897	Handcut	BP20	Lowland	61-70	old	no	0
31	593964	6383483	Trail	RF2-C	Upland	21-30	young	no	4
32	597082	6384081	Road	RF2-C	Upland	21-30	young	no	5
33	597032	6380073	Road	RF2-C	Upland	21-30	young	no	5
34	599423	6385550	Trail	BP26	Lowland	31-40	young	no	1
35	599768	6385158	Trail	RF2-bog	Lowland	21-30	young	no	2
36	603372	6391731	Trail	RF2-bog	Lowland	21-30	young	yes	4
37	603262	6393659	Trail	BP23	Lowland	81-90	old	no	4
38	603659	6393997	Handcut	BP14	Upland	91-100	old	no	0
39	602486	6390678	Trail	RF1-D	Upland	21-30	young	no	2
40	602532	6390665	Handcut	RF1-D	Upland	21-30	young	no	0
41	605184	6389768	Trail	RF2-bog	Lowland	21-30	young	yes	3
42	603621	6388578	Handcut	RF1-C	Upland	21-30	young	no	1
43	599229	6386410	Road	RF2-C	Upland	21-30	young	no	5
44	598968	6387236	Handcut	RF2-C	Upland	21-30	young	no	0
45	607312	6389460	Cutline	BP19	Lowland	91-100	old	yes	0
46	607009	6389679	Cutline	BP12	Upland	81-90	old	no	0
47	606954	6389790	Handcut	BP19	Lowland	61-70	old	no	0
48	607445	6389338	Cutline	RF4-treed bog	Lowland	1-10	young	yes	0
49	607578	6389124	Cutline	RF4-upland	Upland	1-10	young	yes	0
50	606305	6390473	Cutline	RF2-bog	Lowland	21-30	young	yes	0
51	605905	6390770	Cutline	RF2-bog	Lowland	21-30	young	yes	2
52	605749	6390913	Cutline	BP19	Lowland	101-110	old	no	2
53	605514	6391131	Cutline	RF2-bog	Lowland	21-30	young	yes	2
54	605370	6391263	Cutline	RF2-C	Upland	21-30	young	yes	0
55	600919	6396973	Cutline	RF1	Upland	31-40	young	no	0
56	601668	6398210	Handcut	BP2	Upland	91-100	old	no	0
57	595059	6391533	Trail	RF1-C	Upland	21-30	young	no	3
58	595864	6391813	Cutline	RF1-C	Upland	21-30	young	yes	0
59	595715	6391699	Cutline	BP2	Upland	81-90	old	no	1
60	605233	6390677	Road	BP19	Lowland	71-80	old	no	5

Appendix C

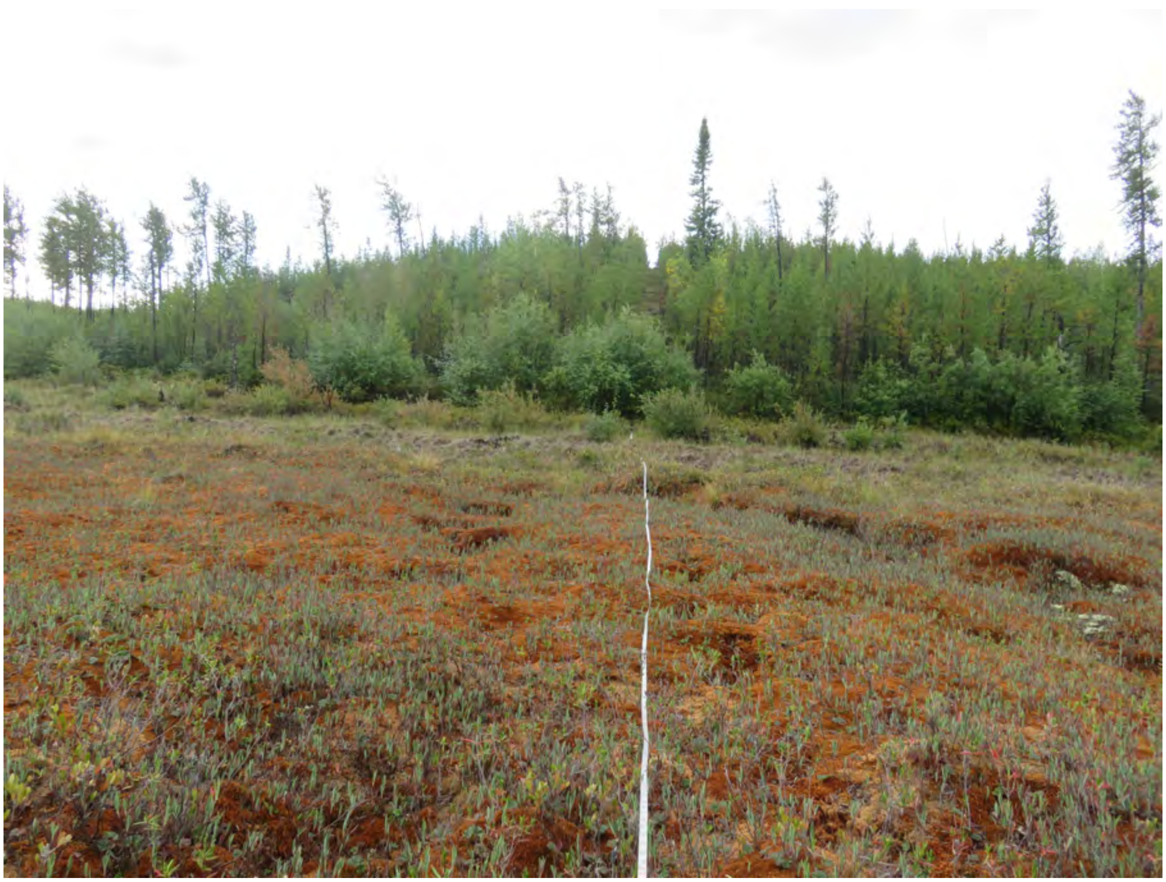
Appendix C. Example Photos from the Linear Feature Natural Regeneration Assessment.

Photograph 7.2-1. Area burned after line creation.

Photograph 7.2-2. Area burned before line creation.

BACK

Photograph 7.2-3. Mature upland.



Photograph 7.2-4. Lowland (bog).


Photograph 7.2-5. No human use (0).


Photograph 7.2-6. Low human use (1).


Photograph 7.2-7. Low/Moderate human use (2).


Photograph 7.2-8. Moderate human use (3).


Photograph 7.2-9. Moderate/High human use (4).


Photograph 7.2-10. High human use (5).

Rook I Project

Environmental Impact Statement

Annex VII.2: Vegetation Baseline Report 2 (Inventory, Rare Plants, and Wetlands)

CanNorth
Canada North Environmental Services Limited Partnership
A First Nation Environmental Services Company

VEGETATION BASELINE REPORT 2
(INVENTORY, RARE PLANTS, AND WETLANDS)
FOR THE ROOK I PROJECT

Final Report

Prepared by:

Canada North Environmental Services
Saskatoon, Saskatchewan

Prepared for:

NexGen Energy Ltd.
Saskatoon, Saskatchewan

Project No. 3008

September 2021

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EXECUTIVE SUMMARY

The Rook I Project (Project) is a proposed new uranium mining and milling operation that is 100% owned by NexGen Energy Ltd. (NexGen). The Project would be located in northwestern Saskatchewan, approximately 40 kilometres (km) east of the Alberta-Saskatchewan border, 130 km north of the town of La Loche, and 640 km northwest of the city of Saskatoon. The vegetation inventory baseline program is a component of a comprehensive baseline program that documents the natural and socio-economic environments in the anticipated area of the Project. Information obtained through database searches and field surveys will be used alongside Indigenous Knowledge in the Environmental Assessment and cumulative effects assessment, to inform Project planning, and for developing future monitoring programs and reclamation plans.

The vegetation inventory baseline program was conducted to obtain comprehensive information characterizing terrestrial environments, wetlands, and aquatic and terrestrial vegetation communities, and to document species of conservation concern (SOCC) and associated habitats in near vicinity to the Project (Site Study Area [SSA]) and a broader Local Study Area (LSA). The SSA consisted of an area 25 km^2 in size encompassing the entire proposed Project footprint, and the LSA consisted of an area 225 km^2 surrounding and including the SSA. To meet study objectives, SOCC database searches, terrestrial and aquatic vegetation inventory surveys, and wetland classifications were completed.

A list of 276 plant species with conservation concern was compiled from database searches of the Mid-Boreal Upland and Athabasca Plain ecoregions, none of which were listed by Committee on the Status of Endangered Wildlife in Canada or on Schedule 1 of the *Species at Risk Act*. The Hunting, Angling and Biodiversity of Saskatchewan (HABISask) database search identified four provincially rare plant species within 30 km of the centre of the SSA; the W.P. Fraser Herbarium and Species at Risk Public Registry database searches yielded no results. The four species previously found within 30 km of the SSA were all located in wetland or shoreline habitats. None of these species were found during field surveys completed in 2018.

Two terrestrial vegetation inventory surveys were conducted in the SSA and LSA in June and August 2018, and one aquatic vegetation inventory survey was completed in Patterson Lake near the Project in August 2018. Vegetation community and ecosite data, and rare plant and weed location, distribution, and abundance were recorded. A total of 164 terrestrial transects and 103 aquatic sampling points were surveyed in the SSA and LSA. Terrestrial vegetation surveys were completed using straight-line transects, and aquatic surveys were completed using a grid-sampling method. A total of 114 plant species were detected across both the terrestrial and aquatic vegetation inventory surveys. The dominant habitats within the SSA and area of the proposed Project consisted of regenerating and recently burned jack pine (*Pinus banksiana*) stands. Other vegetation communities present within the SSA include wetlands and moist mixedwood/deciduous forests. The aquatic vegetation inventory survey revealed that littoral zones in the four surveyed locations in Patterson Lake are largely non-vegetated.

A total of three provincially ranked rare plant species were identified during the vegetation inventory surveys, including two terrestrial plants and one aquatic plant. Both terrestrial rare plant species were sedges (*Carex* spp.), and were found growing in bogs, shrubby rich fens, and in moist forest areas. The aquatic plant water lobelia (*Lobelia dortmanna*) was found floating in Patterson Lake during the aquatic survey, but was not found growing in any of the shallow littoral areas searched.

Wetland classifications identified a total of 15 wetlands within the SSA and LSA and of these, 13 were within the SSA, 4 were in the immediate vicinity of the Project footprint, and 2 were directly inside the proposed Project footprint.

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Abbreviations	Definition
CanNorth	Canada North Environmental Services
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
EA	Environmental Assessment
EIS	Environmental Impact Statement
HABISask	Hunting, Angling and Biodiversity of Saskatchewan
LSA	Local Study Area
NexGen	NexGen Energy Ltd.
Project	Rook I Project
SARA	*Species at Risk Act*
SC	Study components
SKCDC	Saskatchewan Conservation Data Centre
SOCC	species of conservation concern
SOP	Standard Operating Procedures
SSA	Site Study Area
TLU	Traditional Land Use
VC	Valued component

Units	Definition
ha	hectare
km	kilometre
km^2	square kilometre
m	metre
%	percent

1.0 INTRODUCTION

The Rook I Project (Project) is a proposed new uranium mining and milling operation that is 100% owned by NexGen Energy Ltd. (NexGen). The Project would be located in northwestern Saskatchewan, approximately 40 kilometres (km) east of the Alberta-Saskatchewan border, 130 km north of the town of La Loche, and 640 km northwest of the city of Saskatoon (Figure 1.0-1). The Project would reside within Treaty 8 territory and within the Métis Homeland. At a regional scale, the Project would be situated within the southern Athabasca Basin adjacent to Patterson Lake, along the upper Clearwater River system (Figure 1.0-2). Access to the Project would be from an existing road off Highway 955. The Project would include underground and surface facilities to support the extraction and processing of uranium ore from the Arrow deposit, a land-based, basement hosted, high grade uranium deposit.

The vegetation inventory baseline program represents a component of a comprehensive baseline program that documents the natural and socio-economic environments in the anticipated area of the Project. The vegetation inventory baseline program was undertaken to provide context from which terrestrial environment effects from the Project can be assessed in the Environmental Impact Statement (EIS).

Since exploration at the Project commenced in 2013, NexGen has engaged regularly and established relationships with local First Nations and Métis Groups (collectively referred to as Indigenous Groups) and northern communities, specifically those closest and with greatest access to the proposed Project. NexGen respects the rights of Indigenous Peoples and the unique relationship Indigenous Peoples have with the environment, and recognizes the importance of full and open discussion with interested or potentially affected Indigenous communities regarding the development, operation, and decommissioning of the proposed Project. Engagement activities to date, as well as future planned engagement activities, reflect the value NexGen places on meaningful engagement with Indigenous and northern communities who could be potentially affected by the proposed Project. Engagement mechanisms have included, but are not limited to: meetings with leadership, workshops and community information sessions, Project site tours, establishing Joint Working Groups to support the gathering and incorporation of Indigenous and Métis Knowledge throughout the Environmental Assessment (EA) process, and providing funding for Traditional Land Use (TLU) Studies[1] to understand how the proposed Project may interact with the Indigenous communities' traditional use of the anticipated area of the Project.

Feedback received during engagement activities was documented for contribution to the EIS for the Project; examples of feedback received include discussion of concerns, interests, potential adverse effects, mitigation, and design alternatives. Many baseline studies were initiated in advance of formal engagement on the EA for the Project; however, engagement during the execution of baseline studies has helped inform the understanding of baseline conditions and confirmed components of the natural and socio-economic environments that required study. A summary of feedback related to the vegetation inventory baseline program is presented in Appendix A of the Vegetation Baseline Road Map (Annex VII).

Canada North Environmental Services (CanNorth) was retained to complete baseline investigations for select study components (SCs) for the Project. The details of studies conducted between June and August 2018 to characterize vegetation communities in terrestrial and aquatic environments are presented herein.

[1]Traditional Land Use (TLU) Studies include all land use studies developed by the Project's affected Indigenous Groups, including Traditional Land Use and Occupancy studies, Traditional Knowledge and Use studies, and Indigenous Rights and Knowledge studies, henceforth referred collectively as TLU Studies.

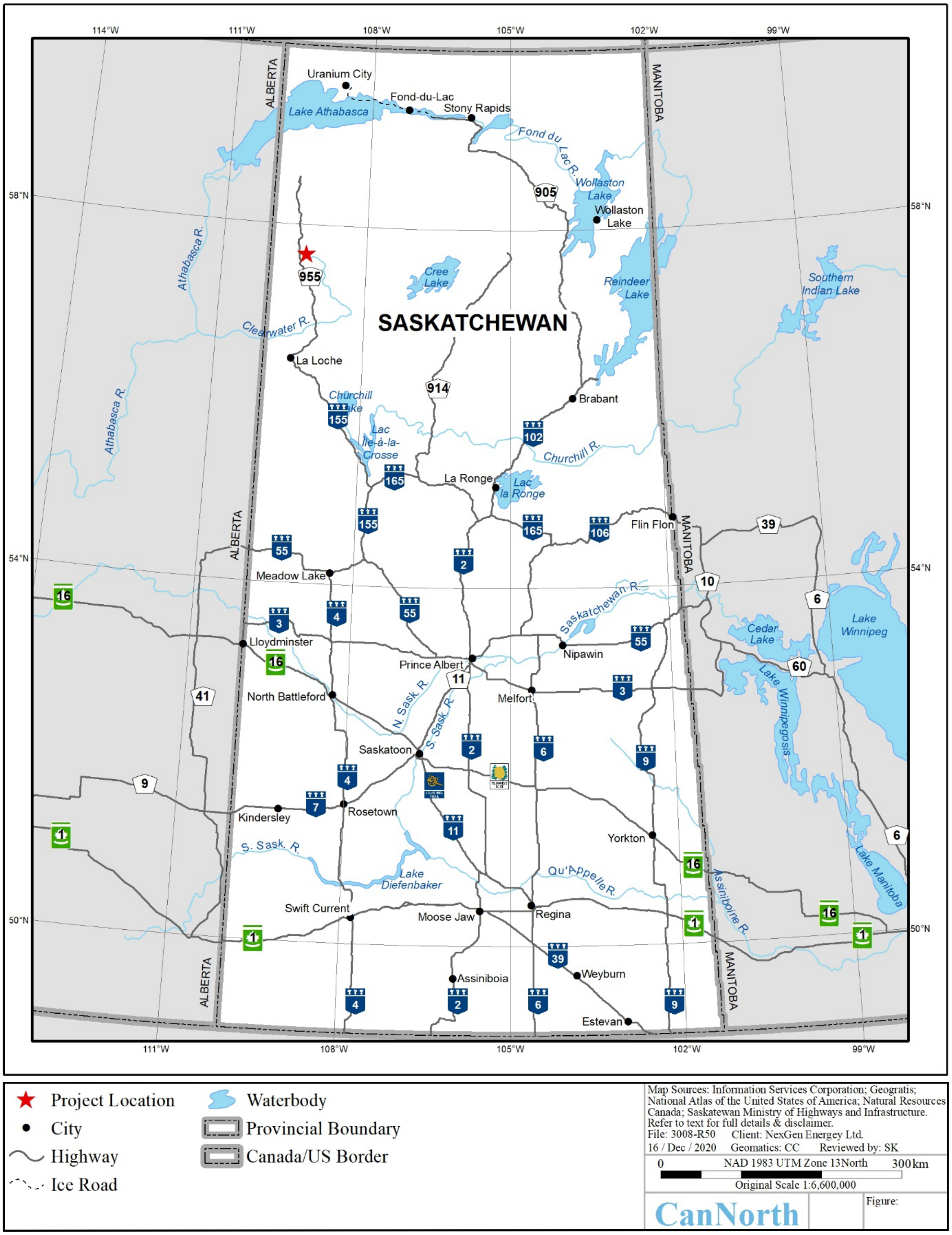

Figure 1.0-1: Location of the Rook I Project within Saskatchewan

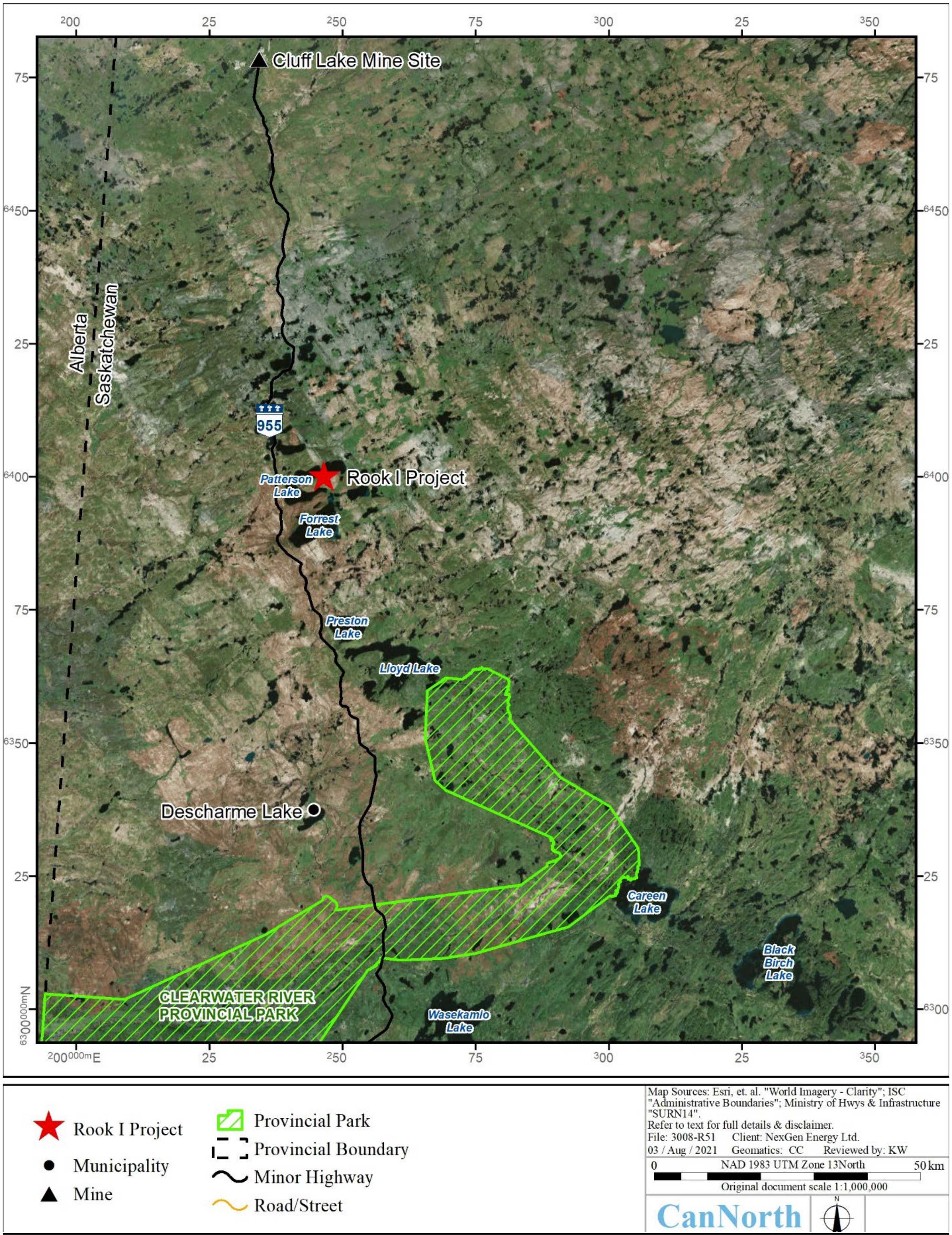

Figure 1.0-2: Location of the Rook I Project within the Region

1.1 Study Objectives

The objective of the vegetation baseline program was to obtain comprehensive information to characterize terrestrial environments, wetlands, and aquatic and terrestrial vegetation communities, and to document species of conservation concern (SOCC) and the associated habitats in study areas surrounding the Project. Study components were chosen for their potential to be selected as a valued component (VC) during the EA process, based on best practices for baseline characterization (ENV 2014; IAAC 2019; CNSC 2020). Valued components are those attributes that are scientifically, ecologically, historically, economically, socially, and culturally important to the government, Indigenous Groups, the public, the proponent, and other stakeholders (ENV 2014). Additionally, "the applicant or licensee should identify all biological species at risk (i.e., endangered, threatened, special concern, extirpated at a federal, provincial or municipal level) known to occur in the area or where the site is within the range of the species" (CNSC 2020).

A lifecycle approach was undertaken for the development and implementation of the Project baseline program that factored in data needs in the short and long term. This information is important for use in the EA and Project planning, and is also integral for developing future monitoring programs. Baseline data would be essential to compare with data obtained once the mine is operational and post-closure, and would inform future reclamation efforts, which was an aspect identified by during community feedback (WD Lewis & Associates Ltd. 2019). Furthermore, baseline vegetation surveys would provide pertinent data on the presence and abundance of traditional food and medicine types that were identified as important by Indigenous Groups in the region through TLU studies and Joint Working Groups (WD Lewis & Associates Ltd. 2019; YNLR 2020; Origins Heritage Consulting Inc. 2020). The information collected through desktop and field studies will be used alongside Indigenous Knowledge to provide a comprehensive and inclusive data set.

To meet study objectives, the following desktop and field studies were completed as part of the vegetation inventory baseline environment investigations for the Project:

- SOCC database searches;
- vegetation inventory surveys; and
- wetland classification.

Studies completed provided quantitative data collected using accepted standards of good scientific practice and up-to-date sampling procedures and equipment (ENV 2017a). The study design and objectives, methods, and results of each component of the vegetation baseline program conducted by CanNorth in 2018 are detailed in Sections 2.0, 3.0, and 4.0. Species nomenclature and common names used in this report follow the Saskatchewan Conservation Data Centre (SKCDC) taxa lists for vascular plants (SKCDC 2018), with the exception of select species used by McLaughlan et al. (2010) to describe forest ecosites, for which the common names used by McLaughlan are followed (e.g., jack pine [*Pinus banksiana*]).

1.2 Study Area

1.2.1 Ecoregion Description

The Project footprint lies within the Boreal Plain Ecozone, with some portions of the Local Study Area (LSA; described below) extending into the adjacent Boreal Shield Ecozone. The Project footprint is within the Firebag Hills landscape area of the Mid-boreal Uplands Ecoregion, whereas the LSA is encompassed by two ecoregions; the Firebag Hills landscape area of the Mid-boreal Uplands Ecoregion and the McTaggart Plain landscape area of the Athabasca Plain Ecoregion.

The Firebag Hills landscape area of the Mid-Boreal Upland Ecoregion is characterized by variable elevational gradients, ranging from 480 metres (m) to 580 m above sea level, with both strong and gentle rolling morainic hills (Acton et al. 1998). All water in this landscape area drains westward through the Clearwater River and associated watercourses. Regosolic soils are found predominantly on the eroding slopes of watercourses, whereas Dystric Brunisoic soils are found on more stable slopes and in the upland sections on top of sandy glacial till and glaciofluvial deposits. The vegetation on the northern part of this area is characterized by shrubby jack pine forests that possess lichen understoreys, a consequence of frequent forest fires and the sandy soils that lie beneath (Acton et al. 1998). Conversely, the poorly drained depression areas consist of tamarack (*Larix laricina*) and black spruce (*Picea mariana*) peatlands.

The McTaggart Plain landscape area of the Athabasca Plain Ecoregion has northward sloping hills from the southern point of this area, ranging from 540 m to 450 m above sea level (Acton et al. 1998). Sandy glaciofluvial deposits and eskers are abundant in the area, where Brunisolic soils can be found on the well-drained slopes and overtop the glacial till plains. Organic soils, Gleysolic soils, and Cryosolic soils dominate the poorly drained depression areas and large flat bogs, with permanently frozen Cryosolic soils occasionally present. Jack pine and black spruce stands dominate the slopes of many eskers, whereas open jack pine forests are exclusive to sandy glaciofluvial areas. The depression/boggy flat areas are covered in dense black spruce forests with stunted trees (Acton et al. 1998).

1.2.2 Vegetation Study Area

Study areas established for the terrestrial vegetation inventory investigations and wetland classifications conducted by CanNorth in 2018 were determined based on the deposit location, the preliminary site layout, regulatory requirements (provincial [ENV 2017a] and federal [IAAC 2019]), and consideration of study area sizes from other baseline investigations completed for other northern mining developments in Saskatchewan (e.g., CanNorth 2010; 2013a,b; AREVA 2016). Investigations were focused in a Site Study Area (SSA), as well as a LSA, which are centred on the Arrow deposit (Figure 1.2-1). The SSA consisted of an area 25 square kilometres (km^2)(5 km x 5 km) encompassing the entire proposed Project footprint, whereas the LSA consisted of an area 225 km^2 (15 km x 15 km) surrounding and including the SSA (Figure 1.2-1).

The SSA included the area where the deposit is located, and ultimately where the construction and mine operations would occur. The SSA area was where effects (i.e., total area subject to vegetation and soil disturbance, which may have direct and indirect effects on vegetation and wildlife) are expected to occur on the terrestrial environment (GS 2014). The LSA included the area surrounding the SSA where there is reasonable potential of direct and/or indirect effects on the terrestrial environment from the Project activities (GS 2014). The SSA and LSA boundaries are of an appropriate scale and location for assessment of effects on potential VCs resulting from existing and planned activities (CanNorth 2010; GS 2014; IAAC 2019). Note that these baseline study boundaries were defined at the beginning of the baseline field studies to inform the field study designs; however, the SSA and LSA vary from those chosen for EA conducted when the Project design was finalized.

Select areas of Patterson Lake located near the Project were the focus of the aquatic vegetation inventory survey. Patterson Lake discharges into Patterson Creek (part of the Clearwater River) and then flows east through a series of lakes including Forrest, Beet, and Naomi lakes as it makes its way through the Clearwater River system. The Clearwater River extends approximately 300 km, and is located in both

Saskatchewan and Alberta. It also runs through Clearwater Provincial Park, and has been granted Canadian Heritage River status.

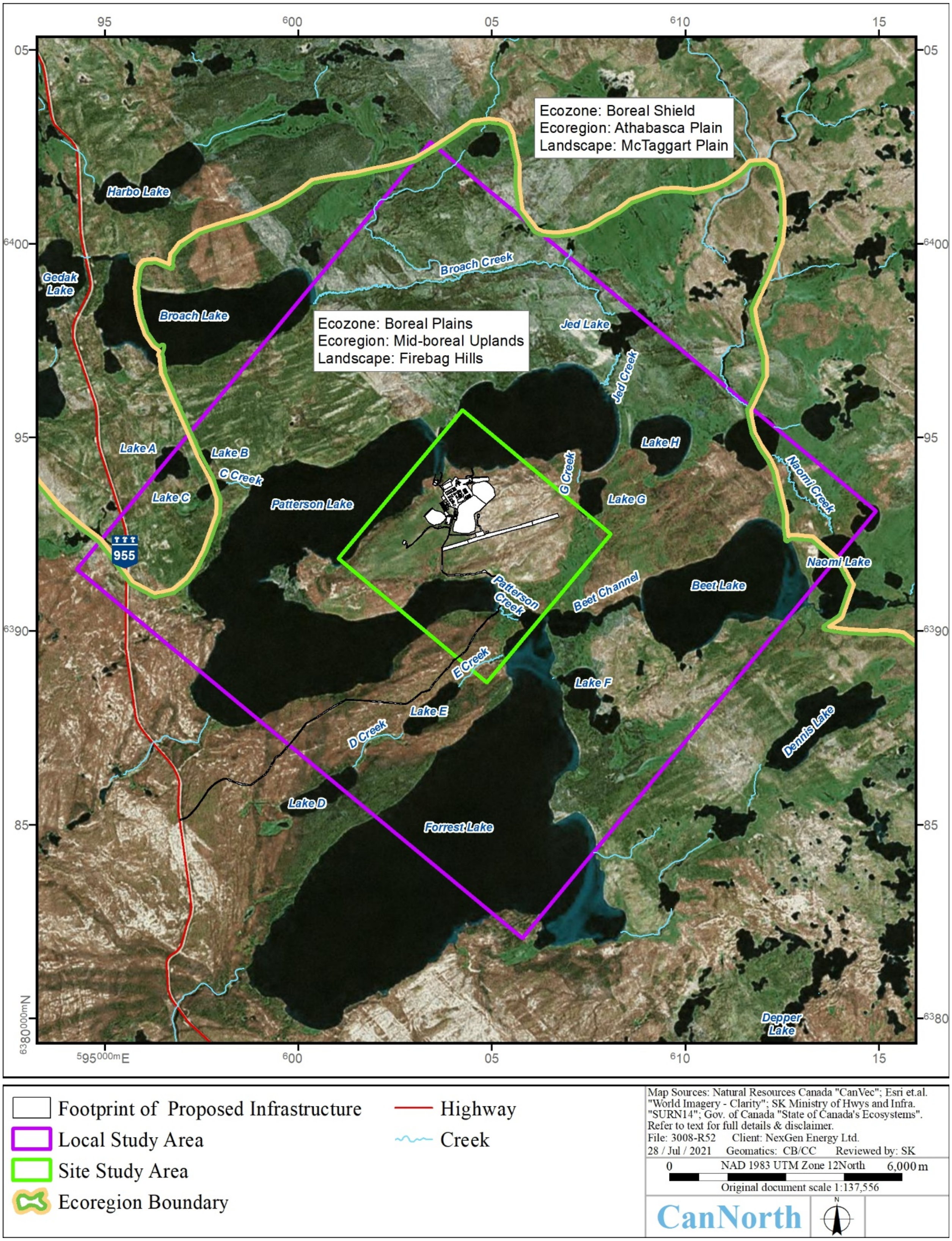

Figure 1.2-1: Site and Local Study Area for the Vegetation Baseline Studies, 2018

2.0 DATABASE SEARCHES

2.1 Study Objectives

To meet regulatory guidance and scientific best practices, database searches were completed to aid in describing terrestrial and aquatic environmental conditions (ENV 2014; IAAC 2019; CNSC 2020). The objectives of the database searches were to summarize ecosites, habitat boundaries, waterbody locations, and historical and geographical data on rare vascular plant SOCC found in the SSA and LSA. Results from database searches were used to plan the in-field terrestrial and aquatic vegetation surveys and wetland classifications, as well as inform field biologists of habitats which are likely to contain SOCC within the SSA and LSA.

2.2 Methods

Prior to field surveys, a list of federal and provincial vascular plant species with conservation concern was compiled. To identify any SOCC that may occur within the SSA and LSA, database searches were completed using the Hunting, Angling and Biodiversity of Saskatchewan (HABISask) mapping application (ENV 2018), the W.P. Fraser Herbarium (SASK 2018), and the Species at Risk Public Registry (SARPR 2018). Search areas used for the HABISask and W.P Fraser Herbarium database results encompassed a 30-km radius from the centre of the SSA. The list of provincially rare vascular plants that occur in the Mid-Boreal Upland and Athabasca Plain ecoregions was reviewed to determine if any protected species may occur within the LSA (including the SSA) (SKCDC 2018).

Search results for SOCC included species considered federally and/or provincially rare or sensitive that are expected to occur in the study areas, as well as previously recorded occurrences of rare, at-risk, and protected species in the vicinity of the LSA. Federally rare or sensitive species are designated as endangered, threatened, special concern, not at risk, or extirpated under Schedule 1 of the Species at Risk Public Registry (SARPR 2018). Provincially rare or sensitive species are designated S1 (critically imperiled/extremely rare), S2 (imperiled/very rare), S3 (vulnerable/rare to uncommon), SH (historically present without recent verification), SNR (species not yet provincially ranked), or SU (provincial status uncertain due to insufficient information) by the SKCDC (2018, 2021).

2.3 Results

The HABISask database search identified four provincially rare plant species within 30 km of the centre of the SSA and with potential to occur within the SSA or LSA; the W.P. Fraser Herbarium and Species at Risk Public Registry database searches yielded no results (SASK 2018; SKCDC 2018; Table 2.3-1). English sundew (*Drosera anglica*), hair-like beaked-rush (*Rhynchospora capillacea*), and horned bladderwort (*Utricularia cornuta*), which are all provincially-ranked S3, have been observed within 30 km of the centre of the SSA, but at least 10 km from the border of the LSA. Heart-leaved twayblade (*Listera cordata* var. *cordata*), which is provincially-ranked S3, has been observed within approximately 1 km of the LSA. Although no provincially rare plants have been documented within the SSA or LSA, due to the remote location of the Project the absence of observation information in HABISask may reflect lack of previous survey effort in the area rather than an absence of rare species. All four of the rare vascular plant species previously found within 30 km of the Project grow in wetland habitats, which was taken into consideration when designing the vegetation inventory and rare plant surveys. Two hundred and seventy six (276) provincially rare plants are known to occur in the Mid-Boreal Upland and Athabasca Plain ecoregions and have potential to occur within the SSA or LSA (SKCDC 2018, 2021; Appendix A, Table 1). None of the plant species identified in these database searches are federally listed by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) or on Schedule 1 of the *Species at Risk Act* (SARA) (SARPR 2018).

Table 2.3-1: Provincially Rare Vascular Plant Species Known to Occur within 30 km of the Centre of the Rook I Project

Scientific Name	Common Name	Provincial Rank and Activity Restriction Guidelines				Habitat
		SKCDC Rank	Protected Aspect	Restricted Activity Dates	Setback Distance (m)	
Drosera anglica	English sundew	S3	Occurrence	Year round	30	Marly shores, fens, and drainage tracks in peat bogs[a].
Rhynchospora capillacea	Hair-like beaked-rush	S3	Occurrence	Year round	30	Moist to wet calcareous fens, seeps over limestone or calcareous rock, and marsh meadows[a].
Listera cordata var. *cordata*	Heart-leaved twayblade	S3	Occurrence	Year round	30	Moist to wet, mossy spruce or mixedwood forests, swamps, and sphagnaceous bogs and fens[b].
Utricularia cornuta	Horned bladderwort	S3	Occurrence	Year round	30	Peaty or muddy shores and bogs[c].

Source: Scientific, common names, and provincial rank from SKCDC (2021); Activity restriction guidelines for high-disturbance activities as per ENV (2017b).

SKCDC = Saskatchewan Conservation Data Centre. S2 = Imperiled/very rare; S3 = Vulnerable/rare to uncommon.

[a]Source: FNA 2018.

[b]Source: Harms and Leighton 2011.

[c]Source: Looman and Best 1979.

3.0 VEGETATION INVENTORY AND RARE PLANT SURVEY

3.1 Study Objectives

To meet regulatory guidance and scientific best practices, field surveys were completed to assist in describing terrestrial and aquatic environmental conditions (ENV 2014; IAAC 2019; CNSC 2020). The objectives of the vegetation inventory and rare plant surveys conducted in summer 2018 were to confirm and expand upon ecosite and plant communities data from database searches, meet Saskatchewan Ministry of Environment (ENV) guidelines for sampling effort in each habitat found within the area of the Project, and to document occurrences of terrestrial and aquatic vascular plant species, including rare and weedy species (ENV 2017a; GS 2010). Surveys were also used to determine which habitats in the LSA have the highest potential to support rare plant populations and gather abundance and distribution data on rare plant occurrences, as SOCC are a potential VC for the EA (ENV 2017a; CNSC 2020).

3.2 Methods

Two terrestrial vegetation inventory surveys were conducted in the LSA between 6 and 13 June 2018, and 14 and 21 August 2018. An aquatic vegetation inventory survey was completed between 15 and 17 August 2018. The surveys were conducted in accordance with the CanNorth Standard Operating Procedures (SOPs) for terrestrial and aquatic vegetation inventory surveys, which conform to ENV guidelines, and account for potential VCs (ENV 2014; ENV 2017a). A Species Detection Research Permit (#18SD005) was obtained from ENV, Fish and Wildlife Branch.

Terrestrial vegetation inventory surveys focused on community composition by identifying and documenting distribution and abundance for vascular plant species present, including the presence of rare/sensitive species and weed species listed under *The Weed Control Act* (GS 2010). Survey locations were determined prior to the commencement of field work, and were based on available ecosite information. Survey locations were aimed to proportionally sample all habitat strata present within the SSA as per the formula provided by ENV (2017a) below, along with select areas of the LSA.

$y = (0.8x/z) + (40/z)$

where:

- "y" is the number of 100 m transects;
- "z" is the total transect width (e.g., for a two-person team) in m; and
- "x" is the area of each habitat strata in hectares (ha) (ENV 2017a).

Habitat strata were based on McLaughlan et al. (2010) mapping layers provided by the author and the Saskatchewan Research Council (SRC; see Section 7.0 for mapping sources). Survey effort was based on the total habitat area of the SSA, not the Project footprint shown in figures, as the footprint was in a preliminary draft stage during the field planning period. Initial survey calculations were used as a rough guide for survey effort (i.e., minimum total number of transects to be completed) with the expectation that *in situ* habitat strata may be different than the habitat predicted by the McLaughlan mapping model due to the model's predictive power and changes in the land cover composition over time, such as disturbance (i.e., fire, mining exploration, flooding, etc.). Additionally, the mapping model used for McLaughlan (2010) habitat strata is based on a coarse scale (1:20000 to 1:50000) that does not always account for small, unique ecosites on the landscape. As per ENV (2017a) guidelines, all habitat strata within a Project footprint should be sampled a minimum of once, and those ecosites on the landscape that were not identified through preliminary desktop searches (i.e., small and unique ecosites) were adequately sampled to meet this requirement when observed *in situ*. The area of the Project lies on the boundary of two ecozones, Boreal Plain and Boreal Shield. Boreal Shield was selected as the primary habitat strata to use for preliminary planning based on available mapping layers, aerial imagery, and previous data collected in the Patterson Lake area. McLaughlan (2010) provides ecozonal synonyms, or comparable ecosites found in different ecozones, which can be useful in a transition zone such as the area of the Project if *in situ* transects prove to be a poor fit for either ecozone.

Surveys were conducted by two qualified botanists via straight-line transects, twice in a growing season for detection of early- and mid-season blooming species (ENV 2017a). Transects are the required sampling unit because they are repeatable, reduce bias, allow calculation of search effort, reduce errors, and are more likely to detect rare plants (Henderson 2009; ENV 2017a). Width and length of transects are determined by the habitat within the survey area. Transect length for forested sites is 100 m, with the maximum width between 4 m to 8 m (2 m to 4 m per person). Transect width is based on the most cryptic (difficult to observe) potential target species and height and depth of vegetation in the habitat. If cryptic species are unlikely and vegetation is short or sparse, transect widths may be wider, while areas with higher potential for cryptic, rare species and dense vegetation require narrower transects (ENV 2017a). These dimensions were used along with ecosite and habitat data from aerial photographs and database search results to calculate the number of transects required (ENV 2017a). All transects were at minimum 10 m apart, as per ENV guidelines, and the minimum area in ha sampled per habitat stratum was 3% of the total habitat area, as per ENV guidance at the time of field planning, as the Project footprint had not been finalized.

A total of 164 terrestrial vegetation inventory transects (Figure 3.2-1; Table 3.2-1), each 100 m in length, at 85 locations, were surveyed fulfilling recommended sampling effort criteria required by ENV (2017a). A total of 79 transect locations were surveyed twice, with the exception of six transect locations surveyed only during the second field visit within the proposed airstrip when the location of the footprint had been updated. These surveys within the proposed airstrip were conducted in a single habitat stratum which had already been surveyed thoroughly enough to meet ENV requirements, and therefore conducting only one survey is not expected to impact data quality. Differences between predicted and completed transects in Table 3.2-1 are related to the presence of unique (unpredicted) ecosites on the landscape, previous landscape disturbances, and the Project footprint adjustments made just before and during in-field vegetation surveys. Where unique ecosites were encountered within polygons predicted to be of a different ecosite type, additional vegetation inventory surveys were completed in these unique habitat strata; conversely, where an ecosite comprised less area than expected from desktop studies, survey effort for that habitat stratum was correspondingly reduced in favour of capturing vegetation community composition of unique ecosites encountered.

Figure 3.2-1: Location of Terrestrial Vegetation Inventory Transects, Summer 2018

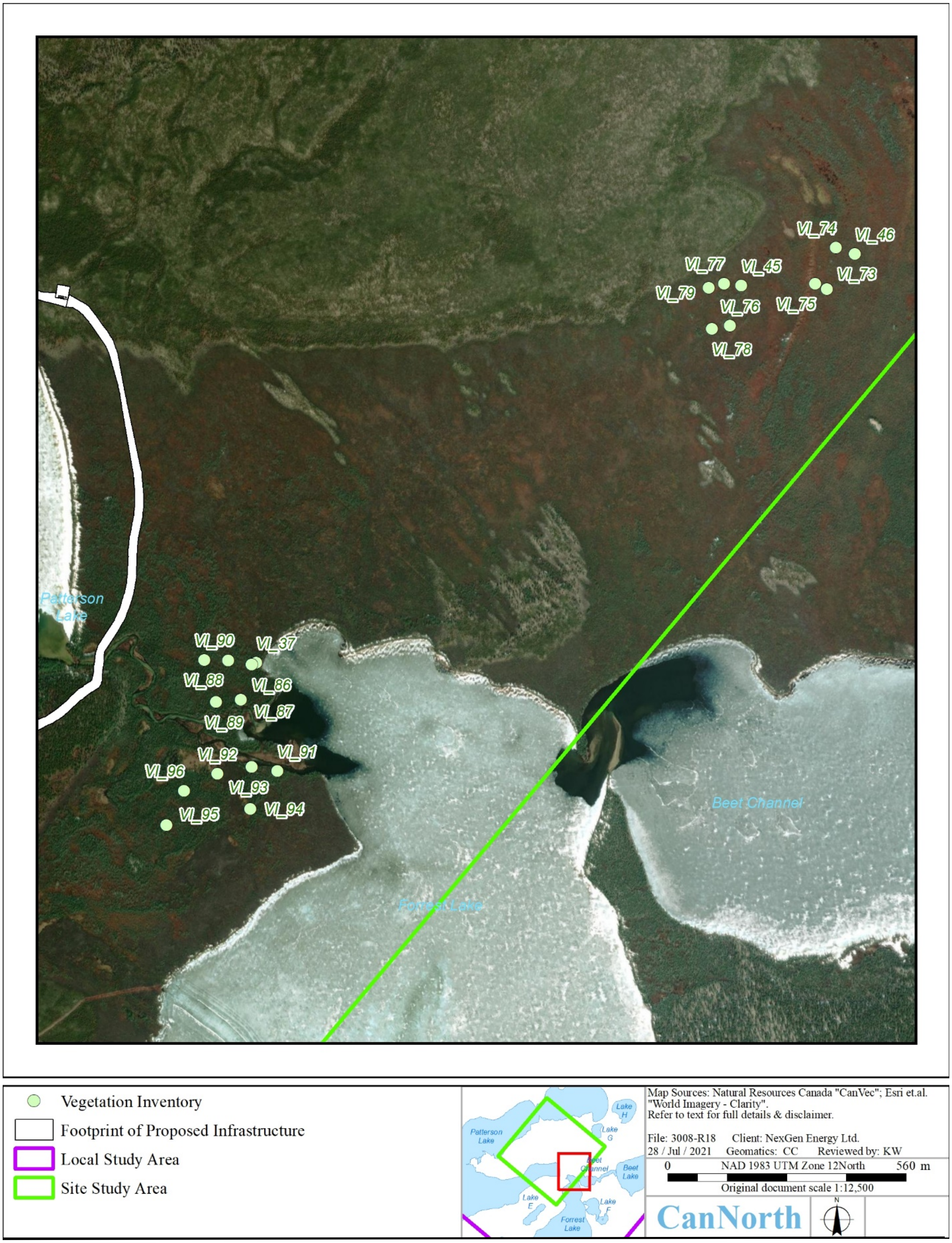

Figure 3.2-1: Location of Terrestrial Vegetation Inventory Transects, Summer 2018 (cont'd)

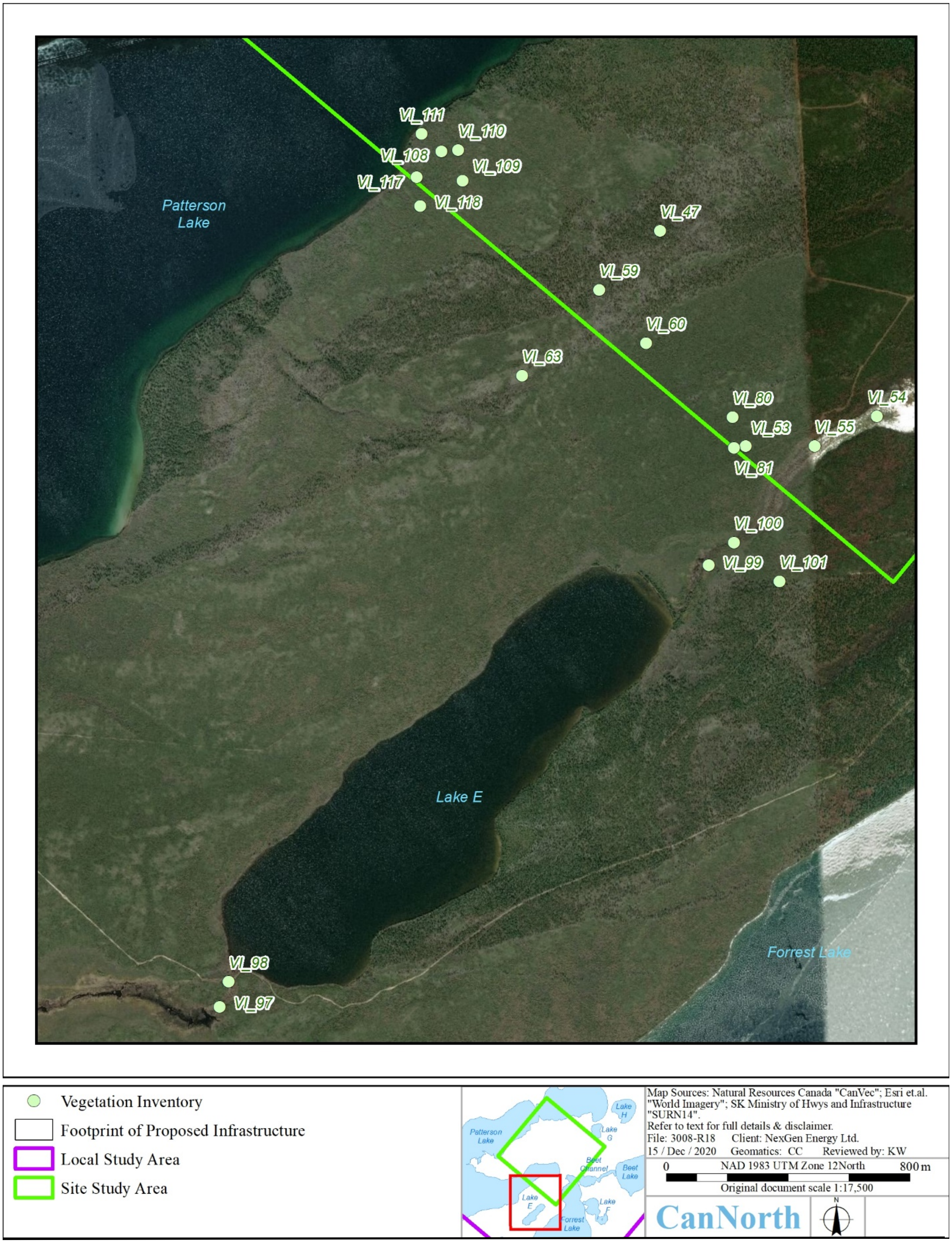

Figure 3.2-1: Location of Terrestrial Vegetation Inventory Transects, Summer 2018 (cont'd)

Table 3.2-1: Habitat Strata and Survey Effort for Rook I Terrestrial Vegetation Inventory Surveys

Predicted Habitat Stratum[a]	Area of Stratum Within SSA (ha)	Minimum Survey Area per Habitat Stratum (ha)[b]	Transect Width (m)	Formula Used[c] y=(0.8x/z)+(40/z)	Predicted Minimum Number of Transects	*In Situ* Habitat Strata	Number of Transects Completed In Field[d]
BS03	816	24.5	8	=(0.8*24.5/8)+(40/8)	7	BS03	21
BS04	511	15.3	8	=(0.8*15.3/8)+(40/8)	7	BS04	7
BS13	21	0.6	8	=(0.8*0.6/8)+(40/8)	5	BS13	2
BS14	33	1.0	8	=(0.8*1.0/8)+(40/8)	5	BS14	3
BS17	104	3.1	4	=(0.8*3.1/4)+(40/4)	11	BS17	12
BS18	81	2.4	4	=(0.8*2.4/4)+(40/4)	10	BS18	13
BS22	58	1.7	4	=(0.8*1.7/4)+(40/4)	10	BS22	-
BS24	6	0.2	4	=(0.8*0.2/4)+(40/4)	10	BS24	1
Unpredicted Ecosite	-	-	-	-	-	BS5	6
						BS10	3
						BS15	1
						BS16	4
						BS21	2
						BS23	2
Revegetating/ Regenerating Burn[e]	262	7.9	4	=(0.8*7.9/8)+(40/8)	12	Burn[e]	8
Total					77		85

LSA = Local Study Area; SSA = Site Study Area.

[a]Source: Habitat strata based on mapping layers provided by McLaughlan et al. (2010) and the Saskatchewan Research Council (SRC). Landcover types unsuitable as terrestrial plant habitat (i.e., water, roads) are omitted.

[b]Calculated as 3% of the total number of ha per habitat stratum in the site study area.

[c]Source: ENV (2017a); x = minimum area in ha per habitat stratum; z = transect width; y = minimum number of transects required.

[d]Where habitat strata differed *in situ* from those predicted from desktop studies, survey effort for predicted habitat strata was reduced in favour of capturing vegetation community composition of unique ecosites encountered.

[e]Regenerating/revegetating burn; treed vegetation <20 years old.

ENV (2017a) recommends the completion of aquatic vegetation surveys for projects within 45 m of semi-permanent or permanent wetlands, including lakes and large waterbodies. Consequently, aquatic vegetation inventory surveys were conducted in four survey locations in Patterson Lake, within close proximity to existing (e.g., exploration camp dock) and potential future site operations. Each location had a rectangular grid/array of sampling points, with the points extending from the shoreline outwards into the lake, ending at the maximum depth most likely to support aquatic plant populations. A total of 103 sampling points were surveyed within these four survey locations (Figure 3.2-2). As per previous research and regulatory standards (Madsen 1999; ENV 2017a), the arrays had at least four sampling points per hectare of the littoral zones, with points spaced 25 m to 70 m apart. The number of points per array was dependent on the size of the littoral zones, with larger zones having more sampling points. At each sampling point, the presence and identification of any existing submerged, floating-leaved, and emergent vegetation was recorded.

All species observed during terrestrial and aquatic vegetation inventory surveys were recorded. Where field identification of a plant specimen was not possible, photographs were taken of the specimen and habitat and confirmed upon return from the field trip. Specimen collection was only completed if necessary for identification and if the collection resulted in a loss of less than 4% of the local population (ENV 2017a).

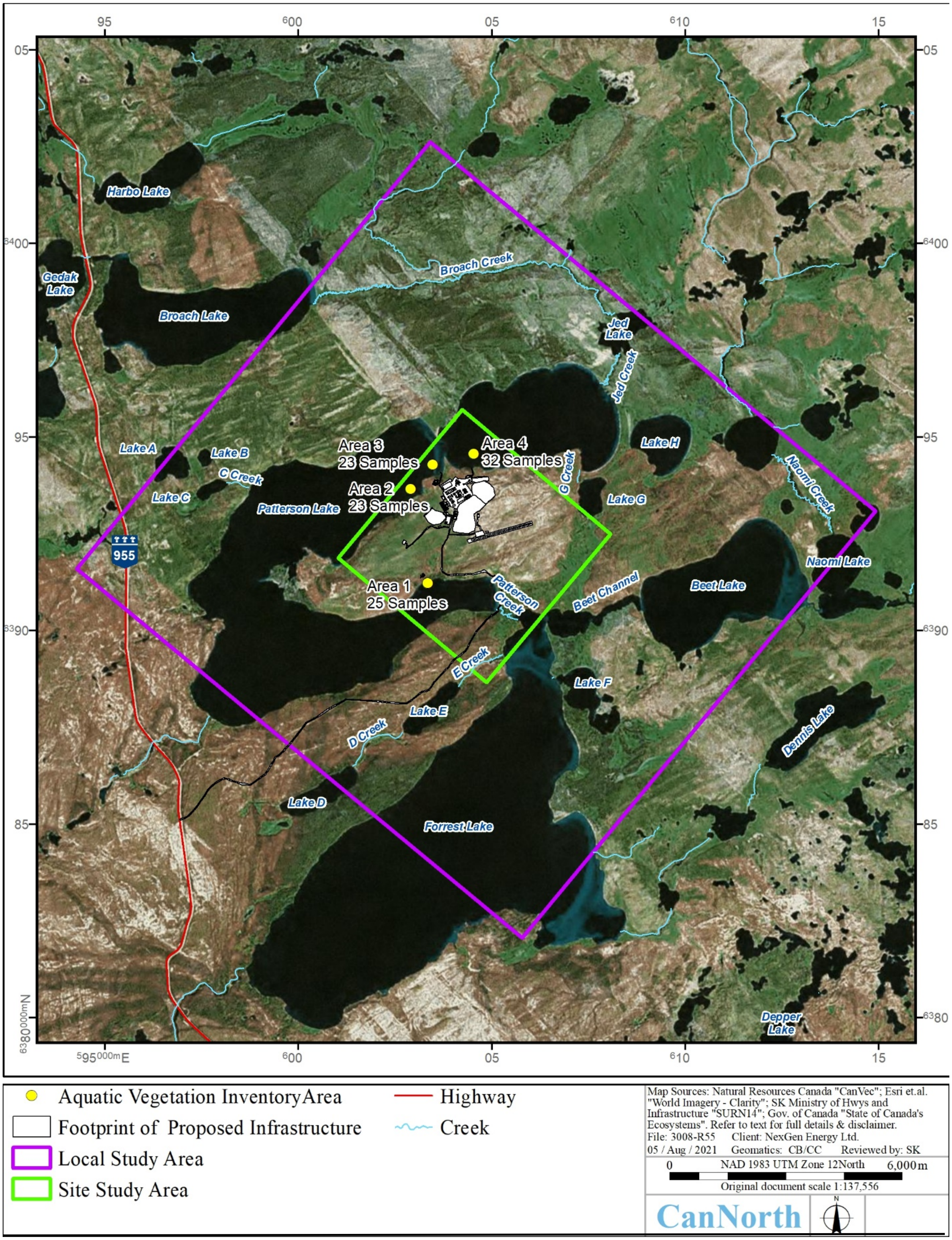

Figure 3.2-2: Overview of Aquatic Vegetation Inventory Sampling Locations, Summer 2018 Results

3.3 Results

A total of 114 plant species were detected across both the terrestrial and aquatic vegetation inventory surveys within the SSA and LSA (Appendix A, Table 2). The dominant habitats within the SSA and the area of the proposed Project consisted of regenerating and recently burned jack pine stands (Appendix B, Photo 1). These vegetation communities tend to have very low species diversity, being almost exclusively dominated by jack pine and common ericaceous shrub species (e.g., bearberry [*Arctostaphylos uva-ursi*], Labrador tea [*Rhododendron groenlandicum*], blueberry [*Vaccinium myrtilloides*], mountain cranberry [*Vaccinium vitis-idaea* ssp. *minus*]), and green alder (*Alnus viridis* ssp. *crispa*). The forest floors of these communities have a greater proportion of lichens than mosses and are typically covered with needle litter, woody debris, and rocks. To a lesser extent, mature jack pine-dominated forests were also observed within the SSA and LSA (Appendix B, Photo 2). These are similar to the regenerating stands, but differ in tree height and canopy cover, tend to have greater green alder cover, and have more mosses on the forest floor than lichens. Other vegetation communities present within the SSA and LSA include wetlands (see Section 4.3) and moist mixedwood/deciduous forests.

A total of three provincially rare plant species were identified in the SSA during the vegetation inventory surveys; two of these were terrestrial species, and one was aquatic (Figure 3.3-1). The terrestrial rare plants included two rare sedge species: Hudson Bay sedge (*Carex heleonastes*) and beautiful sedge (C. *concinna*) (Appendix B, Photos 3 and 4). Both sedge species are provincially ranked as S3 (vulnerable/rare to uncommon) (SKCDC 2018; Table 3.3-1). Over 50 individuals of beautiful sedge and one individual of Hudson Bay sedge were observed. Both rare sedge species were observed growing in moist habitats (i.e., bogs, fens, moist woods) (Table 3.3-1).

Outside of the proposed disturbance area of the Project, vegetation communities in the SSA or LSA are largely undisturbed from anthropogenic sources. Thus, additional rare plant populations may also exist in areas of high habitat potential within the SSA or LSA, as only a portion of available habitat was surveyed. These vegetation inventory surveys do not preclude the potential for additional rare plant species to be present (i.e., due to variable emergence between years). A detailed vegetation table denoting terrestrial plant species found per transect is provided in Appendix A, Table 3.

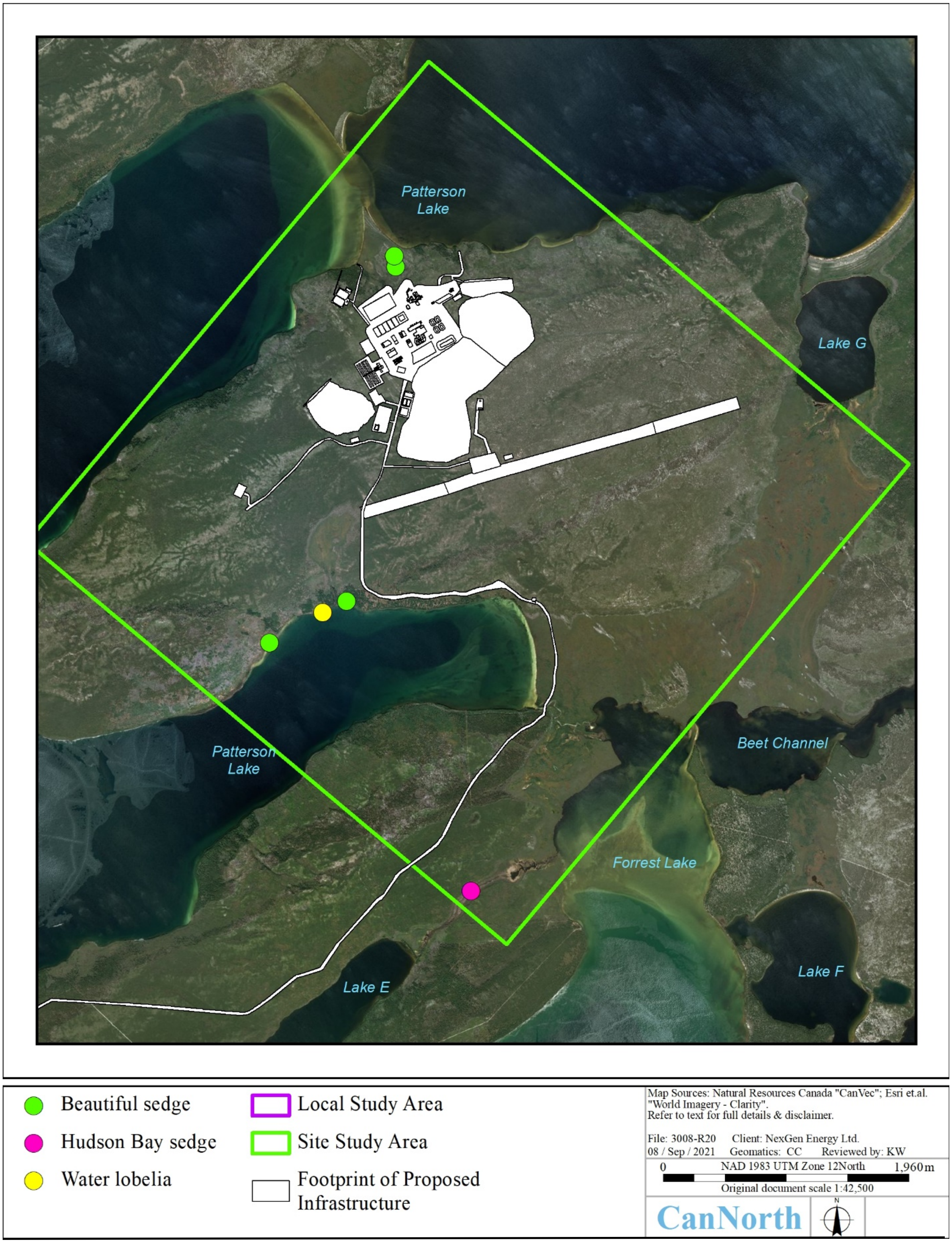

Figure 3.3-1: Provincially Rare Plant Species Observed in Site Study Area, Summer 2018

Table 3.3-1: Provincially Rare Plant Species Observed in the Site Study Area, Summer 2018

Scientific Name	Common Name	SKCDC Rank	Count	Study Area	Habitat	UTM Coordinates[a]	
						Easting	Northing
Carex heleonastes	Hudson Bay sedge	S3	1	SSA	Shrubby rich fen	604581	6389094
Carex concinna	Beautiful sedge	S3	50+	SSA	Shrubby bog	603984	6394070
			2	SSA	Lakeshore/moist coniferous	603974	6394157
			1	SSA	Moist mixedwood	602978	6391074
Lobelia dortmanna[b]	Water lobelia	S3	1	SSA	Aquatic/lake shoreline	603402	6391316

Source: All scientific, common names, and provincial ranks from SKCDC (2018a) with the exception of water lobelia (see footnote b).

a) UTM = NAD83, Zone 12U.

b) Floating fragment only, no rooted specimen found. Species ranking from SKCDC (2021).

SKCDC = Saskatchewan Conservation Data Centre; S3 = vulnerable/rare to uncommon; SSA = Site Study Area.

The aquatic vegetation inventory survey revealed that littoral zones in the four surveyed locations in Patterson Lake are largely non-vegetated. Four different areas were sampled, and of the 103 sampling points visited, plant occurrences were documented at only 16 points (Figure 3.3-2; Appendix A, Table 4). Area 1 was sampled at 25 points for a total of three observed species: sago pondweed (*Stuckena pectinata*) ranked S4; narrow-leaved bur-reed (*Sparganium angustifolium*), ranked S4; and a floating fragment of water lobelia (*Lobelia dortmanna*), ranked S3 (SKCDC 2021), detected at a single survey point (Appendix B, Photo 5). No rooted specimens of this species were detected at any sampling points and the source of the floating fragment was unknown. Area 2 was sampled at 23 points with one species observed: spiny-spored quillwort (*Isoetes echinospora*), ranked S4. Area 3 was sampled at 23 points for a total of four observed species: sago pondweed; narrow-leaved bur-reed; northern pondweed (*Potamageton alpinus*), ranked S4; and yellow cowlily (*Nuphar variegata*), ranked S4. Area 4 was sampled at 32 points for a total of three observed species: sago pondweed, spiny-spored quillwort, and narrow-leaved bur-reed.

Although none of the rare plant species listed in Table 2.3-1 are listed under SARA or protected under *The Wildlife Act* (GS 1998; SARPR 2018), they are provincially rare (S3). All provincially ranked plant species have recommended activity restriction setback distances. For high disturbance activities such as mining developments, there is a recommended year-round setback of 30 m for all S1 through S3 species (ENV 2017b).

No weeds listed under *The Weed Control Act* (GS 2010) were observed within the LSA or SSA. American mistletoe (*Arceuthobium americanum*) was observed in eight transects within the LSA (Table 3.3-2), four of which were near the area of the proposed Project (Figure 3.3-3). American mistletoe is a parasitic plant that grows on pine trees, with jack pine being the main host in Saskatchewan. Although this is a native species, it is considered to be a problematic forest pest that can infest large areas of pine forests (GS 2016). The most recognizable symptom of mistletoe infestations is the prolific growth of infected branches known as “witches’ broom” (Appendix B, Photo 6). American mistletoe uses trees of any age as hosts, with younger trees and seedlings being more susceptible to mortality from infection. Ultimately, mistletoe infestations can kill large volumes of trees and can produce a substantial fire hazard (GS 2016).

Figure 3.3-2: Patterson Lake Aquatic Vegetation Inventory Survey Results, August 2018

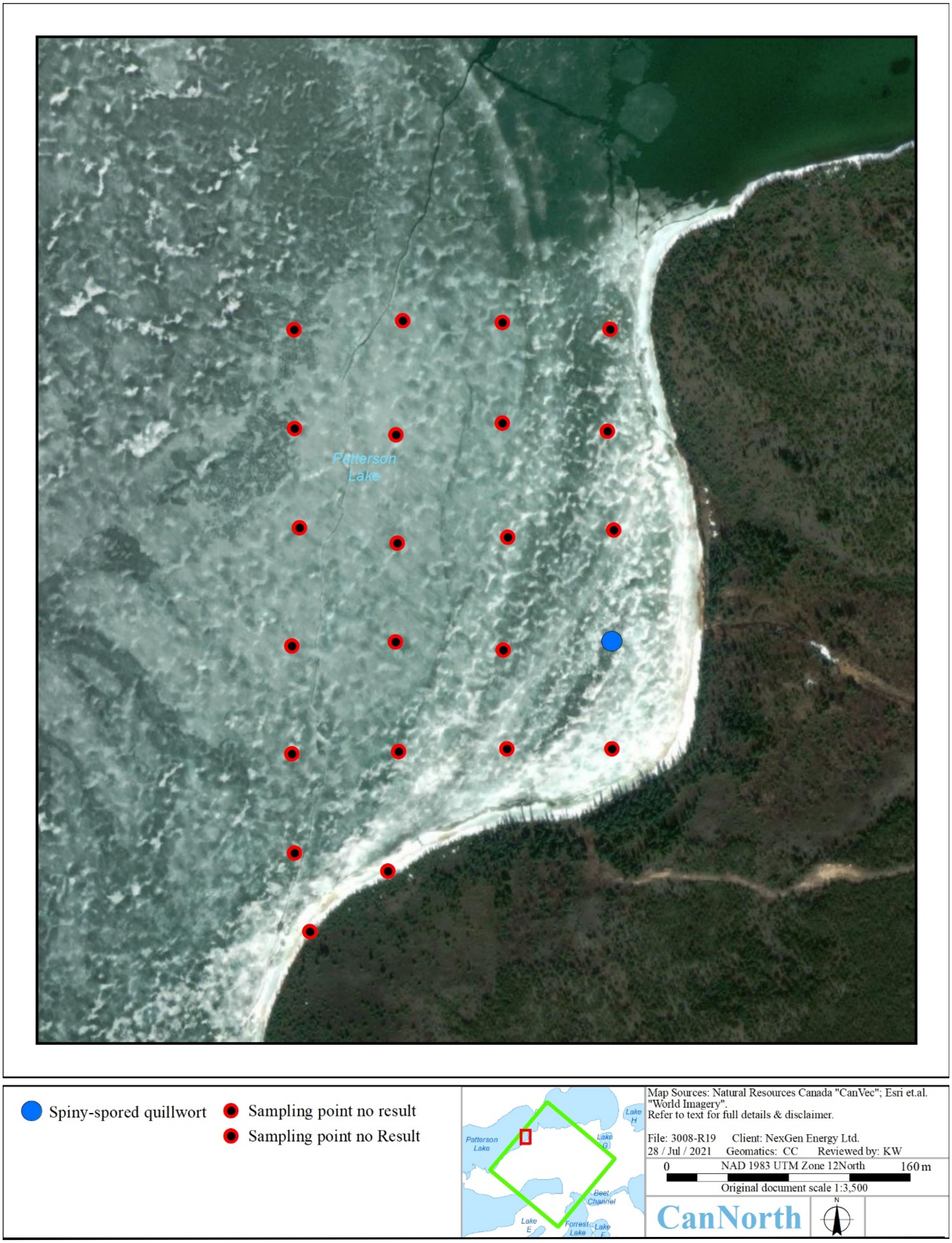

Figure 3.3-2: Patterson Lake Aquatic Vegetation Inventory Survey Results, August 2018 (cont'd)

Figure 3.3-2: Patterson Lake Aquatic Vegetation Inventory Survey Results, August 2018 (cont'd)

Table 3.3-2: American Mistletoe (*Arceuthobium americanum*) Observations, Summer 2018

Transect	Description	Stand Age	Study Area	UTM Coordinates[a]	
				Easting	Northing
VI_011	Regenerating/recent burn	0-5 years	SSA/Near Project Footprint	605005	6393332
VI_018	Regenerating/recent burn	6-20 years	SSA/Near Project Footprint	604477	6391766
VI_021	Mature/old-growth	> 100 years	SSA/Near Project Footprint	603865	6391505
VI_033	Regenerating/recent burn	0-5 years	SSA/Near Project Footprint	605263	6393444
VI_047	Mature/old-growth	> 100 years	SSA	604102	6389822
VI_059	Mature/old-growth	> 100 years	SSA	603902	6389627
VI_060	Regenerating/recent burn	6-20 years	SSA	604056	6389453
VI_063	Mid-succession	21-60 years	LSA	603647	6389346

a) UTM = NAD83, Zone 12U.

SSA = Site Study Area, LSA = Local Study Area.

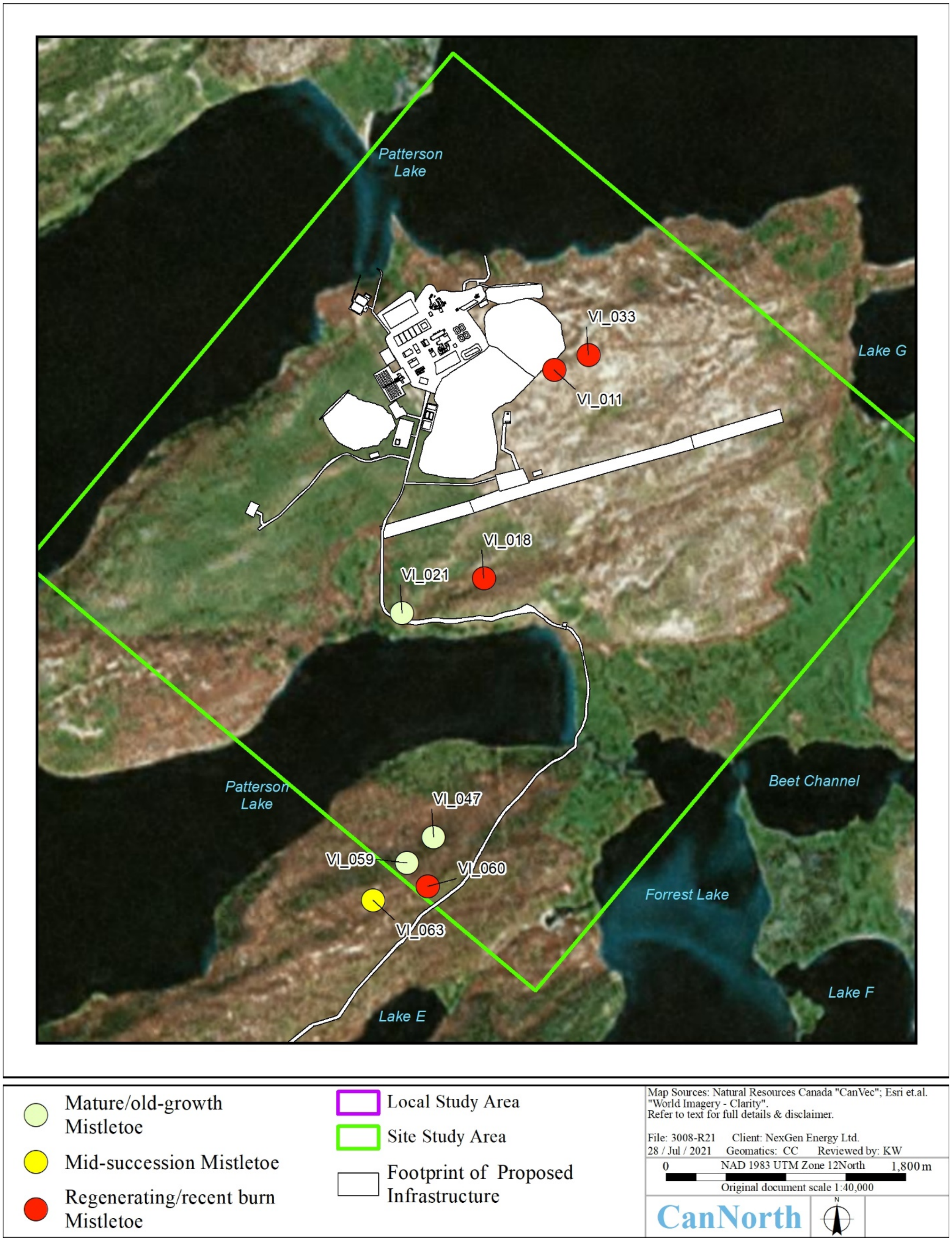

Figure 3.3-3: American Mistletoe Observed in the Site and Local Study Areas, Summer 2018

4.0 WETLAND CLASSIFICATION

4.1 Study Objectives

To meet regulatory guidance and scientific best practices, wetland classifications were completed to assist in describing terrestrial environmental conditions (ENV 2014; IAAC 2019; CNSC 2020). The objectives of the wetland classification surveys conducted in summer 2018 were to confirm and expand upon information obtained from database searches, classify wetlands and associated ecosites, and determine which wetlands were found within the area of the Project, SSA, and LSA. Wetland habitats have a high potential for use as habitat by SOCC, and are considered a potential VC for the EA.

4.2 Methods

Wetland classifications were completed primarily in the SSA and in select areas of the LSA to verify preliminary desktop habitat classification. All wetlands were classified using CanNorth's SOP for northern wetland classification, which is derived from a combination of the Canadian Wetland Classification System (Warner and Rubec, Eds., 1997), Smith et al. (2007), and McLaughlan et al. (2010). Due to incomplete alignment of boreal wetlands in Saskatchewan with any of these classification systems, both the Smith–type wetland and the McLaughlin–type ecosite were recorded. Wetland classifications were conducted between 6 and 13 June 2018, in conjunction with the first round of vegetation inventory surveys.

Several environmental conditions including hydrology, nutrient availability, geology, and climate interact to dictate wetland vegetation communities. Therefore, plant species can be used to identify wetland classes and ecosite type. Dominant tree and shrub species and associated percent cover were recorded at each sampled wetland to identify the wetland classification, sub-category, and ecosite type based on Smith et al. (2007) and McLaughlin et al. (2010), respectively. A legend defining the boreal wetland classifications and their sub-categories is presented in Appendix A, Table 5.

4.3 Results

A total of 15 wetlands were classified within the SSA and LSA. Of these 15 wetlands, 13 were within the SSA, 4 were in the immediate vicinity of the area of the Project, and 2 (Wetlands 5 and 13) were located within the proposed Project footprint. Wetland 5 was within the originally proposed camp expansion location (Figure 4.3-1; Table 4.3-1). Through the Project design refinement process, the proposed camp location has now been moved closer to the mining operations, eliminating the associated potential impacts to the aforementioned wetland. Wetland 13 remains within the boundary of the currently proposed Project footprint.

Field ecologists identified three classes of wetlands, including bogs (10 observances), fens (3 observances), and swamps (2 observances) (Table 4.3-1). The bogs were classified further into two sub-categories (i.e., shrubby and treed bogs) and two corresponding ecosite types (i.e., BS18 and BS17) (Appendix B, Photos 7 to 8). These two sub-categories of bog are both dominated by ericaceous shrubs, but differ in the proportion of *Sphagnum* to feathermosses, tree cover, and composition. Each of the three fens was classified to a unique sub-category (i.e., graminoid poor, shrubby rich and treed poor fens) and unique ecosite (i.e., BS24, BS23, and BS21) (Appendix B, Photos 9 to 11). These fen sub-categories/ecosites differ substantially in species composition and tree and shrub cover, but share similar moisture regimes (i.e., mesic to hygric with some medium/rich mineral water inputs [Smith et al. 2007]).

Finally, the two swamps were also classified to unique sub-categories (i.e., black spruce and hardwood swamps), based on differing forest canopy composition, but both were identified as the same ecosite type (i.e., BS16) (Appendix B, Photos 12 to 13). This ecosite is dominated by black spruce or balsam poplar (*Populus balsamifera*) and may contain scattered patches of white birch (*Betula papyrifera*), with river alder (*Alnus incana* ssp. *tenuifolia*) abundant in the understory (McLaughlan et al. 2010).

Table 4.3-1: Wetlands Observed in the Rook I Study Area, Summer 2018

Wetland ID	Boreal Wetland Classification	Ecosite Type	Dominant Tree Species	Dominant Shrub Species	Study Area	UTM Coordinates[a]	
						Easting	Northing
1	Shrubby bog	BS18	Black spruce (*Picea mariana*)	Labrador tea (*Rhododendron groenlandicum)*	SSA	603750	6394168
2	Shrubby bog	BS18	Black spruce	Labrador tea	SSA	605537	6390598
3	Shrubby bog	BS18	Black spruce	Labrador tea	SSA	606631	6391383
4	Shrubby bog	BS18	Black spruce	Labrador tea	SSA	606927	6391456
5	Shrubby bog	BS18	Black spruce	Labrador tea	Near Project Footprint	603521	6392017
6	Treed bog	BS17	Black spruce	Labrador tea	SSA	605527	6390492
7	Graminoid poor fen	BS24	Black spruce	Labrador tea	SSA	605422	6390305
8	Treed bog	BS17	Black spruce	Labrador tea	SSA	605516	6390254
9	Shrubby rich fen	BS23	Willows (*Salix* spp.)	Willows	LSA	602625	6387256
10	Treed poor fen	BS21	Tamarack (*Larix laricina*)	Swamp birch (*Betula pumila*), willows	LSA	604236	6388686
11	Black spruce swamp	BS16	Black spruce	Western river alder (*Alnus incana* ssp. *tenuifolia*), Labrador tea	Project Footprint	603369	6391503
12	Hardwood swamp	BS16	White birch (*Betula papyrifera*), Western river alder	Labrador tea, Western river alder	SSA	603311	6393687
13	Shrubby bog	BS18	Black spruce	Labrador tea, leatherleaf (*Chamaedaphne calyculata*)	Near Project Footprint	604677	6393898
14	Shrubby bog	BS17	Black spruce	Labrador tea, pale laurel (*Kalmia polifolia*)	Near Project Footprint	603375	6391849
15	Shrubby bog	BS18	Black spruce	Labrador tea, pale laurel	Near Project Footprint	604576	6394064

Source: Boreal wetland classifications from Smith et al. (2007); Ecosite type from McLaughlan et al. (2010); All scientific and common names from SKCDC (2018).

[a]UTM = NAD83, Zone 12U.
SSA = Site Study Area, LSA = Local Study Area.

Figure 4.3-1: Wetlands Observed in the Site and Local Study Area, Summer 2018

5.0 SUMMARY

The vegetation inventory environment baseline program was designed to obtain comprehensive information characterizing terrestrial environments, wetlands, and aquatic and terrestrial vegetation communities, and to document SOCC and associated habitats in near vicinity to the SSA and a broader LSA. Information obtained through database searches and field surveys will be used alongside Indigenous Knowledge in the EA, to help ensure the completion of accurate effects assessments as well as inform Project planning and develop future monitoring programs and reclamation plans. To meet study objectives, the following studies were completed as part of the vegetation inventory baseline environment investigations for the Project:

- species of conservation concern database searches;
- vegetation inventory surveys; and
- wetland classification.

A list of 276 plant SOCC was compiled from database searches of the Mid-Boreal Upland and Athabasca Plain ecoregions; none of the plant species known to these ecoregions are listed by COSEWIC or *The* SARA (SARPR 2018). The HABISask database search identified four provincially rare plant species within 30 km of the centre of the SSA; the W.P. Fraser Herbarium database search yielded no results. The four species previously found within 30 km of the SSA were all located in wetland or shoreline habitats. None of these species were found during field surveys completed in 2018.

Two terrestrial vegetation inventory surveys were conducted in the SSA and LSA, and one aquatic vegetation inventory survey was completed in Patterson Lake near the proposed Project location. Vegetation community and ecosite data, as well as rare plant and weed location, distribution, and abundance were recorded. A total of 164 terrestrial transects and 103 aquatic sampling points were surveyed in the SSA and LSA. Terrestrial vegetation surveys were completed using straight-line transects, and aquatic surveys were completed using a grid-sampling method. A total of 114 plant species were detected across both the terrestrial and aquatic vegetation inventory surveys within the SSA and LSA. The dominant habitats within the SSA and area of the proposed Project consisted of regenerating and recently burned jack pine stands. Other vegetation communities present within the SSA include wetlands and moist mixedwood/deciduous forests. The aquatic vegetation inventory survey revealed that littoral zones in the four surveyed locations in Patterson Lake are largely non-vegetated.

A total of three provincially-rare plant species were identified during the vegetation inventory surveys, including two terrestrial plants and one aquatic plant. Both terrestrial rare plants were species of sedge (*Carex* spp.), and were found growing in bogs, shrubby rich fens, and in moist forest areas. Water lobelia was found floating in Patterson Lake during the aquatic survey, but was not found growing in any of the shallow littoral areas searched.

Wetland classifications identified a total of 15 wetlands within the SSA and LSA; of these, 13 were within the SSA, 4 were in the immediate vicinity of the area of the Project, and 2 were directly inside the originally proposed camp expansion location. After further refinement to the Project design, only one wetland is still located within the boundary of the currently proposed Project footprint.

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7.0 MAP SOURCES AND DISCLAIMERS

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Provincially Rare Vascular Plant Species Known to Occur Within the Mid-Boreal Upland and Athabasca Plain Ecoregions of Saskatchewan

Scientific Name	Common Name	SKCDC Rank (2018)	SKCDC Rank (2021)
Achillea millefolium var. *megacephala*	Large-headed wooly yarrow	S1	S1
Achnatherum richardsonii	Richardson's speargrass	S3	S3
Adoxa moschatellina	Musk-root	S3	S3
Agrostis mertensii	Northern bent-grass	SH	SH
Allium cernuum var. *cernuum*	Nodding onion	**S1**	**S3**
Allium schoenoprasum var. *sibiricum*	Wild chives	S3	S3
Amelanchier humilis	Running serviceberry	S2	S2
Anaphalis margaritacea	Pearly everlasting	S3	S3
Andromeda polifolia var. *latifolia*	Glaucous-leaved bog-rosemary	S2	S2
Anemone parviflora var. *parviflora*	Small-flowered anemone	S1	S1
Anemone quinquefolia var. *quinquefolia*	Wood anemone	S2	S2
Anemone richardsonii	Yellow anemone	S2	S2
Arabidopsis arenicola	Arctic rock-cress	S2	S2
Arceuthobium pusillum	Dwarf mistletoe	S1	S1
Arctous rubra	Red alpine bearberry	S3	S3
Arethusa bulbosa	Dragon's-mouth orchid	**S1**	**S2**
Armeria maritima ssp. *interior*	Athabasca rhrift	S1	S1
Arnica angustifolia ssp. *angustifolia*	Narrow-leaf leopardbane	**S2**	**SH**
Arnica cordifolia	Heart-leaved arnica	S3	S3
Arnica lonchophylla	Spear-leaved arnica	S2	S2
Artemisia campestris ssp. *canadensis*	Canada sagewort	S3	S3
Astragalus australis	Indian milk-vetch	S3	S3
Athyrium filix-femina	Lady-fern	**-**	**S4**
Athyrium filix-femina var. *angustum*	Northern lady-fern	S3	S3
Bidens beckii	Water-marigold	**S1**	**S2**
Bidens frondosa	Tall beggar's-ticks	S3	S3
Bistorta vivipara	Alpine bistort	**S1**	**S3**
Blysmopsis rufa	Red bulrush	S3	S3
Botrychium ascendens	Triangle-lobe moonwort	**-**	**S1**
Botrychium hesperium	Western moonwort	**S2**	**S3**
Botrychium lanceolatum	Triangle grape-fern	S2	S2
Botrychium lunaria	Common moonwort	**S1**	**S4**
Botrychium matricariifolium	Chamomile grape-fern	**-**	**S1**
Botrychium minganense	Mingan moonwort	S1	S1
Botrychium minganense	Mingan moonwort	**-**	**S1**
Botrychium pallidum	Pale moonwort	**-**	**S1**
Botrychium pinnatum	Northwestern moonwort	SNA	SNA
Botrychium simplex	Least grape-fern	**S2**	**S3**
Calamagrostis lapponica	Lapland reed-grass	S3	S3
Calamagrostis purpurascens var. *purpurascens*	Purple reed grass	S3	S3
Calamagrostis rubescens	Pine grass	S2	S2

Appendix A, Table 1

Provincially Rare Vascular Plant Species Known to Occur Within the Mid-Boreal Upland and Athabasca Plain Ecoregions of Saskatchewan

Scientific Name	Common Name	SKCDC Rank (2018)	SKCDC Rank (2021)
Calypso bulbosa	Fairy slipper	**-**	**S3**
Calypso bulbosa var. *americana*	Fairy slipper	S3	S3
Campanula aparinoides	Marsh bellflower	S3	S3
Canadanthus modestus	Large northern aster	S3	S3
Cardamine nymanii	Meadow bitter cress	S3	S3
Cardamine parviflora	Small bitter cress	S1	S1
Carex arcta	Bear sedge	S2	S2
Carex bigelowii	Bigelow's sedge	**SH**	**S1**
Carex buxbaumii	Brown sedge	S3	S3
Carex chordorrhiza	Prostrate sedge	**-**	**S3**
Carex concinna	Beautiful sedge	S3	S3
Carex crawei	Crawe's sedge	S3	S3
Carex cristatella	Small-crested sedge	**S2**	**S1**
Carex cryptolepis	Yellow sedge	S2	S2
Carex eburnea	Bristle-leaved sedge	S3	S3
Carex echinata ssp. *echinata*	Prickly sedge	S3	S3
Carex garberi	Garber's sedge	S3	S3
Carex glacialis	Glacier sedge	SH	SH
Carex heleonastes	Hudson Bay sedge	S3	S3
Carex hystericina	Porcupine sedge	S3	S3
Carex leptonervia	Pleasing sedge	**S1**	**S3**
Carex mackenziei	Mackenzie sedge	S1	S1
Carex maritima	Seaside sedge	S1	S1
Carex michauxiana	Michaux's sedge	S3	S3
Carex pachystachya	Thick-spike sedge	**-**	**SNR**
Carex pedunculata	Long-stalked sedge	SH	SH
Carex projecta	Necklace sedge	S1	S1
Carex pseudocyperus	Cyperus-like sedge	S3	S3
Carex saxatilis	Rocky ground sedge	S3	S3
Carex saximontana	Rocky mountain sedge	S3	S3
Carex sterilis	Dioecious sedge	S1	S1
Carex supina ssp. *spaniocarpa*	Weak arctic sedge	SH	SH
Carex trisperma var. *trisperma*	Three-fruited sedge	**S3**	**S4**
*Carex vulpinoide*a var. *vulpinoidea*	Fox sedge	S3	S3
Castilleja raupii	Purple paintbrush	S2	S2
Cerastium alpinum ssp. *alpinum*	Alpine chickweed	**-**	**S1**
Cerastium beeringianum	Bering sea chickweed	S1	S1
Cerastium brachypodum	Short-stalked mouse-ear chickweed	**-**	**S3**
Chimaphila umbellata ssp. *occidentalis*	Western prince's-pine	**S3**	**SNR**
Chimaphila umbellata ssp. *umbellata*	Western prince's-pine	S3	S3
Chrysosplenium iowense	Iowa golden saxifrage	S1	S1

Appendix A, Table 1

Provincially Rare Vascular Plant Species Known to Occur Within the Mid-Boreal Upland and Athabasca Plain Ecoregions of Saskatchewan

Scientific Name	Common Name	SKCDC Rank (2018)	SKCDC Rank (2021)
Cirsium drummondii	Short-stemmed thistle	S3	S3
Cirsium muticum	Swamp thistle	S3	S3
Clematis occidentalis var. *grosseserrata*	Clematis	S2	S2
Corallorhiza maculata var. *maculata*	Spotted coralroot	**-**	**SH**
Corallorhiza striata var. *striata*	Striped coral-root	S3	S3
Corispermum americanum var. *americanum*	American bugseed	S3	S3
Corispermum hookeri var. *hookeri*	Hooker's bugseed	S2	S2
Corispermum ochotense var. *ochotense*	Russian bugseed	S1	S1
Cypripedium parviflorum	Small yellow lady's slipper	**-**	**S3**
Cypripedium parviflorum var. *makasin*	Small yellow lady's slipper	S3	S3
Cypripedium parviflorum var. *pubescens*	Large yellow lady's-slipper	S2	S2
Cypripedium passerinum	Sparrow's-egg lady's-slipper	S3	S3
Cypripedium reginae	Showy lady's-slipper	S1	S1
Cystopteris montana	Mountain bladder fern	S1	S1
Delphinium glaucum	Tall larkspur	S2	S2
Deschampsia mackenzieana	Mackenzie hairgrass	S2	S2
Dichanthelium acuminatum var. *fasciculatum*	Hairy panic-grass	S3	S3
Diervilla lonicera	Northern bush-honeysuckle	S3	S3
Diphasiastrum sitchense	Alaskan clubmoss	**S2**	**S3**
Draba aurea	Golden whitlow-grass	S1	S1
Draba cana	Hoary whitlow-grass	S2	S2
Draba cinerea	Ashy whitlow-grass	SH	SH
Drosera anglica	English sundew	S3	S3
Drosera linearis	Slenderleaf sundew	**S1**	**S3**
Dryas drummondii	Yellow mountain-avens	SH	SH
Dryopteris cristata	Crested shield-fern	S3	S3
Dryopteris filix-mas	Male fern	S1	S1
Elatine triandra	Longstem water-wort	S2	S2
Eleocharis compressa var. *acutisquamata*	Flat-stemmed spike-rush	S3	S3
Eleocharis elliptica	Slender spike-rush	S3	S3
Eleocharis mamillata ssp. *mamillata*	Soft-stem spike-rush	S1	S1
Eleocharis nitida	Neat spike-rush	S3	S3
Eleocharis uniglumis	One-glumed spike-rush	**S3**	**SH**
Elodea canadensis	Canada waterweed	S3	S3
Elymus diversiglumis	Various-glumed wild rye	S3	S3
Elymus glaucus	Smooth wild-rye	S3	S3
Epilobium hornemannii ssp. *hornemannii*	Hornemann's willowwherb	S1	S1
Eremogone congesta var. *lithophila*	Rocky-round sandwort	**-**	**S3**
Erigeron compositus	Compound fleabane	S3	S3
Erigeron elatus	Tall white fleabane	S3	S3
Erigeron hyssopifolius	Hyssop-leaved fleabane	S3	S3

Appendix A, Table 1

Provincially Rare Vascular Plant Species Known to Occur Within the Mid-Boreal Upland and Athabasca Plain Ecoregions of Saskatchewan

Scientific Name	Common Name	SKCDC Rank (2018)	SKCDC Rank (2021)
Erigeron hyssopifolius var. *hyssopifolius*	Hyssop-leaved fleabane	**-**	**S3**
Erigeron strigosus	White-top	**-**	**S3**
Erigeron strigosus var. *strigosus*	Daisy fleabane	S3	S3
Eriophorum scheuchzeri	Scheuchzer cotton-grass	S2	S2
Eriophorum tenellum	Delicate cotton-grass	**S2**	**SH**
Euphrasia subarctica	Arctic eyebright	**S1**	**S3**
Fallopia scandens	Climbing false-buckwheat	S3	S3
Festuca brachyphylla ssp. *brachyphylla*	Short-leaf fescue	S2	S2
Festuca hallii	Plains rough fescue	S3	S3
Festuca prolifera var. *lasiolepis*	Proliferous red fescue	SH	SH
Gentianopsis virgata ssp. *macounii*	Macoun's gentian	**-**	**S3**
Gentianopsis virgata ssp. *virgata*	Lesser fringed gentian	S3	S3
Geranium carolinianum	Carolina wild geranium	S3	S3
Gymnocarpium jessoense ssp. *parvulum*	Limestone oak fern	S3	S3
Huperzia selago var. *densa*	Mountain club-moss	S1	S1
Huperzia selago var. *selago*	Mountain club-moss	S1	S1
Impatiens noli-tangere	Yellow touch-me-not	S2	S2
Isoetes lacustris	Lake quillwort	S2	S2
Isoetes x *hickeyi*	Hickey's quillwort	S1	S1
Juncus stygius ssp. *americanus*	Moor rush	**S1**	**S3**
Juncus triglumis var. *albescens*	Pale three-flowered rush	S2	S2
Kalmia procumbens	Alpine azalea	**S1**	**S2**
Lactuca biennis	Tall blue lettuce	S3	S3
Lechea intermedia var. *depauperata*	Impoverished pinweed	S1	S1
Lemna minor	Lesser duckweed	**S1**	**-**
Leucophysalis grandiflora	Large white-flowered ground-cherry	S3	S3
Leymus mollis ssp. *mollis*	Sea lyme-grass	S2	S2
Lilium philadelphicum	Wood lily	**-**	**S4**
Lilium philadelphicum var. *andinum* f *immaculata*	Immaculate lily	S1	S1
Lilium philadelphicum var. *philadelphicum*	Eastern red wood lily	S1	S1
Liparis loeselii	Yellow twayblade	**S1**	**S3**
Listera borealis	Northern twayblade	**S1**	**S3**
Listera cordata	Heart-leaved twayblade	**-**	**S3**
Listera cordata var. *cordata*	Heart-leaved twayblade	**S2**	**S3**
Lobelia dortmanna	Water lobelia	**S2**	**S3**
Lomatogonium rotatum	Marsh felwort	S3	S3
Lonicera oblongifolia	Swamp fly honeysuckle	S3	S3
Luzula acuminata var. *acuminata*	Hairy wood-rush	**S1**	**S3**
Luzula multiflora	Many-flowered woodrush	**-**	**S3**
Luzula multiflora ssp. *frigida*	Common woodrush	S3	S3
Luzula multiflora ssp. *multiflora*	Many-flowered woodrush	S3	S3

Appendix A, Table 1

Provincially Rare Vascular Plant Species Known to Occur Within the Mid-Boreal Upland and Athabasca Plain Ecoregions of Saskatchewan

Scientific Name	Common Name	SKCDC Rank (2018)	SKCDC Rank (2021)
Lycopodiella inundata	Northern bog clubmoss	S1	S1
Lycopodium hickeyi	Hickey's club-moss	**-**	**S1**
Maianthemum racemosum	False Solomon's-seal	**S1**	**-**
Malaxis monophyllos var. *brachypoda*	White bog adder's-mouth orchid	S1	S1
Malaxis paludosa	Bog adder's-mouth orchid	**S1**	**S3**
Micranthes pensylvanica	Swamp saxifrage	S1	S1
Milium effusum var. *cisatlanticum*	Tall millet-grass	S1	S1
Minuartia rubella	Boreal sandwort	S3	S3
Moehringia macrophylla	Large-leaved sandwort	S3	S3
Muhlenbergia andina	Foxtail muhly	S1	S1
Myriophyllum alterniflorum	Alternate-flowered water milfoil	**S1**	**S2**
Najas flexilis	Flexible naiad	S3	S3
Nymphaea leibergii	Small white water-lily	S2	S2
Nymphaea tetragona	Pygmy water-lily	S2	S2
Oxytropis campestris	Late yellow locoweed	**-**	**S4**
Packera streptanthifolia	Northern groundsel	**S1**	**S3**
Parnassia glauca	Glaucous grass-of-Parnassus	S3	S3
Pedicularis groenlandica	Elephant-head	S2	S2
Pedicularis labradorica var. *labradorica*	Labrador lousewort	S3	S3
Pedicularis macrodonta	Purple lousewort	**S2**	**S3**
Pellaea gastonyi	Gastony's cliffbrake	S2	S2
Pellaea glabella ssp. *occidentalis*	Western smooth cliff-brake	S1	S1
Persicaria punctata	Dotted smartweed	S2	S2
Phegopteris connectilis	Long beech-fern	S3	S3
Phleum alpinum	Mountain Timothy	**S1**	**-**
Pinguicula villosa	Hairy butterwort	S3	S3
Pinguicula vulgaris	Common butterwort	S3	S3
Piptatherum canadense	Canada mountain-ricegrass	**S2**	**S3**
Plantago maritima var. *juncoides*	Seaside plantain	**S1**	**S2**
Platanthera dilatata var. *dilatata*	Scentbottle	S3	S3
Platanthera orbiculata	Large roundleaf orchid	S3	S3
Poa alpina ssp. *alpina*	Alpine bluegrass	S2	S2
Poa arctica ssp. *arctica*	Arctic blue grass	S2	S2
Poa arctica ssp. *lanata*	Lanate bluegrass	**SNA**	**-**
Polygala paucifolia	Pink fringed milkwort	S3	S3
Potamogeton amplifolius	Large-leaved pondweed	SH	SH
Potamogeton epihydrus	Ribbon-leaf pondweed	S2	S2
Potamogeton nodosus	Longleaf pondweed	**-**	**S1**
Potamogeton obtusifolius	Blunt-leaved pondweed	S3	S3
Potamogeton robbinsii	Flatleaf	S3	S3
Potamogeton strictifolius	Upright narrow-leaved pondweed	S3	S3

Appendix A, Table 1

Provincially Rare Vascular Plant Species Known to Occur Within the Mid-Boreal Upland and Athabasca Plain Ecoregions of Saskatchewan

Scientific Name	Common Name	SKCDC Rank (2018)	SKCDC Rank (2021)
Potentilla arenosa ssp. *arenosa*	Bluff cinquefoil	S1	S1
Potentilla bimundorum	Cut-leaved cinquefoil	S2	S2
Potentilla rubricaulis	Red-stemmed cinquefoil	S3	S3
Prenanthes alba	White lettuce	S3	S3
Primula mistassinica	Bird's-eye primrose	S3	S3
Puccinellia distans ssp. *hauptiana*	Haupt's alkali-grass	S2	S2
Pyrola grandiflora	Arctic wintergreen	SH	SH
Ranunculus hyperboreus	Northern buttercup	S2	S2
Ranunculus pedatifidus var. *affinis*	Northern buttercup	S3	S3
Rhinanthus minor ssp. *minor*	Yellow-rattle	S2	S3
Rhododendron tomentosum	Labrador-tea	**S3**	**-**
Rhynchospora alba	White beaked-rush	S3	S3
Rhynchospora capillacea	Hair-like beaked-rush	S3	S3
Rhynchospora fusca	Sooty beaked-rush	S1	S1
Ribes oxyacanthoides ssp. *setosum*	Bristly gooseberry	S2	S2
Rosa blanda	Smooth wild rose	S1	S1
Rosa x *dulcissima*	Hybrid rose	S1	S1
Ruppia cirrhosa	Widgeon-grass	S3	S3
Ruppia maritima	Beaked ditch-grass	S3	S3
Sagina nodosa ssp. *borealis*	Knotted pearlwort	**S3**	**S2**
Salix arctophila	Northern willow	S2	S2
Salix brachycarpa var. *psammophila*	Sand-dune small-fruit willow	S3	S3
Salix commutata	Under-green willow	S1	S1
Salix glauca var. *villosa*	Gray-leaf willow	S2	S2
Salix planifolia ssp. *tyrrellii*	Tyrrell's willow	S2	S2
Salix silicicola	Blanket-leaf willow	S2	S2
Salix turnorii	Turnor's willow	S2	S2
Salix x *brachypurpurea*	Hybrid willow	SH	SH
Sambucus racemosa ssp. *pubens*	Red elderberry	S2	S2
Sceptridium multifidum	Leathery grape-fern	**S3**	**-**
Schoenoplectus subterminalis	Subterminal bulrush	**S1**	**SH**
Scutellaria lateriflora	Mad dog skullcap	S3	S3
Selaginella selaginoides	Low spike-moss	S3	S2
Silene acaulis	Moss campion	S2	S2
Silene antirrhina	Sleepy catchfly	**S1**	**S2**

Appendix A, Table 1

Provincially Rare Vascular Plant Species Known to Occur Within the Mid-Boreal Upland and Athabasca Plain Ecoregions of Saskatchewan

Scientific Name	Common Name	SKCDC Rank (2018)	SKCDC Rank (2021)
Silene menziesii	Menzies' catchfly	S3	S3
Sisyrinchium mucronatum	Mucronate blue-eyed-grass	S3	S3
Sisyrinchium septentrionale	Northern blue-eyed-grass	**-**	**S3**
Sorbus scopulina	Western mountain-ash	S3	S3
Spergularia canadensis var. *occidentalis*	Western Canada sand-spurry	S1	S1
Spiraea lucida	Shining-leaved meadow-sweet	S2	S2
Spiranthes lacera var. *lacera*	Northern slender ladies'-tresses	S3	S3
Stellaria longipe s ssp. *arenicola*	Sand chickweed	S3	S3
Streptopus amplexifolius	Clasping-leaf twisted-stalk	S3	S3
Subularia aquatica var. *americana*	Water awlwort	S3	S3
Tanacetum huronense	Floccose tansy	**-**	**S3**
Tanacetum huronense var. *bifarium*	Lake Huron tansy	S2	S2
Tanacetum huronense var. *floccosum*	Floccose tansy	S3	S3
Taraxacum ceratophorum	Horned dandelion	S3	S3
Thelypteris palustris var. *pubescens*	Marsh fern	S1	S1
Torreyochloa pallida var. *fernaldii*	Pale manna grass	S3	S3
Trichophorum clintonii	Clinton's bulrush	S1	S1
Trientalis europaea ssp. *arctica*	Arctic starwort	S2	S2
Trillium cernuum	Nodding trillium	S2	S2
Trisetum spicatum	Spike trisetum	S3	S3
Utricularia cornuta	Horned bladderwort	S3	S3
Utricularia minor	Lesser bladderwort	**S2**	**-**
Viburnum lentago	Nannyberry	**S2**	**S3**
Viola blanda	Sweet white violet	S2	S2
Viola labradorica	Northern blue violet	S1	S1
Viola macloskeyi	Smooth white violet	**S1**	**S2**
Viola pedatifida	Crowfoot violet	S3	S3
Viola pubescens var. *scabriuscula*	Downy yellow violet	S2	S2
Viola selkirkii	Long-spurred violet	S3	S3
Viola sororia	Downy blue violet	S1	S1
Wolffia columbiana	Columbia water-meal	**-**	**S1**
Woodsia alpina	Alpine cliff fern	S1	S1
Woodsia glabella	Smooth woodsia	S3	S3
Woodsia oregana ssp. *cathcartiana*	Oregon woodsia	**-**	**S3**
Woodsia oregana ssp. *oregana*	Oregon woodsia	S2	S2
Woodsia scopulina ssp. *scopulina*	Rocky mountain woodsia	SH	SH

Bolded species rankings have changed between 2018 and 2021.

Source: Scientific, common names, and provincial rankings from SKCDC (2018, 2021).

SKCDC = Saskatchewan Conservation Data Centre. S1 = Critically imperiled/extremely rare; S2 = Imperiled/very rare; S3 = Vulnerable/rare to uncommon; S4 = Apparently secure; SH = Historical occurrence; SNR= Rank is not yet assigned or species has not yet been assessed (not ranked); SNA = Species not yet ranked; '-' = Species not on list.

Appendix A, Table 2

Vascular Plant Species Observed During Terrestrial and Aquatic Vegetation Inventory Surveys in the Vegetation Study Area, June and August 2018

Scientific Name	Common Name	SKCDC Rank
Agrostis scabra var. *scabra*	Hair grass	S4
Alnus incana ssp. *tenuifolia*	Western river alder	S4
Alnus viridis ssp. *crispa*	Green alder	S4
Andromeda polifolia var. *polifolia*	Bog-rosemary	S4
Apocynum androsaemifolium	Spreading dogbane	S4
Aralia nudicaulis	Wild sarsaparilla	S4
Arceuthobium americanum	American mistletoe	S4
Arctostaphylos uva-ursi	Bearberry	S4
Athyrium filix-femina var. *cyclosorum*	Northern lady-fern	S4
Betula glandulosa	Dwarf birch	S4
Betula papyrifera	Paper birch	S5
Betula pumila	Swamp birch	S4
Calamagrostis sp.	Reedgrass	-
Calamagrostis canadensis var. *canadensis*	Blue-joint reedgrass	S4
Calamagrostis stricta	Northern reed grass	S5
Caltha palustris var. *palustris*	Yellow marsh-marigold	S4
Carex aquatilis var. *aquatilis*	Water sedge	S4
Carex brunnescens	Brownish sedge	S4
Carex canescens ssp. *canescens*	Hoary sedge	S4
Carex concinna	**Beautiful sedge**	**S3**
Carex deflexa	Bent sedge	S4
Carex diandra	Two-stamened sedge	S4
Carex foenea	Hay sedge	S4
Carex heleonastes	**Hudson Bay sedge**	**S3**
Carex limosa	Mud sedge	S4
Carex magellanica ssp. *irrigua*	Boreal-bog sedge	S4
Carex trisperma var. *trisperma*	Three-fruited sedge	S4
Carex utriculata	Northwest territory sedge	S4
Chamaedaphne calyculata	Leatherleaf	S4
Chamerion angustifolium ssp. *angustifolium*	Narrow-leaf fireweed	S4
Chamerion angustifolium ssp. *circumvagum*	Narrow-leaf fireweed	S4
Cicuta bulbifera	Water hemlock	S4
Cicuta maculata var. *maculata*	Spotted water-hemlock	S4
Comarum palustre	Marsh cinquefoil	S4
Cornus canadensis	Bunchberry	S4
Cyperaceae sp.	Sedges	-
Cypripedium acaule	Stemless lady's-slipper	S4
Deschampsia cespitosa ssp. *cespitosa*	Tufted hair grass	S4
Diphasiastrum complanatum	Trailing club-moss	S4
Drosera rotundifolia	Round-leaved sundew	S4
Dryopteris carthusiana	Spinulose wood fern	S4
Empetrum nigrum ssp. *hermaphroditum*	Black crowberry	S4
Epilobium ciliatum ssp. *ciliatum*	Hairy willow-herb	S4
Epilobium palustre	Marsh willowherb	S4
Equisetum arvense	Common horsetail	S5
Equisetum pratense	Meadow horsetail	S4
Equisetum sylvaticum	Woodland horsetail	S4

Appendix A, Table 2

Vascular Plant Species Observed During Terrestrial and Aquatic Vegetation Inventory Surveys in the Vegetation Study Area, June and August 2018

Scientific Name	Common Name	SKCDC Rank
Eriophorum vaginatum var. *vaginatum*	Tussock cotton-grass	S4
Galium trifidum ssp. *trifidum*	Small bedstraw	S4
Galium triflorum	Sweet-scented bedstraw	S4
Geocaulon lividum	Northern comandra	S4
Geranium bicknellii	Bicknell's geranium	S4
Hudsonia tomentosa var. *tomentosa*	Sand golden-heather	S4
Isoetes echinospora	Spiny-spored quillwort	S4
Kalmia polifolia	Pale laurel	S4
Larix laricina	Tamarack	S5
Linnaea borealis ssp. *americana*	American twinflower	S4
Lobelia dortmanna	**Water lobelia**	**S3**[a]
Lycopodium annotinum	Stiff club-moss	S4
Maianthemum canadense	Two-leaved Solomon's-seal	S4
Maianthemum stellatum	Starflower false Solomon's-seal	S4
Maianthemum trifolium	Three-leaf Solomon's-seal	S4
Menyanthes trifoliata	Bog buckbean	S4
Mitella nuda	Bishop's-cap	S4
Myrica gale	Sweet gale	S4
Nuphar variegata	Yellow cowlily	S4
Phalaris arundinacea	Reed canary grass	S4
Picea glauca	White spruce	S5
Picea mariana	Black spruce	S5
Pinus banksiana	Jackpine	S5
Populus balsamifera ssp. *balsamifera*	Balsam poplar	S5
Populus tremuloides	Trembling aspen	S5
Potamogeton alpinus	Northern pondweed	S4
Potentilla norvegica	Rough cinquefoil	S4
Prunus pensylvanica	Pin cherry	S4
Pyrola asarifolia ssp. *asarifolia*	Pink wintergreen	S4
Rhododendron groenlandicum	Common labrador tea	S4
Ribes americanum	Wild black currant	S4
Ribes glandulosum	Skunk currant	S4
Ribes hudsonianum var. *hudsonianum*	Northern black currant	S4
Ribes lacustre	Bristly black currant	S4
Ribes oxyacanthoides ssp. *oxyacanthoides*	Bristly gooseberry	S4
Rosa acicularis ssp. *sayi*	Prickly rose	S5
Rubus arcticus ssp. *acaulis*	Nagoon berry	S4
Rubus chamaemorus	Cloudberry	S4
Rubus idaeus ssp. *strigosus*	American red raspberry	S5
Rubus pubescens	Dewberry	S4
Rumex triangulivalvis	Triangular-valved dock	S5
Salix sp.	Willow	-
Salix bebbiana	Long-beaked willow	S4
Salix discolor	Pussy willow	S4
Salix planifolia ssp. *planifolia*	Plane-leaf willow	S4
Salix pyrifolia	Balsam willow	S4
Salix scouleriana	Scouler's willow	S4

Appendix A, Table 2

Vascular Plant Species Observed During Terrestrial and Aquatic Vegetation Inventory Surveys in the Vegetation Study Area, June and August 2018

Scientific Name	Common Name	SKCDC Rank
Salix serissima	Autumn willow	S4
Scheuchzeria palustris	American Scheuchzeria	S4
Scutellaria galericulata	Marsh skullcap	S4
Sparganium angustifolium	Narrow-leaved bur-reed	S4
Stachys pilosa var. *pilosa*	Hairy hedge-nettle	S4
Stellaria longifolia	Long-leaved stitchwort	S4
Stellaria longipes ssp. *longipes*	Long-leaved starwort	S4
Stuckenia pectinata	Sago pondweed	S4
Trientalis borealis ssp. *borealis*	Maystar	S4
Urtica dioica ssp. *gracilis*	Stinging nettle	S4
Vaccinium myrtilloides	Blueberry	S4
Vaccinium oxycoccos	Small cranberry	S4
Vaccinium vitis-idaea ssp. *minus*	Mountain cranberry	S4
Viburnum edule	Low bush-cranberry	S4
Viburnum opulus var. *americanum*	High bush-cranberry	S4
Viola adunca var. *adunca*	Early blue violet	S5
Viola canadensis var. *rugulosa*	Western Canada violet	S4
Viola nephrophylla	Northern bog violet	S4
Viola palustris	Marsh violet	S4
Viola renifolia	Kidney-leaved white violet	S4

Source: All scientific, common names and provincial ranks from SKCDC (2018); with exception (see footnote a).

Bold text indicates provincially-rare (S1 to S3) species.

SKCDC = Saskatchewan Conservation Data Centre; S3 = vulnerable/rare to uncommon, S4 = apparently secure, S5 = secure/common.

[a]Species rank from SKCDC (2021).

Appendix A, Table 3

Species Occurrences Within the Terrestrial Vegetation Inventory Surveys in the Vegetation Study Area, June to August 2018

Scientific Name	Common Name	SKCDC Rank	Transects												
			VI_001	VI_002	VI_003	VI_004	VI_005	VI_006	VI_007	VI_008	VI_009	VI_010	VI_011	VI_012	VI_013
Agrostis scabra var. *scabra*	Hair grass	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Alnus incana ssp. *tenuifolia*	Western river alder	S4	X	X	-	-	-	X	-	-	-	-	-	-	-
Alnus viridis ssp. *crispa*	Green alder	S4	-	X	X	X	-	X	X	-	-	-	-	X	X
Andromeda polifolia var. *polifolia*	Bog-rosemary	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Apocynum androsaemifolium	Spreading dogbane	S4	-	-	-	-	-	-	X	-	-	-	-	-	-
Aralia nudicaulis	Wild sarsaparilla	S4	-	X	-	-	-	-	-	-	-	-	-	-	-
Arceuthobium americanum	American mistletoe	S4	-	-	-	-	-	-	-	-	-	-	X	-	-
Arctostaphylos uva-ursi	Bearberry	S4	X	-	-	X	-	-	X	X	X	-	X	-	-
Athyrium filix-femina var. *cyclosorum*	Northern lady-fern	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Betula glandulosa	Dwarf birch	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Betula papyrifera	Paper birch	S5	X	X	X	-	X	X	X	X	-	-	-	-	-
Betula pumila	Swamp birch	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Calamagrostis sp.	Reedgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calamagrostis canadensis var. *canadensis*	Blue-joint reedgrass	S4	X	X	-	-	X	X	-	-	-	-	-	-	-
Calamagrostis stricta	Northern reed grass	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Caltha palustris var. *palustris*	Yellow marsh-marigold	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex aquatilis var. *aquatilis*	Water sedge	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Carex brunnescens	Brownish Sedge	S4	X	-	-	-	-	-	-	-	-	-	-	-	-
Carex canescens ssp. *canescens*	Hoary sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex concinna	**Beautiful sedge**	**S3**	**-**	**-**	**-**	**-**	**-**	**X**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Carex deflexa	Bent sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex diandra	Two-stamened sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex foenea	Hay sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex heleonastes	**Hudson Bay sedge**	**S3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Carex limosa	Mud sedge	S4	-	-	-	-	X	-	-	-	-	-	-	-	-
Carex magellanica ssp. *irrigua*	Boreal-bog sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex trisperma* var. *trisperma	**Three-fruited sedge**	**S3**	**-**	**-**	**-**	**-**	**X**	**-**	**-**	**X**	**-**	**-**	**-**	**-**	**-**
Carex utriculata	Northwest territory sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Chamaedaphne calyculata	Leatherleaf	S4	X	-	-	-	X	X	-	X	-	-	-	-	-
Chamerion angustifolium ssp. *angustifolium*	Narrow-leaf fireweed	S4	-	X	-	-	-	-	-	-	-	-	-	-	-
Chamerion angustifolium ssp. *circumvagum*	Narrow-leaf fireweed	S4	-	X	-	-	-	X	X	-	-	-	-	-	-
Cicuta bulbifera	Water hemlock	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Cicuta maculata var. maculata	Spotted water-hemlock	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Comarum palustre	Marsh cinquefoil	S4	X	-	-	-	-	-	-	-	-	-	-	-	-
Cornus canadensis	Bunchberry	S4	-	X	X	-	-	X	X	-	-	-	-	-	-
Cyperaceae sp.	Sedge	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cypripedium acaule	Stemless lady's-slipper	S4	-	-	-	-	-	-	X	-	-	-	-	-	-
Deschampsia cespitosa ssp. *cespitosa*	Tufted hair grass	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Diphasiastrum complanatum	Trailing club-moss	S4	-	X	-	-	-	-	-	-	-	-	-	-	-
Drosera rotundifolia	Round-leaved sundew	S4	-	-	-	-	X	-	-	X	-	-	-	-	-
Dryopteris carthusiana	Spinulose wood fern	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Empetrum nigrum ssp. *hermaphroditum*	Black crowberry	S4	-	-	-	-	-	-	-	-	-	-	X	-	-
Epilobium ciliatum ssp. *ciliatum*	Hairy willow-herb	S4	X	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium palustre	Marsh willowherb	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum arvense	Common horsetail	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum pratense	Meadow horsetail	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum sylvaticum	Woodland horsetail	S4	X	X	-	-	-	X	-	X	-	-	-	-	-
Eriophorum vaginatum var. *vaginatum*	Tussock cotton-grass	S4	-	-	-	-	X	-	-	-	-	-	-	-	-
Galium trifidum ssp. *trifidum*	Small bedstraw	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Galium triflorum	Sweet-scented bedstraw	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Geocaulon lividum	Northern comandra	S4	-	-	X	-	-	-	X	X	-	-	-	-	-
Geranium bicknellii	Bicknell's geranium	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Hudsonia tomentosa var. *tomentosa*	Sand golden-heather	S4	-	-	-	X	-	-	-	-	-	-	X	-	-
Kalmia polifolia	Pale laurel	S4	X	-	-	-	X	X	-	X	-	-	-	-	-
Larix laricina	Tamarack	S5	X	-	-	-	-	-	-	-	-	-	-	-	-
Linnaea borealis ssp. *americana*	American twinflower	S4	-	-	-	-	-	-	X	-	-	-	-	-	-
Lycopodium annotinum	Stiff club-moss	S4	-	X	-	-	-	-	X	-	-	-	-	-	-
Maianthemum canadense	Two-leaved Solomon's-seal	S4	-	-	-	-	-	-	X	-	-	-	-	-	-
Maianthemum stellatum	Starflower false Solomon's-seal	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Maianthemum trifolium	Three-leaf Solomon's-seal	S4	X	-	-	-	X	-	-	X	-	-	-	-	-
Menyanthes trifoliata	Bog buckbean	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Mitella nuda	Bishop's-cap	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Myrica gale	Sweet gale	S4	-	X	-	-	X	-	-	-	-	-	-	-	-
Phalaris arundinacea	Reed canary grass	S4	X	-	-	-	-	-	-	-	-	-	-	-	-
Picea glauca	White spruce	S5	-	X	-	X	-	-	-	-	-	-	-	X	X
Picea mariana	Black spruce	S5	X	X	X	X	X	X	X	X	-	-	-	X	X
Pinus banksiana	Jackpine	S5	X	X	-	X	-	X	X	X	X	-	X	X	X
Populus balsamifera ssp. *balsamifera*	Balsam poplar	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Populus tremuloides	Trembling aspen	S5	-	X	-	-	-	X	-	-	-	-	-	-	-
Potentilla norvegica	Rough cinquefoil	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Prunus pensylvanica	Pin cherry	S4	-	-	X	-	-	X	X	-	-	-	-	-	-
Pyrola asarifolia ssp. *asarifolia*	Pink wintergreen	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhododendron groenlandicum	Common labrador tea	S4	X	X	X	X	X	X	X	X	-	-	-	X	X
Ribes americanum	Wild black currant	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes glandulosum	Skunk currant	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes hudsonianum var. *hudsonianum*	Northern black currant	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes lacustre	Bristly black currant	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes oxyacanthoides ssp. *oxyacanthoides*	Bristly gooseberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Rosa acicularis ssp. *sayi*	Prickly rose	S5	-	-	-	-	-	-	X	-	-	-	-	-	-
Rubus arcticus ssp. *acaulis*	Nagoon berry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubus chamaemorus	Cloudberry	S4	X	-	-	-	X	X	-	X	-	-	-	-	-
Rubus idaeus ssp. *strigosus*	American red raspberry	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubus pubescens	Dewberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Rumex triangulivalvis	Triangular-valved dock	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix sp.	Willow	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Salix bebbiana	Long-beaked willow	S4	X	X	-	-	-	-	-	-	-	-	-	-	-
Salix discolor	Pussy willow	S4	-	-	X	-	-	-	X	-	-	-	-	-	-
Salix planifolia ssp. *planifolia*	Plane-leaf willow	S4	X	X	-	-	-	X	-	-	-	-	-	-	-
Salix pyrifolia	Balsam willow	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix scouleriana	Scouler's willow	S4	-	X	-	X	-	-	X	-	-	-	-	-	-
Salix serissima	Autumn willow	S4	X	-	-	-	-	-	-	X	-	-	-	-	-
Scheuchzeria palustris	American Scheuchzeria	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Scutellaria galericulata	Marsh skullcap	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Stachys pilosa var. *pilosa*	Hairy hedge-nettle	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Stellaria longifolia	Long-leaved stitchwort	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Stellaria longipes ssp. *longipes*	Long-leaved starwort	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Trientalis borealis ssp. *borealis*	Maystar	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Urtica dioica ssp. *gracilis*	Stinging nettle	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium myrtilloides	Blueberry	S4	X	X	X	X	-	X	X	X	X	-	X	X	X
Vaccinium oxycoccos	Small cranberry	S4	X	-	-	-	X	X	-	X	-	-	-	-	-
Vaccinium vitis-idaea ssp. *minus*	Mountain cranberry	S4	X	X	X	X	X	X	X	X	X	-	X	X	X
Viburnum edule	Low bush-cranberry	S4	-	-	-	-	-	-	X	-	-	-	-	-	-
Viburnum opulus var. *americanum*	High bush-cranberry	S4	-	-	-	-	-	-	X	-	-	-	-	-	-
Viola adunca var. *adunca*	Early blue violet	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola canadensis var. *rugulosa*	Western Canada violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola nephrophylla	Northern bog violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola palustris	Marsh violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola renifolia	Kidney-leaved white violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix A, Table 3

Species Occurrences Within the Terrestrial Vegetation Inventory Surveys in the Vegetation Study Area, June to August 2018

Scientific Name	Common Name	SKCDC Rank	Transects												
			VI_014	VI_016	VI_018	VI_019	VI_020	VI_021	VI_022	VI_023	VI_026	VI_029	VI_033	VI_034	VI_037
Agrostis scabra var. *scabra*	Hair grass	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Alnus incana ssp. *tenuifolia*	Western river alder	S4	-	-	-	-	X	-	-	-	-	-	-	-	-
Alnus viridis ssp. *crispa*	Green alder	S4	X	-	X	X	X	X	X	X	-	-	-	-	-
Andromeda polifolia var. *polifolia*	Bog-rosemary	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Apocynum androsaemifolium	Spreading dogbane	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Aralia nudicaulis	Wild sarsaparilla	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Arceuthobium americanum	American mistletoe	S4	-	-	X	-	-	X	-	-	-	-	X	-	-
Arctostaphylos uva-ursi	Bearberry	S4	X	-	X	X	-	X	X	X	X	X	X	X	-
Athyrium filix-femina var. *cyclosorum*	Northern lady-fern	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Betula glandulosa	Dwarf birch	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Betula papyrifera	Paper birch	S5	-	X	-	-	X	X	X	X	-	-	-	-	X
Betula pumila	Swamp birch	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Calamagrostis sp.	Reedgrass	-	-	-	-	-	X	-	-	-	-	-	-	-	-
Calamagrostis canadensis var. *canadensis*	Blue-joint reedgrass	S4	-	-	-	-	X	-	-	-	-	-	-	-	-
Calamagrostis stricta	Northern reed grass	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Caltha palustris var. *palustris*	Yellow marsh-marigold	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex aquatilis var. *aquatilis*	Water sedge	S4	-	X	-	-	-	-	-	-	-	-	-	-	-
Carex brunnescens	Brownish Sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex canescens ssp. *canescens*	Hoary sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex concinna	**Beautiful sedge**	**S3**	**-**	**-**	**-**	**-**	**X**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Carex deflexa	Bent sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex diandra	Two-stamened sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex foenea	Hay sedge	S4	-	-	-	-	X	-	-	-	-	-	-	-	-
Carex heleonastes	**Hudson Bay sedge**	**S3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Carex limosa	Mud sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex magellanica ssp. *irrigua*	Boreal-bog sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex trisperma* var. *trisperma	**Three-fruited sedge**	**S3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Carex utriculata	Northwest territory sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Chamaedaphne calyculata	Leatherleaf	S4	-	X	-	-	-	-	-	-	-	-	-	-	X
Chamerion angustifolium ssp. *angustifolium*	Narrow-leaf fireweed	S4	-	-	-	-	X	-	-	-	-	-	-	-	-
Chamerion angustifolium ssp. *circumvagum*	Narrow-leaf fireweed	S4	-	-	-	-	X	-	-	-	-	-	-	-	-
Cicuta bulbifera	Water hemlock	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Cicuta maculata var. maculata	Spotted water-hemlock	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Comarum palustre	Marsh cinquefoil	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Cornus canadensis	Bunchberry	S4	-	-	-	-	X	-	-	-	-	-	-	-	-
Cyperaceae sp.	Sedge	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cypripedium acaule	Stemless lady's-slipper	S4	-	-	-	-	-	-	X	-	-	-	-	-	-
Deschampsia cespitosa ssp. *cespitosa*	Tufted hair grass	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Diphasiastrum complanatum	Trailing club-moss	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Drosera rotundifolia	Round-leaved sundew	S4	-	X	-	-	-	-	-	-	-	-	-	-	-
Dryopteris carthusiana	Spinulose wood fern	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Empetrum nigrum ssp. *hermaphroditum*	Black crowberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium ciliatum ssp. *ciliatum*	Hairy willow-herb	S4	-	-	-	-	X	-	-	-	-	-	-	-	-
Epilobium palustre	Marsh willowherb	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum arvense	Common horsetail	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum pratense	Meadow horsetail	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum sylvaticum	Woodland horsetail	S4	-	-	-	-	X	-	-	-	-	-	-	-	-
Eriophorum vaginatum var. *vaginatum*	Tussock cotton-grass	S4	-	X	-	-	-	-	-	-	-	-	-	-	X
Galium trifidum ssp. *trifidum*	Small bedstraw	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Galium triflorum	Sweet-scented bedstraw	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Geocaulon lividum	Northern comandra	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Geranium bicknellii	Bicknell's geranium	S4	-	-	-	-	X	-	-	-	-	-	-	-	-
Hudsonia tomentosa var. *tomentosa*	Sand golden-heather	S4	-	-	-	-	-	-	-	-	-	X	X	X	-
Kalmia polifolia	Pale laurel	S4	-	X	-	-	X	-	-	-	-	-	-	-	X
Larix laricina	Tamarack	S5	-	X	-	-	-	-	-	-	-	-	-	-	-
Linnaea borealis ssp. *americana*	American twinflower	S4	-	-	-	-	X	-	X	-	-	-	-	-	-
Lycopodium annotinum	Stiff club-moss	S4	-	-	-	-	X	-	X	-	-	-	-	-	-
Maianthemum canadense	Two-leaved Solomon's-seal	S4	-	-	-	-	X	-	-	-	-	-	-	-	-
Maianthemum stellatum	Starflower false Solomon's-seal	S4	-	X	-	-	-	-	-	-	-	-	-	-	-
Maianthemum trifolium	Three-leaf Solomon's-seal	S4	-	X	-	-	-	-	-	-	-	-	-	-	-
Menyanthes trifoliata	Bog buckbean	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Mitella nuda	Bishop's-cap	S4	-	-	-	-	X	-	-	-	-	-	-	-	-
Myrica gale	Sweet gale	S4	-	-	-	-	X	-	-	-	-	-	-	-	-
Phalaris arundinacea	Reed canary grass	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Picea glauca	White spruce	S5	-	-	X	-	-	-	-	-	-	-	-	-	-
Picea mariana	Black spruce	S5	-	X	-	-	X	X	-	X	-	-	-	-	X
Pinus banksiana	Jackpine	S5	X	X	X	X	X	X	X	X	X	X	X	X	X
Populus balsamifera ssp. *balsamifera*	Balsam poplar	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Populus tremuloides	Trembling aspen	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Potentilla norvegica	Rough cinquefoil	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Prunus pensylvanica	Pin cherry	S4	-	-	-	-	-	-	X	-	-	-	-	-	-
Pyrola asarifolia ssp. *asarifolia*	Pink wintergreen	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhododendron groenlandicum	Common labrador tea	S4	-	X	X	-	X	X	-	X	-	-	-	-	X
Ribes americanum	Wild black currant	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes glandulosum	Skunk currant	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes hudsonianum var. *hudsonianum*	Northern black currant	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes lacustre	Bristly black currant	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes oxyacanthoides ssp. *oxyacanthoides*	Bristly gooseberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Rosa acicularis ssp. *sayi*	Prickly rose	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubus arcticus ssp. *acaulis*	Nagoon berry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubus chamaemorus	Cloudberry	S4	-	X	-	-	-	-	-	-	-	-	-	-	X
Rubus idaeus ssp. *strigosus*	American red raspberry	S5	-	-	-	-	X	-	-	-	-	-	-	-	-
Rubus pubescens	Dewberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Rumex triangulivalvis	Triangular-valved dock	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix sp.	Willow	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix bebbiana	Long-beaked willow	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix discolor	Pussy willow	S4	-	-	X	-	-	-	X	-	-	-	-	-	-
Salix planifolia ssp. *planifolia*	Plane-leaf willow	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix pyrifolia	Balsam willow	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix scouleriana	Scouler's willow	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix serissima	Autumn willow	S4	-	-	-	-	X	-	-	-	-	-	-	-	-
Scheuchzeria palustris	American Scheuchzeria	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Scutellaria galericulata	Marsh skullcap	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Stachys pilosa var. *pilosa*	Hairy hedge-nettle	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Stellaria longifolia	Long-leaved stitchwort	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Stellaria longipes ssp. *longipes*	Long-leaved starwort	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Trientalis borealis ssp. *borealis*	Maystar	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Urtica dioica ssp. *gracilis*	Stinging nettle	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium myrtilloides	Blueberry	S4	X	-	X	X	X	X	X	X	X	X	X	X	X
Vaccinium oxycoccos	Small cranberry	S4	-	X	-	-	-	-	-	-	-	-	-	-	X
Vaccinium vitis-idaea ssp. *minus*	Mountain cranberry	S4	-	X	X	X	X	X	X	X	-	-	X	X	X
Viburnum edule	Low bush-cranberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viburnum opulus var. *americanum*	High bush-cranberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola adunca var. *adunca*	Early blue violet	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola canadensis var. *rugulosa*	Western Canada violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola nephrophylla	Northern bog violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola palustris	Marsh violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola renifolia	Kidney-leaved white violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix A, Table 3

Species Occurrences Within the Terrestrial Vegetation Inventory Surveys in the Vegetation Study Area, June to August 2018

Scientific Name	Common Name	SKCDC Rank	Transects												
			VI_045	VI_046	VI_047	VI_053	VI_054	VI_055	VI_059	VI_060	VI_063	VI_073	VI_074	VI_075	VI_076
Agrostis scabra var. *scabra*	Hair grass	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Alnus incana ssp. *tenuifolia*	Western river alder	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Alnus viridis ssp. *crispa*	Green alder	S4	-	-	X	X	-	X	X	X	X	-	-	-	-
Andromeda polifolia var. *polifolia*	Bog-rosemary	S4	X	X	-	-	-	-	-	-	-	X	X	X	X
Apocynum androsaemifolium	Spreading dogbane	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Aralia nudicaulis	Wild sarsaparilla	S4	-	-	-	-	-	-	-	X	-	-	-	-	-
Arceuthobium americanum	American mistletoe	S4	-	-	X	-	-	-	X	X	X	-	-	-	-
Arctostaphylos uva-ursi	Bearberry	S4	-	-	-	X	-	-	X	X	X	-	-	-	-
Athyrium filix-femina var. *cyclosorum*	Northern lady-fern	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Betula glandulosa	Dwarf birch	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Betula papyrifera	Paper birch	S5	-	-	X	X	X	X	-	X	X	-	-	-	-
Betula pumila	Swamp birch	S4	-	-	-	-	-	X	-	-	-	-	-	-	-
Calamagrostis sp.	Reedgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calamagrostis canadensis var. *canadensis*	Blue-joint reedgrass	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Calamagrostis stricta	Northern reed grass	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Caltha palustris var. *palustris*	Yellow marsh-marigold	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Carex aquatilis var. *aquatilis*	Water sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex brunnescens	Brownish Sedge	S4	-	-	-	-	-	X	-	-	-	-	-	-	-
Carex canescens ssp. *canescens*	Hoary sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex concinna	**Beautiful sedge**	**S3**	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex deflexa	Bent sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex diandra	Two-stamened sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex foenea	Hay sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex heleonastes	**Hudson Bay sedge**	**S3**	-	-	-	-	-	**X**	-	-	-	-	-	-	-
Carex limosa	Mud sedge	S4	-	-	-	-	-	-	-	-	-	-	-	X	-
Carex magellanica ssp. *irrigua*	Boreal-bog sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex trisperma* var. *trisperma	**Three-fruited sedge**	**S3**	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex utriculata	Northwest territory sedge	S4	-	-	-	-	-	-	-	-	-	-	-	X	-
Chamaedaphne calyculata	Leatherleaf	S4	X	X	-	-	-	-	-	-	-	X	X	X	X
Chamerion angustifolium ssp. *angustifolium*	Narrow-leaf fireweed	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Chamerion angustifolium ssp. *circumvagum*	Narrow-leaf fireweed	S4	X	-	-	-	-	-	-	-	-	-	-	-	-
Cicuta bulbifera	Water hemlock	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Cicuta maculata var. maculata	Spotted water-hemlock	S4	-	-	-	-	X	-	-	-	-	-	-	-	-
Comarum palustre	Marsh cinquefoil	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Cornus canadensis	Bunchberry	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Cyperaceae sp.	Sedge	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cypripedium acaule	Stemless lady's-slipper	S4	-	-	X	-	-	-	-	-	-	-	-	-	-
Deschampsia cespitosa ssp. *cespitosa*	Tufted hair grass	S4	-	-	-	-	-	X	-	-	-	-	-	-	-
Diphasiastrum complanatum	Trailing club-moss	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Drosera rotundifolia	Round-leaved sundew	S4	X	X	-	-	-	-	-	-	-	X	X	X	X
Dryopteris carthusiana	Spinulose wood fern	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Empetrum nigrum ssp. *hermaphroditum*	Black crowberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium ciliatum ssp. *ciliatum*	Hairy willow-herb	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium palustre	Marsh willowherb	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum arvense	Common horsetail	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum pratense	Meadow horsetail	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum sylvaticum	Woodland horsetail	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Eriophorum vaginatum var. *vaginatum*	Tussock cotton-grass	S4	X	X	-	-	-	-	-	-	-	X	X	X	X
Galium trifidum ssp. *trifidum*	Small bedstraw	S4	-	-	-	-	-	X	-	-	-	-	-	-	-
Galium triflorum	Sweet-scented bedstraw	S4	-	-	-	-	X	-	-	-	-	-	-	-	-
Geocaulon lividum	Northern comandra	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Geranium bicknellii	Bicknell's geranium	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Hudsonia tomentosa var. *tomentosa*	Sand golden-heather	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalmia polifolia	Pale laurel	S4	X	X	-	-	-	-	-	-	-	X	X	X	X
Larix laricina	Tamarack	S5	-	-	-	-	-	-	-	-	-	-	X	X	-
Linnaea borealis ssp. *americana*	American twinflower	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Lycopodium annotinum	Stiff club-moss	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Maianthemum canadense	Two-leaved Solomon's-seal	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Maianthemum stellatum	Starflower false Solomon's-seal	S4	-	X	-	-	-	-	-	-	-	-	-	-	-
Maianthemum trifolium	Three-leaf Solomon's-seal	S4	-	X	-	-	-	-	-	-	-	-	X	X	-
Menyanthes trifoliata	Bog buckbean	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Mitella nuda	Bishop's-cap	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Myrica gale	Sweet gale	S4	-	-	-	-	-	X	-	-	-	-	-	-	-
Phalaris arundinacea	Reed canary grass	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Picea glauca	White spruce	S5	-	-	-	-	X	-	-	-	-	-	-	-	-
Picea mariana	Black spruce	S5	X	X	-	-	X	X	-	-	-	X	X	X	X
Pinus banksiana	Jackpine	S5	X	-	X	X	X	X	X	X	X	-	-	-	X
Populus balsamifera ssp. *balsamifera*	Balsam poplar	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Populus tremuloides	Trembling aspen	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Potentilla norvegica	Rough cinquefoil	S4	-	-	-	-	-	X	-	-	-	-	-	-	-
Prunus pensylvanica	Pin cherry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyrola asarifolia ssp. *asarifolia*	Pink wintergreen	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Rhododendron groenlandicum	Common labrador tea	S4	X	X	X	X	X	X	X	X	X	X	X	X	X
Ribes americanum	Wild black currant	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes glandulosum	Skunk currant	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes hudsonianum var. *hudsonianum*	Northern black currant	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Ribes lacustre	Bristly black currant	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes oxyacanthoides ssp. *oxyacanthoides*	Bristly gooseberry	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Rosa acicularis ssp. *sayi*	Prickly rose	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubus arcticus ssp. *acaulis*	Nagoon berry	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Rubus chamaemorus	Cloudberry	S4	X	X	-	-	-	-	-	-	-	X	X	X	X
Rubus idaeus ssp. *strigosus*	American red raspberry	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubus pubescens	Dewberry	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Rumex triangulivalvis	Triangular-valved dock	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix sp.	Willow	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix bebbiana	Long-beaked willow	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix discolor	Pussy willow	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix planifolia ssp. *planifolia*	Plane-leaf willow	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Salix pyrifolia	Balsam willow	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix scouleriana	Scouler's willow	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Salix serissima	Autumn willow	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Scheuchzeria palustris	American Scheuchzeria	S4	-	-	-	-	-	-	-	-	-	-	-	X	-
Scutellaria galericulata	Marsh skullcap	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Stachys pilosa var. *pilosa*	Hairy hedge-nettle	S4	-	-	-	-	-	X	-	-	-	-	-	-	-
Stellaria longifolia	Long-leaved stitchwort	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Stellaria longipes ssp. *longipes*	Long-leaved starwort	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Trientalis borealis ssp. *borealis*	Maystar	S4	-	-	-	-	X	X	-	-	-	-	-	-	-
Urtica dioica ssp. *gracilis*	Stinging nettle	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium myrtilloides	Blueberry	S4	X	-	X	X	-	X	X	X	X	-	-	-	-
Vaccinium oxycoccos	Small cranberry	S4	X	X	-	-	-	-	-	-	-	X	X	X	X
Vaccinium vitis-idaea ssp. *minus*	Mountain cranberry	S4	X	-	X	X	-	X	X	X	X	-	-	-	X
Viburnum edule	Low bush-cranberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viburnum opulus var. *americanum*	High bush-cranberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola adunca var. *adunca*	Early blue violet	S5	-	-	-	-	X	-	-	-	-	-	-	-	-
Viola canadensis var. *rugulosa*	Western Canada violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola nephrophylla	Northern bog violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola palustris	Marsh violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola renifolia	Kidney-leaved white violet	S4	-	-	-	-	X	X	-	-	-	-	-	-	-

Appendix A, Table 3

Species Occurrences Within the Terrestrial Vegetation Inventory Surveys in the Vegetation Study Area, June to August 2018

Scientific Name	Common Name	SKCDC Rank	Transects												
			VI_077	VI_078	VI_079	VI_080	VI_081	VI_082	VI_083	VI_084	VI_086	VI_087	VI_088	VI_089	VI_090
Agrostis scabra var. *scabra*	Hair grass	S4	-	-	-	-	-	-	-	-	X	-	-	-	-
Alnus incana ssp. *tenuifolia*	Western river alder	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Alnus viridis ssp. *crispa*	Green alder	S4	-	-	-	X	X	X	-	-	-	-	-	-	-
Andromeda polifolia var. *polifolia*	Bog-rosemary	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Apocynum androsaemifolium	Spreading dogbane	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Aralia nudicaulis	Wild sarsaparilla	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Arceuthobium americanum	American mistletoe	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Arctostaphylos uva-ursi	Bearberry	S4	-	-	-	X	X	X	X	-	-	-	-	-	-
Athyrium filix-femina var. *cyclosorum*	Northern lady-fern	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Betula glandulosa	Dwarf birch	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Betula papyrifera	Paper birch	S5	-	-	-	-	X	-	-	-	-	-	-	-	-
Betula pumila	Swamp birch	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Calamagrostis sp.	Reedgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calamagrostis canadensis var. *canadensis*	Blue-joint reedgrass	S4	-	-	-	-	-	-	-	-	X	-	-	-	-
Calamagrostis stricta	Northern reed grass	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Caltha palustris var. *palustris*	Yellow marsh-marigold	S4	-	-	-	-	-	-	-	-	X	-	-	-	-
Carex aquatilis var. *aquatilis*	Water sedge	S4	-	X	X	-	-	-	-	X	-	-	-	-	-
Carex brunnescens	Brownish Sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex canescens ssp. *canescens*	Hoary sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex concinna	**Beautiful sedge**	**S3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Carex deflexa	Bent sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex diandra	Two-stamened sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex foenea	Hay sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex heleonastes	**Hudson Bay sedge**	**S3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Carex limosa	Mud sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex magellanica ssp. *irrigua*	Boreal-bog sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex trisperma* var. *trisperma	**Three-fruited sedge**	**S3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Carex utriculata	Northwest territory sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Chamaedaphne calyculata	Leatherleaf	S4	X	X	X	-	-	-	-	X	X	X	X	X	X
Chamerion angustifolium ssp. *angustifolium*	Narrow-leaf fireweed	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Chamerion angustifolium ssp. *circumvagum*	Narrow-leaf fireweed	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Cicuta bulbifera	Water hemlock	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Cicuta maculata var. maculata	Spotted water-hemlock	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Comarum palustre	Marsh cinquefoil	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Cornus canadensis	Bunchberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyperaceae sp.	Sedge	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cypripedium acaule	Stemless lady's-slipper	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Deschampsia cespitosa ssp. *cespitosa*	Tufted hair grass	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Diphasiastrum complanatum	Trailing club-moss	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Drosera rotundifolia	Round-leaved sundew	S4	X	X	X	-	-	-	-	X	X	X	X	X	X
Dryopteris carthusiana	Spinulose wood fern	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Empetrum nigrum ssp. *hermaphroditum*	Black crowberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium ciliatum ssp. *ciliatum*	Hairy willow-herb	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium palustre	Marsh willowherb	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum arvense	Common horsetail	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum pratense	Meadow horsetail	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum sylvaticum	Woodland horsetail	S4	-	-	-	-	-	-	-	X	-	-	-	-	-
Eriophorum vaginatum var. *vaginatum*	Tussock cotton-grass	S4	X	X	X	-	-	-	-	X	X	X	X	X	X
Galium trifidum ssp. *trifidum*	Small bedstraw	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Galium triflorum	Sweet-scented bedstraw	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Geocaulon lividum	Northern comandra	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Geranium bicknellii	Bicknell's geranium	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Hudsonia tomentosa var. *tomentosa*	Sand golden-heather	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalmia polifolia	Pale laurel	S4	X	X	X	-	-	-	-	X	X	X	X	X	X
Larix laricina	Tamarack	S5	-	-	-	-	-	-	-	X	-	-	X	-	-
Linnaea borealis ssp. *americana*	American twinflower	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Lycopodium annotinum	Stiff club-moss	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Maianthemum canadense	Two-leaved Solomon's-seal	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Maianthemum stellatum	Starflower false Solomon's-seal	S4	-	X	-	-	-	-	-	-	X	-	-	-	-
Maianthemum trifolium	Three-leaf Solomon's-seal	S4	X	X	X	-	-	-	-	X	X	X	X	X	X
Menyanthes trifoliata	Bog buckbean	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Mitella nuda	Bishop's-cap	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Myrica gale	Sweet gale	S4	-	-	-	-	-	-	-	-	X	-	-	-	X
Phalaris arundinacea	Reed canary grass	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Picea glauca	White spruce	S5	-	-	-	-	X	-	-	-	-	-	-	-	-
Picea mariana	Black spruce	S5	X	X	X	-	-	-	-	X	X	X	X	X	X
Pinus banksiana	Jackpine	S5	X	X	X	X	X	X	X	X	-	-	-	-	-
Populus balsamifera ssp. *balsamifera*	Balsam poplar	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Populus tremuloides	Trembling aspen	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Potentilla norvegica	Rough cinquefoil	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Prunus pensylvanica	Pin cherry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyrola asarifolia ssp. *asarifolia*	Pink wintergreen	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhododendron groenlandicum	Common labrador tea	S4	X	X	X	X	X	-	-	X	X	X	X	X	X
Ribes americanum	Wild black currant	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes glandulosum	Skunk currant	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes hudsonianum var. *hudsonianum*	Northern black currant	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes lacustre	Bristly black currant	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes oxyacanthoides ssp. *oxyacanthoides*	Bristly gooseberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Rosa acicularis ssp. *sayi*	Prickly rose	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubus arcticus ssp. *acaulis*	Nagoon berry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubus chamaemorus	Cloudberry	S4	X	X	X	-	-	-	-	X	X	X	X	X	X
Rubus idaeus ssp. *strigosus*	American red raspberry	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubus pubescens	Dewberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Rumex triangulivalvis	Triangular-valved dock	S5	-	-	-	-	-	-	-	-	X	-	-	-	-
Salix sp.	Willow	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix bebbiana	Long-beaked willow	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix discolor	Pussy willow	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix planifolia ssp. *planifolia*	Plane-leaf willow	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix pyrifolia	Balsam willow	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix scouleriana	Scouler's willow	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix serissima	Autumn willow	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Scheuchzeria palustris	American Scheuchzeria	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Scutellaria galericulata	Marsh skullcap	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Stachys pilosa var. *pilosa*	Hairy hedge-nettle	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Stellaria longifolia	Long-leaved stitchwort	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Stellaria longipes ssp. *longipes*	Long-leaved starwort	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Trientalis borealis ssp. *borealis*	Maystar	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Urtica dioica ssp. *gracilis*	Stinging nettle	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium myrtilloides	Blueberry	S4	-	-	X	X	X	X	X	-	-	-	-	-	-
Vaccinium oxycoccos	Small cranberry	S4	X	X	X	-	-	-	-	X	X	X	X	X	X
Vaccinium vitis-idaea ssp. *minus*	Mountain cranberry	S4	X	X	X	X	X	X	X	X	X	X	X	X	X
Viburnum edule	Low bush-cranberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viburnum opulus var. *americanum*	High bush-cranberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola adunca var. *adunca*	Early blue violet	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola canadensis var. *rugulosa*	Western Canada violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola nephrophylla	Northern bog violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola palustris	Marsh violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola renifolia	Kidney-leaved white violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix A, Table 3

Species Occurrences Within the Terrestrial Vegetation Inventory Surveys in the Vegetation Study Area, June to August 2018

Scientific Name	Common Name	SKCDC Rank	Transects												
			VI_091	VI_092	VI_093	VI_094	VI_095	VI_096	VI_097	VI_098	VI_099	VI_100	VI_101	VI_102	VI_103
Agrostis scabra var. *scabra*	Hair grass	S4	-	-	-	-	-	-	X	X	-	-	-	-	-
Alnus incana ssp. *tenuifolia*	Western river alder	S4	-	-	-	-	-	-	-	-	X	-	-	-	-
Alnus viridis ssp. *crispa*	Green alder	S4	-	-	-	-	-	-	X	X	-	-	X	-	-
Andromeda polifolia var. *polifolia*	Bog-rosemary	S4	-	-	-	X	-	-	-	-	-	-	-	-	-
Apocynum androsaemifolium	Spreading dogbane	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Aralia nudicaulis	Wild sarsaparilla	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Arceuthobium americanum	American mistletoe	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Arctostaphylos uva-ursi	Bearberry	S4	-	-	-	-	-	-	-	X	-	-	X	-	X
Athyrium filix-femina var. *cyclosorum*	Northern lady-fern	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Betula glandulosa	Dwarf birch	S4	-	X	-	-	-	-	X	-	-	-	-	-	-
Betula papyrifera	Paper birch	S5	-	X	X	-	-	-	-	X	X	-	X	-	X
Betula pumila	Swamp birch	S4	-	X	-	-	-	-	X	-	X	X	-	-	-
Calamagrostis sp.	Reedgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calamagrostis canadensis var. *canadensis*	Blue-joint reedgrass	S4	-	X	-	-	-	-	X	X	X	X	-	-	-
Calamagrostis stricta	Northern reed grass	S5	-	-	-	-	-	-	-	X	-	-	-	-	-
Caltha palustris var. *palustris*	Yellow marsh-marigold	S4	-	X	-	-	-	-	X	-	X	X	-	-	-
Carex aquatilis var. *aquatilis*	Water sedge	S4	-	X	-	-	-	-	X	-	X	X	-	-	-
Carex brunnescens	Brownish Sedge	S4	-	X	-	-	-	-	X	X	X	-	-	-	-
Carex canescens ssp. *canescens*	Hoary sedge	S4	-	X	-	-	-	-	X	-	-	-	-	-	-
Carex concinna	**Beautiful sedge**	**S3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Carex deflexa	Bent sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex diandra	Two-stamened sedge	S4	-	X	-	-	-	-	-	-	-	-	-	-	-
Carex foenea	Hay sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex heleonastes	**Hudson Bay sedge**	**S3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Carex limosa	Mud sedge	S4	-	X	-	-	-	-	-	-	X	-	-	-	-
Carex magellanica ssp. *irrigua*	Boreal-bog sedge	S4	-	X	-	-	-	-	-	-	-	-	-	-	-
Carex trisperma* var. *trisperma	**Three-fruited sedge**	**S3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**X**	**-**
Carex utriculata	Northwest territory sedge	S4	-	-	-	-	-	-	X	-	-	-	-	-	-
Chamaedaphne calyculata	Leatherleaf	S4	X	X	X	X	X	X	X	X	X	X	-	X	-
Chamerion angustifolium ssp. *angustifolium*	Narrow-leaf fireweed	S4	-	-	-	-	-	-	X	X	-	-	-	-	-
Chamerion angustifolium ssp. *circumvagum*	Narrow-leaf fireweed	S4	-	-	-	-	-	-	-	X	-	-	-	-	-
Cicuta bulbifera	Water hemlock	S4	-	-	-	-	-	-	X	-	-	-	-	-	-
Cicuta maculata var. maculata	Spotted water-hemlock	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Comarum palustre	Marsh cinquefoil	S4	-	X	-	-	-	-	X	-	X	X	-	-	-
Cornus canadensis	Bunchberry	S4	-	-	-	-	-	-	X	X	-	-	-	-	X
Cyperaceae sp.	Sedge	-	-	X	-	-	-	-	-	-	-	-	-	-	-
Cypripedium acaule	Stemless lady's-slipper	S4	-	-	-	-	-	-	-	-	-	-	-	-	X
Deschampsia cespitosa ssp. *cespitosa*	Tufted hair grass	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Diphasiastrum complanatum	Trailing club-moss	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Drosera rotundifolia	Round-leaved sundew	S4	X	X	X	X	X	X	-	-	X	X	-	X	-
Dryopteris carthusiana	Spinulose wood fern	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Empetrum nigrum ssp. *hermaphroditum*	Black crowberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium ciliatum ssp. *ciliatum*	Hairy willow-herb	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium palustre	Marsh willowherb	S4	-	X	-	-	-	-	X	X	-	-	-	-	-
Equisetum arvense	Common horsetail	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum pratense	Meadow horsetail	S4	-	-	-	-	-	-	-	X	-	-	-	-	-
Equisetum sylvaticum	Woodland horsetail	S4	-	-	-	-	-	-	X	X	-	X	-	-	-
Eriophorum vaginatum var. *vaginatum*	Tussock cotton-grass	S4	X	X	X	X	X	X	-	-	-	X	-	X	-
Galium trifidum ssp. *trifidum*	Small bedstraw	S4	-	X	-	-	-	-	X	-	-	-	-	-	-
Galium triflorum	Sweet-scented bedstraw	S4	-	-	-	-	-	-	X	-	-	-	-	-	-
Geocaulon lividum	Northern comandra	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Geranium bicknellii	Bicknell's geranium	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Hudsonia tomentosa var. *tomentosa*	Sand golden-heather	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalmia polifolia	Pale laurel	S4	X	X	X	X	X	X	X	X	X	X	-	X	-
Larix laricina	Tamarack	S5	-	X	-	-	X	X	X	-	X	X	-	X	-
Linnaea borealis ssp. *americana*	American twinflower	S4	-	-	-	-	-	-	-	X	-	-	-	-	-
Lycopodium annotinum	Stiff club-moss	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Maianthemum canadense	Two-leaved Solomon's-seal	S4	-	-	-	-	-	-	X	X	-	-	-	-	-
Maianthemum stellatum	Starflower false Solomon's-seal	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Maianthemum trifolium	Three-leaf Solomon's-seal	S4	-	X	X	X	X	X	-	-	X	X	-	X	-
Menyanthes trifoliata	Bog buckbean	S4	-	X	-	-	-	-	-	-	-	-	-	-	-
Mitella nuda	Bishop's-cap	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Myrica gale	Sweet gale	S4	X	-	X	X	-	-	X	-	X	X	-	-	-
Phalaris arundinacea	Reed canary grass	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Picea glauca	White spruce	S5	-	-	-	-	-	-	-	X	-	-	X	-	-
Picea mariana	Black spruce	S5	X	X	X	X	X	X	X	-	X	X	-	X	-
Pinus banksiana	Jackpine	S5	-	-	X	X	-	-	X	X	-	X	X	X	X
Populus balsamifera ssp. *balsamifera*	Balsam poplar	S5	-	-	-	-	-	-	-	X	-	-	-	-	-
Populus tremuloides	Trembling aspen	S5	-	-	-	-	-	-	-	X	-	-	-	-	X
Potentilla norvegica	Rough cinquefoil	S4	-	-	-	-	-	-	X	X	-	-	-	-	-
Prunus pensylvanica	Pin cherry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyrola asarifolia ssp. *asarifolia*	Pink wintergreen	S4	-	-	-	-	-	-	-	X	-	-	-	-	-
Rhododendron groenlandicum	Common labrador tea	S4	X	X	X	X	X	X	X	X	X	X	X	X	-
Ribes americanum	Wild black currant	S4	-	-	-	-	-	-	X	-	-	-	-	-	-
Ribes glandulosum	Skunk currant	S4	-	-	-	-	-	-	-	X	-	-	-	-	-
Ribes hudsonianum var. *hudsonianum*	Northern black currant	S4	-	-	-	-	-	-	-	X	-	-	-	-	-
Ribes lacustre	Bristly black currant	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes oxyacanthoides ssp. *oxyacanthoides*	Bristly gooseberry	S4	-	-	-	-	-	-	X	X	-	-	-	-	-
Rosa acicularis ssp. *sayi*	Prickly rose	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubus arcticus ssp. *acaulis*	Nagoon berry	S4	-	-	-	-	-	-	X	X	X	X	-	-	-
Rubus chamaemorus	Cloudberry	S4	X	X	X	X	X	X	X	-	X	X	-	X	-
Rubus idaeus ssp. *strigosus*	American red raspberry	S5	-	-	-	-	-	-	-	X	-	-	-	-	-
Rubus pubescens	Dewberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Rumex triangulivalvis	Triangular-valved dock	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix sp.	Willow	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix bebbiana	Long-beaked willow	S4	-	X	-	-	-	-	X	-	-	-	-	-	-
Salix discolor	Pussy willow	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix planifolia ssp. *planifolia*	Plane-leaf willow	S4	-	X	-	-	-	-	X	X	X	X	-	-	-
Salix pyrifolia	Balsam willow	S4	-	X	-	-	-	-	-	-	-	-	-	-	-
Salix scouleriana	Scouler's willow	S4	-	-	-	-	-	-	X	X	-	-	-	-	-
Salix serissima	Autumn willow	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Scheuchzeria palustris	American Scheuchzeria	S4	-	X	-	-	-	-	-	-	-	-	-	-	-
Scutellaria galericulata	Marsh skullcap	S4	-	-	-	-	-	-	X	X	-	-	-	-	-
Stachys pilosa var. *pilosa*	Hairy hedge-nettle	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Stellaria longifolia	Long-leaved stitchwort	S4	-	X	-	-	-	-	X	-	-	-	-	-	-
Stellaria longipes ssp. *longipes*	Long-leaved starwort	S4	-	X	-	-	-	-	-	-	-	-	-	-	-
Trientalis borealis ssp. *borealis*	Maystar	S4	-	-	-	-	-	-	X	X	-	-	-	-	-
Urtica dioica ssp. *gracilis*	Stinging nettle	S4	-	-	-	-	-	-	X	X	-	-	-	-	-
Vaccinium myrtilloides	Blueberry	S4	-	-	-	-	-	-	X	X	-	-	X	-	X
Vaccinium oxycoccos	Small cranberry	S4	X	X	X	X	X	X	X	-	X	X	-	X	-
Vaccinium vitis-idaea ssp. *minus*	Mountain cranberry	S4	X	X	X	X	X	X	X	X	X	X	X	X	X
Viburnum edule	Low bush-cranberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viburnum opulus var. *americanum*	High bush-cranberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola adunca var. *adunca*	Early blue violet	S5	-	-	-	-	-	-	-	X	-	-	-	-	-
Viola canadensis var. *rugulosa*	Western Canada violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola nephrophylla	Northern bog violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola palustris	Marsh violet	S4	-	-	-	-	-	-	X	-	-	-	-	-	-
Viola renifolia	Kidney-leaved white violet	S4	-	-	-	-	-	-	X	X	X	-	-	-	-

Appendix A, Table 3

Species Occurrences Within the Terrestrial Vegetation Inventory Surveys in the Vegetation Study Area, June to August 2018

Scientific Name	Common Name	SKCDC Rank	Transects												
			VI_104	VI_105	VI_106	VI_107	VI_108	VI_109	VI_110	VI_111	VI_112	VI_113	VI_114	VI_115	VI_116
Agrostis scabra var. *scabra*	Hair grass	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Alnus incana ssp. *tenuifolia*	Western river alder	S4	-	-	-	-	-	-	-	-	X	X	X	X	X
Alnus viridis ssp. *crispa*	Green alder	S4	-	-	-	-	X	X	X	X	X	X	X	-	-
Andromeda polifolia var. *polifolia*	Bog-rosemary	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Apocynum androsaemifolium	Spreading dogbane	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Aralia nudicaulis	Wild sarsaparilla	S4	-	-	-	-	-	-	-	-	X	X	-	-	-
Arceuthobium americanum	American mistletoe	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Arctostaphylos uva-ursi	Bearberry	S4	X	-	X	X	-	-	-	-	X	X	-	-	-
Athyrium filix-femina var. *cyclosorum*	Northern lady-fern	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Betula glandulosa	Dwarf birch	S4	-	-	-	-	-	-	-	-	-	-	X	X	X
Betula papyrifera	Paper birch	S5	-	X	-	-	X	X	X	X	X	X	-	X	-
Betula pumila	Swamp birch	S4	-	-	-	-	-	-	-	-	-	-	X	X	X
Calamagrostis sp.	Reedgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calamagrostis canadensis var. *canadensis*	Blue-joint reedgrass	S4	-	-	-	-	-	-	-	-	X	X	X	X	X
Calamagrostis stricta	Northern reed grass	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Caltha palustris var. *palustris*	Yellow marsh-marigold	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex aquatilis var. *aquatilis*	Water sedge	S4	-	-	-	-	-	-	-	-	X	-	X	X	X
Carex brunnescens	Brownish Sedge	S4	-	X	-	-	-	-	-	-	-	X	-	-	-
Carex canescens ssp. *canescens*	Hoary sedge	S4	-	-	-	-	-	-	-	-	-	-	-	X	-
Carex concinna	**Beautiful sedge**	**S3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**X**	**-**	**-**	**-**	**-**
Carex deflexa	Bent sedge	S4	-	-	-	-	-	-	-	-	X	-	-	-	-
Carex diandra	Two-stamened sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex foenea	Hay sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex heleonastes	**Hudson Bay sedge**	**S3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Carex limosa	Mud sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex magellanica ssp. *irrigua*	Boreal-bog sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex trisperma* var. *trisperma	**Three-fruited sedge**	**S3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Carex utriculata	Northwest territory sedge	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Chamaedaphne calyculata	Leatherleaf	S4	-	X	-	-	-	-	-	-	-	-	X	X	X
Chamerion angustifolium ssp. *angustifolium*	Narrow-leaf fireweed	S4	-	X	-	-	-	-	-	-	X	X	X	X	X
Chamerion angustifolium ssp. *circumvagum*	Narrow-leaf fireweed	S4	-	X	-	-	-	-	-	-	X	X	X	X	X
Cicuta bulbifera	Water hemlock	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Cicuta maculata var. maculata	Spotted water-hemlock	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Comarum palustre	Marsh cinquefoil	S4	-	-	-	-	-	-	-	-	-	X	-	-	-
Cornus canadensis	Bunchberry	S4	-	X	-	-	-	-	-	-	X	X	X	X	X
Cyperaceae sp.	Sedge	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cypripedium acaule	Stemless lady's-slipper	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Deschampsia cespitosa ssp. *cespitosa*	Tufted hair grass	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Diphasiastrum complanatum	Trailing club-moss	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Drosera rotundifolia	Round-leaved sundew	S4	-	-	-	-	-	-	-	-	-	-	X	X	-
Dryopteris carthusiana	Spinulose wood fern	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Empetrum nigrum ssp. *hermaphroditum*	Black crowberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium ciliatum ssp. *ciliatum*	Hairy willow-herb	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium palustre	Marsh willowherb	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum arvense	Common horsetail	S5	-	-	-	-	-	-	-	-	X	-	-	-	-
Equisetum pratense	Meadow horsetail	S4	-	-	-	-	-	-	-	-	-	X	-	-	-
Equisetum sylvaticum	Woodland horsetail	S4	-	X	-	-	-	-	-	-	X	X	X	X	X
Eriophorum vaginatum var. *vaginatum*	Tussock cotton-grass	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Galium trifidum ssp. *trifidum*	Small bedstraw	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Galium triflorum	Sweet-scented bedstraw	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Geocaulon lividum	Northern comandra	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Geranium bicknellii	Bicknell's geranium	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Hudsonia tomentosa var. *tomentosa*	Sand golden-heather	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalmia polifolia	Pale laurel	S4	-	X	-	-	-	-	-	-	-	-	X	X	X
Larix laricina	Tamarack	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Linnaea borealis ssp. *americana*	American twinflower	S4	-	-	-	-	-	-	-	-	X	-	-	-	-
Lycopodium annotinum	Stiff club-moss	S4	-	-	-	-	-	-	-	-	X	X	X	-	-
Maianthemum canadense	Two-leaved Solomon's-seal	S4	-	-	-	-	-	-	-	-	X	X	-	-	-
Maianthemum stellatum	Starflower false Solomon's-seal	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Maianthemum trifolium	Three-leaf Solomon's-seal	S4	-	X	-	-	-	-	-	-	-	-	X	X	X
Menyanthes trifoliata	Bog buckbean	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Mitella nuda	Bishop's-cap	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Myrica gale	Sweet gale	S4	-	-	-	-	-	-	-	-	X	-	-	-	-
Phalaris arundinacea	Reed canary grass	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Picea glauca	White spruce	S5	-	-	-	-	X	X	X	X	X	X	-	-	-
Picea mariana	Black spruce	S5	-	X	-	-	X	-	-	X	X	X	X	X	X
Pinus banksiana	Jackpine	S5	X	X	X	X	X	X	X	X	X	X	X	X	X
Populus balsamifera ssp. *balsamifera*	Balsam poplar	S5	-	-	-	-	-	-	-	-	-	X	-	-	-
Populus tremuloides	Trembling aspen	S5	-	-	-	-	-	-	-	-	X	X	-	-	-
Potentilla norvegica	Rough cinquefoil	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Prunus pensylvanica	Pin cherry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyrola asarifolia ssp. *asarifolia*	Pink wintergreen	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhododendron groenlandicum	Common labrador tea	S4	-	X	-	-	X	X	X	X	X	X	X	X	X
Ribes americanum	Wild black currant	S4	-	-	-	-	-	-	-	-	-	X	-	-	-
Ribes glandulosum	Skunk currant	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes hudsonianum var. *hudsonianum*	Northern black currant	S4	-	-	-	-	-	-	-	-	X	X	-	-	-
Ribes lacustre	Bristly black currant	S4	-	-	-	-	-	-	-	-	X	-	-	X	-
Ribes oxyacanthoides ssp. *oxyacanthoides*	Bristly gooseberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Rosa acicularis ssp. *sayi*	Prickly rose	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubus arcticus ssp. *acaulis*	Nagoon berry	S4	-	-	-	-	-	-	-	-	-	X	X	X	X
Rubus chamaemorus	Cloudberry	S4	-	X	-	-	-	-	-	-	X	-	X	X	X
Rubus idaeus ssp. *strigosus*	American red raspberry	S5	-	-	-	-	-	-	-	-	X	-	-	-	-
Rubus pubescens	Dewberry	S4	-	-	-	-	-	-	-	-	-	X	-	-	-
Rumex triangulivalvis	Triangular-valved dock	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix sp.	Willow	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix bebbiana	Long-beaked willow	S4	-	-	-	-	-	-	-	-	X	X	X	X	X
Salix discolor	Pussy willow	S4	-	X	-	-	-	-	-	-	-	-	-	-	-
Salix planifolia ssp. *planifolia*	Plane-leaf willow	S4	-	X	X	-	-	-	-	-	X	X	X	X	X
Salix pyrifolia	Balsam willow	S4	-	-	-	-	-	-	-	-	X	-	-	-	-
Salix scouleriana	Scouler's willow	S4	-	-	-	-	-	-	-	X	X	X	-	-	-
Salix serissima	Autumn willow	S4	-	-	X	-	-	-	-	-	-	-	-	-	-
Scheuchzeria palustris	American Scheuchzeria	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Scutellaria galericulata	Marsh skullcap	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Stachys pilosa var. *pilosa*	Hairy hedge-nettle	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Stellaria longifolia	Long-leaved stitchwort	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Stellaria longipes ssp. *longipes*	Long-leaved starwort	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Trientalis borealis ssp. *borealis*	Maystar	S4	-	-	-	-	-	-	-	-	X	X	X	X	X
Urtica dioica ssp. *gracilis*	Stinging nettle	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium myrtilloides	Blueberry	S4	X	X	X	X	X	X	X	X	X	X	X	X	X
Vaccinium oxycoccos	Small cranberry	S4	-	X	-	-	-	-	-	-	-	-	X	X	X
Vaccinium vitis-idaea ssp. *minus*	Mountain cranberry	S4	-	X	X	-	X	X	X	X	X	X	X	X	X
Viburnum edule	Low bush-cranberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viburnum opulus var. *americanum*	High bush-cranberry	S4	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola adunca var. *adunca*	Early blue violet	S5	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola canadensis var. *rugulosa*	Western Canada violet	S4	-	-	-	-	-	-	-	-	-	X	-	-	-
Viola nephrophylla	Northern bog violet	S4	-	-	-	-	-	-	-	-	-	X	-	-	-
Viola palustris	Marsh violet	S4	-	-	-	-	-	-	-	-	-	X	-	-	-
Viola renifolia	Kidney-leaved white violet	S4	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix A, Table 3

Species Occurrences Within the Terrestrial Vegetation Inventory Surveys in the Vegetation Study Area, June to August 2018

Scientific Name	Common Name	SKCDC Rank	Transects							
			VI_117	VI_118	VI_119	VI_120	VI_121	VI_122	VI_123	VI_124
Agrostis scabra var. *scabra*	Hair grass	S4	-	-	-	-	-	-	-	-
Alnus incana ssp. *tenuifolia*	Western river alder	S4	-	-	-	-	-	-	-	-
Alnus viridis ssp. *crispa*	Green alder	S4	X	X	-	-	-	-	-	-
Andromeda polifolia var. *polifolia*	Bog-rosemary	S4	-	-	-	-	-	-	-	-
Apocynum androsaemifolium	Spreading dogbane	S4	-	-	-	-	-	-	-	-
Aralia nudicaulis	Wild sarsaparilla	S4	-	X	-	-	-	-	-	-
Arceuthobium americanum	American mistletoe	S4	-	-	-	-	-	-	-	-
Arctostaphylos uva-ursi	Bearberry	S4	-	-	X	X	X	X	X	X
Athyrium filix-femina var. *cyclosorum*	Northern lady-fern	S4	-	-	-	-	-	-	-	-
Betula glandulosa	Dwarf birch	S4	-	-	-	-	-	-	-	-
Betula papyrifera	Paper birch	S5	X	X	-	-	-	-	-	-
Betula pumila	Swamp birch	S4	-	-	-	-	-	-	-	-
Calamagrostis sp.	Reedgrass	-	-	-	-	-	-	-	-	-
Calamagrostis canadensis var. *canadensis*	Blue-joint reedgrass	S4	-	-	-	-	-	-	-	-
Calamagrostis stricta	Northern reed grass	S5	-	-	-	-	-	-	-	-
Caltha palustris var. *palustris*	Yellow marsh-marigold	S4	-	-	-	-	-	-	-	-
Carex aquatilis var. *aquatilis*	Water sedge	S4	-	-	-	-	-	-	-	-
Carex brunnescens	Brownish Sedge	S4	-	-	-	-	-	-	-	-
Carex canescens ssp. *canescens*	Hoary sedge	S4	-	-	-	-	-	-	-	-
Carex concinna	**Beautiful sedge**	**S3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Carex deflexa	Bent sedge	S4	-	-	-	-	-	-	-	-
Carex diandra	Two-stamened sedge	S4	-	-	-	-	-	-	-	-
Carex foenea	Hay sedge	S4	-	-	-	-	-	-	-	-
Carex heleonastes	**Hudson Bay sedge**	**S3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Carex limosa	Mud sedge	S4	-	-	-	-	-	-	-	-
Carex magellanica ssp. *irrigua*	Boreal-bog sedge	S4	-	-	-	-	-	-	-	-
Carex trisperma* var. *trisperma	**Three-fruited sedge**	**S3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Carex utriculata	Northwest territory sedge	S4	-	-	-	-	-	-	-	-
Chamaedaphne calyculata	Leatherleaf	S4	-	-	-	-	-	-	-	-
Chamerion angustifolium ssp. *angustifolium*	Narrow-leaf fireweed	S4	-	-	-	-	-	-	-	-
Chamerion angustifolium ssp. *circumvagum*	Narrow-leaf fireweed	S4	-	-	-	-	-	-	-	-
Cicuta bulbifera	Water hemlock	S4	-	-	-	-	-	-	-	-
Cicuta maculata var. maculata	Spotted water-hemlock	S4	-	-	-	-	-	-	-	-
Comarum palustre	Marsh cinquefoil	S4	-	-	-	-	-	-	-	-
Cornus canadensis	Bunchberry	S4	-	-	-	-	-	-	-	-
Cyperaceae sp.	Sedge	-	-	-	-	-	-	-	-	-
Cypripedium acaule	Stemless lady's-slipper	S4	-	-	-	-	-	-	-	-
Deschampsia cespitosa ssp. *cespitosa*	Tufted hair grass	S4	-	-	-	-	-	-	-	-
Diphasiastrum complanatum	Trailing club-moss	S4	-	-	-	-	-	-	-	-
Drosera rotundifolia	Round-leaved sundew	S4	-	-	-	-	-	-	-	-
Dryopteris carthusiana	Spinulose wood fern	S4	-	-	-	-	-	-	-	-
Empetrum nigrum ssp. *hermaphroditum*	Black crowberry	S4	-	-	-	-	-	-	-	-
Epilobium ciliatum ssp. *ciliatum*	Hairy willow-herb	S4	-	-	-	-	-	-	-	-
Epilobium palustre	Marsh willowherb	S4	-	-	-	-	-	-	-	-
Equisetum arvense	Common horsetail	S5	-	-	-	-	-	-	-	-
Equisetum pratense	Meadow horsetail	S4	-	-	-	-	-	-	-	-
Equisetum sylvaticum	Woodland horsetail	S4	-	X	-	-	-	-	-	-
Eriophorum vaginatum var. *vaginatum*	Tussock cotton-grass	S4	-	-	-	-	-	-	-	-
Galium trifidum ssp. *trifidum*	Small bedstraw	S4	-	-	-	-	-	-	-	-
Galium triflorum	Sweet-scented bedstraw	S4	-	-	-	-	-	-	-	-
Geocaulon lividum	Northern comandra	S4	-	-	-	-	-	-	-	-
Geranium bicknellii	Bicknell's geranium	S4	-	-	-	-	-	-	-	-
Hudsonia tomentosa var. *tomentosa*	Sand golden-heather	S4	-	-	-	-	X	-	-	X
Kalmia polifolia	Pale laurel	S4	-	-	-	-	-	-	-	-
Larix laricina	Tamarack	S5	-	-	-	-	-	-	-	-
Linnaea borealis ssp. *americana*	American twinflower	S4	-	-	-	-	-	-	-	-
Lycopodium annotinum	Stiff club-moss	S4	-	-	-	-	-	-	-	-
Maianthemum canadense	Two-leaved Solomon's-seal	S4	-	-	-	-	-	-	-	-
Maianthemum stellatum	Starflower false Solomon's-seal	S4	-	-	-	-	-	-	-	-
Maianthemum trifolium	Three-leaf Solomon's-seal	S4	-	-	-	-	-	-	-	-
Menyanthes trifoliata	Bog buckbean	S4	-	-	-	-	-	-	-	-
Mitella nuda	Bishop's-cap	S4	-	-	-	-	-	-	-	-
Myrica gale	Sweet gale	S4	-	-	-	-	-	-	-	-
Phalaris arundinacea	Reed canary grass	S4	-	-	-	-	-	-	-	-
Picea glauca	White spruce	S5	X	X	-	-	-	-	-	-
Picea mariana	Black spruce	S5	-	-	-	-	-	-	-	-
Pinus banksiana	Jackpine	S5	X	X	X	X	X	X	X	X
Populus balsamifera ssp. *balsamifera*	Balsam poplar	S5	-	-	-	-	-	-	-	-
Populus tremuloides	Trembling aspen	S5	-	-	-	-	-	-	-	-
Potentilla norvegica	Rough cinquefoil	S4	-	-	-	-	-	-	-	-
Prunus pensylvanica	Pin cherry	S4	-	-	-	-	-	-	-	-
Pyrola asarifolia ssp. *asarifolia*	Pink wintergreen	S4	-	-	-	-	-	-	-	-
Rhododendron groenlandicum	Common labrador tea	S4	X	X	-	-	-	-	-	-
Ribes americanum	Wild black currant	S4	-	-	-	-	-	-	-	-
Ribes glandulosum	Skunk currant	S4	-	-	-	-	-	-	-	-
Ribes hudsonianum var. *hudsonianum*	Northern black currant	S4	-	-	-	-	-	-	-	-
Ribes lacustre	Bristly black currant	S4	-	-	-	-	-	-	-	-
Ribes oxyacanthoides ssp. *oxyacanthoides*	Bristly gooseberry	S4	-	-	-	-	-	-	-	-
Rosa acicularis ssp. *sayi*	Prickly rose	S5	-	-	-	-	-	-	-	-
Rubus arcticus ssp. *acaulis*	Nagoon berry	S4	-	-	-	-	-	-	-	-
Rubus chamaemorus	Cloudberry	S4	-	-	-	-	-	-	-	-
Rubus idaeus ssp. *strigosus*	American red raspberry	S5	-	-	-	-	-	-	-	-
Rubus pubescens	Dewberry	S4	-	-	-	-	-	-	-	-
Rumex triangulivalvis	Triangular-valved dock	S5	-	-	-	-	-	-	-	-
Salix sp.	Willow	-	-	-	-	-	-	-	-	-
Salix bebbiana	Long-beaked willow	S4	-	-	-	-	-	-	-	-
Salix discolor	Pussy willow	S4	-	-	-	-	-	-	-	-
Salix planifolia ssp. *planifolia*	Plane-leaf willow	S4	-	-	-	-	-	-	-	-
Salix pyrifolia	Balsam willow	S4	-	-	-	-	-	-	-	-
Salix scouleriana	Scouler's willow	S4	-	-	-	-	-	-	-	-
Salix serissima	Autumn willow	S4	-	-	-	-	-	-	-	-
Scheuchzeria palustris	American Scheuchzeria	S4	-	-	-	-	-	-	-	-
Scutellaria galericulata	Marsh skullcap	S4	-	-	-	-	-	-	-	-
Stachys pilosa var. *pilosa*	Hairy hedge-nettle	S4	-	-	-	-	-	-	-	-
Stellaria longifolia	Long-leaved stitchwort	S4	-	-	-	-	-	-	-	-
Stellaria longipes ssp. *longipes*	Long-leaved starwort	S4	-	-	-	-	-	-	-	-
Trientalis borealis ssp. *borealis*	Maystar	S4	-	-	-	-	-	-	-	-
Urtica dioica ssp. *gracilis*	Stinging nettle	S4	-	-	-	-	-	-	-	-
Vaccinium myrtilloides	Blueberry	S4	X	X	X	X	X	X	X	X
Vaccinium oxycoccos	Small cranberry	S4	-	-	-	-	-	-	-	-
Vaccinium vitis-idaea ssp. *minus*	Mountain cranberry	S4	X	X	-	X	-	-	X	-
Viburnum edule	Low bush-cranberry	S4	-	-	-	-	-	-	-	-
Viburnum opulus var. *americanum*	High bush-cranberry	S4	-	-	-	-	-	-	-	-
Viola adunca var. *adunca*	Early blue violet	S5	-	-	-	-	-	-	-	-
Viola canadensis var. *rugulosa*	Western Canada violet	S4	-	-	-	-	-	-	-	-
Viola nephrophylla	Northern bog violet	S4	-	-	-	-	-	-	-	-
Viola palustris	Marsh violet	S4	-	-	-	-	-	-	-	-
Viola renifolia	Kidney-leaved white violet	S4	-	-	-	-	-	-	-	-

Source: All scientific, common names and provincial ranks from SKCDC (2018).

Bold text indicates provincially-rare (S1 to S3) species.

SKCDC = Saskatchewan Conservation Data Centre; S3 = vulnerable/rare to uncommon, S4 = apparently secure, S5 = secure/common.

Appendix A, Table 4

Observations Recorded for the Aquatic Vegetation Inventory Surveys Conducted in the Vegetation Study Area, August 2018

Survey Point ID	Depth (m)	Plant Species Observed	UTM Coordinates[a]	
			Easting	Northing
A1	3.3	-	602918	6393864
A2	2.6	-	602989	6393870
A3	2.1	-	603055	6393869
A4	1.6	-	603125	6393864
A5	3.2	-	602918	6393799
A6	2.4	-	602985	6393795
A7	2.3	-	603055	6393803
A8	2.2	-	603124	6393797
A9	2.9	-	602922	6393734
A10	2.5	-	602986	6393724
A11	2.3	-	603058	6393728
A12	2.2	-	603128	6393732
A13	2.8	-	602917	6393656
A14	2.4	-	602985	6393659
A15	2.2	-	603055	6393654
A16	2.0	Spiny-spored quillwort (*Isoetes echinospora*)	603127	6393660
A17	3.7	-	602917	6393585
A18	2.3	-	602987	6393587
A19	2.1	-	603058	6393589
A20	1.3	-	603127	6393589
A21	2.1	-	602918	6393520
A22	<0.5	-	602980	6393508
A23	<0.5	-	602929	6393469
B1	1.5	-	603478	6394430
B2	1.0	-	603543	6394424
B3	<0.5	-	603615	6394424
B4	<0.5	-	603686	6394427
B5	1.5	-	603479	6394359
B6	1.0	-	603546	6394354
B7	<0.5	-	603616	6394354
B8	<0.5	-	603685	6394359
B9	1.3	-	603482	6394286
B10	<0.5	-	603545	6394292
B11	<0.5	Northern pondweed (*Potamogeton alpinus*)	603618	6394285
B12	<0.5	Northern pondweed	603687	6394286
B13	1.4	-	603479	6394218
B14	<0.5	-	603552	6394216
B15	<0.5	-	603617	6394215
B16	<0.5	-	603684	6394217
B17	0.9	-	603477	6394148
B18	<0.5	-	603547	6394146
B19	<0.5	-	603615	6394149

Appendix A, Table 4

Observations Recorded for the Aquatic Vegetation Inventory Surveys Conducted in the Vegetation Study Area, August 2018

Survey Point ID	Depth (m)	Plant Species Observed	UTM Coordinates[a]	
			Easting	Northing
B20	<0.5	Narrow-leaved bur-reed (*Sparganium angustifolium*), Sago pondweed (*Stuckenia pectinata*), Yellow cowlily (*Nuphar variegata*)	603686	6394146
B21	<0.5	-	603480	6394077
B22	<0.5	-	603546	6394076
B23	<0.5	-	603615	6394078
C1	1.7	-	604456	6394564
C2	1.6	-	604525	6394568
C3	1.6	-	604602	6394569
C4	1.5	-	604322	6394504
C5	1.5	-	604390	6394504
C6	1.5	-	604456	6394501
C7	1.5	-	604528	6394499
C8	1.6	Spiny-spored quillwort	604597	6394499
C9	1.6	Sago pondweed	604670	6394500
C10	1.6	Spiny-spored quillwort	604738	6394494
C11	1.5	-	604315	6394423
C12	1.5	Sago pondweed	604387	6394424
C13	1.4	-	604456	6394424
C14	1.4	-	604525	6394430
C15	1.5	-	604596	6394427
C16	1.5	-	604668	6394423
C17	1.5	Narrow-leaved bur-reed	604734	6394429
C18	1.3	-	604315	6394358
C19	1.3	-	604385	6394355
C20	1.5	Spiny-spored quillwort	604457	6394357
C21	1.4	Spiny-spored quillwort	604528	6394359
C22	1.3	-	604597	6394356
C23	0.9	-	604667	6394353
C24	1.1	Sago pondweed	604736	6394353
C25	0.8	-	604317	6394290
C26	1.0	-	604385	6394285
C27	1.2	-	604461	6394281
C28	0.8	-	604527	6394288
C29	0.9	-	604596	6394291
C30	0.9	Narrow-leaved bur-reed	604665	6394284
C31	1.0	-	604740	6394283
C32	<0.5	-	604739	6394221
D1	**1.2**	**Water lobelia (*Lobelia dortmanna*)**	**603402**	**6391316**
D3	0.8	Narrow-leaved bur-reed	603447	6391340
D4	1.9	-	603332	6391297
D5	1.4	-	603365	6391302
D6	1.4	-	603379	6391305

Appendix A, Table 4

Observations Recorded for the Aquatic Vegetation Inventory Surveys Conducted in the Vegetation Study Area, August 2018

Survey Point ID	Depth (m)	Plant Species Observed	UTM Coordinates[a]	
			Easting	Northing
D7	3.2	-	603403	6391289
D8	1.9	Sago pondweed	603278	6391282
D9	2.9	-	603313	6391275
D10	3.0	-	603336	6391277
D11	3.5	-	603356	6391267
D12	3.4	-	603384	6391275
D13	3.5	-	603413	6391278
D14	3.4	-	603294	6391243
D15	3.4	-	603312	6391251
D16	3.7	-	603332	6391247
D17	3.8	-	603355	6391248
D18	4.0	-	603381	6391255
D19	3.7	-	603409	6391257
D20	3.9	-	603287	6391224
D21	3.7	-	603307	6391222
D22	3.8	-	603332	6391226
D23	3.9	-	603358	6391225
D24	3.9	-	603384	6391223
D25	3.8	-	603410	6391218
D26	3.8	-	603289	6391202

Source: All scientific and common names from SKCDC (2018).

Bold text indicates rare species.

a) UTM = NAD83, Zone 12U.

Appendix A, Table 5

Definitions for Boreal Wetland Classifications and their Corresponding Sub-categories

Boreal Wetland Classification	Definition	Sub-category	Definition
Bog	Raised surface relative to surrounding terrain; only hydrologic input is rain water; poor/very poor nutrient regime; mesic; trees (if present) <10 m in height and <60% canopy cover, dominated by black spruce (*Picea mariana*); ericaeous shrub layer (i.e., *Vaccinium* spp., *Rhododendron groenlandicum*, and *Kalmia polifolia*), *Sphagnum* moss on ground layer.	Treed	Trees >25% cover
		Shrubby	Shrubs >25% cover
		Open	Mosses/herbs/forbs >25% cover
Fen Poor	Some mineral rich water inputs; mesic/hygric moisture regimes; more species rich than bogs; trees (if present) <10 m in height (usually <2 m) and <60% canopy cover, dominated by both black spruce and tamarack (*Larix laricina*); shrub layer mixture of ericaceaous shrubs, dwarf willows (*Salix* spp.), and shrubby birch (*Betula* spp.); graminoids can be more dominant.	Treed	Trees >25% cover
		Shrubby	Shrubs >25% cover
		Graminoid	Mosses/herbs/forbs >25% cover
Fen Rich	Medium/rich water inputs from surface and groundwater; hygric to hydric moisture regime; tree layer with trees <10 m in height and <60% canopy cover, dominated by either black spruce or tamarack; shrub layer containing shrubby birch only.	Treed	Trees >25% cover
		Shrubby	Shrubs >25% cover
		Graminoid	Mosses/herbs/forbs >25% cover
Swamp	Wetlands with woody vegetation >1m, treed vegetation can be deciduous (i.e., *Betula* spp.) and/or coniferous (i.e., black spruce or tamarack); standing water with hummocky microtopography; poor to rich nutrient regime.	Black Spruce	Fibric/woody peat accumulation; tree layer >10 m in height and >60% canopy closure, black spruce dominant; roots in contact with mineral-rich water; ground layer mix of feather and *Sphagnum* mosses
		Tamarack	Tree layers >10 m in height and >60% canopy closure, tamarack dominant
		Shrub	Trees <25% cover, shrubs >25%; shrub cover primarily taller >2 m; species rich understory with herbs/forbs
		Hardwood	Trees >25% cover, hardwood dominated (white birch [*Betula papyrifera*] in transitional zones/aspen[*Populus tremuloides*] in floodplains); trees >10 m in height and >60% canopy closure
		Mixedwood	Wetlands with hardwood (white birch) and/or conifers (tamarack, black spruce), neither dominant (<80% single tree type in canopy); trees≥10 m in height and >60% canopy closure, rich/very rich nutrient regimes
Marsh	Periodic/persistent flooding or slow moving surface water; dominated by herbaceous or forb vegetation.	Emergent	Vegetation >25% emergent species
		Graminoid	Vegetation >25% graminoid/forb species
Shallow Open Water	<25% herbaceous/woody vegetation present (submerged or floating-leaved vegetation may be present); persistent water table well above surface with flooded conditions.	Aquatic Bed	Floating/submerged aquatic vegetation >25% cover
		Mudflats	Exposed mud/sand/gravel/rock >25% cover
		Shallow/Open Water	No vegetation present, permanent/semi-permanent water table

Source: Wetland classifications and sub-categories as per Smith et al. (2007).

APPENDIX B

VEGETATION PHOTOGRAPHS

APPENDIX B: VEGETATION PHOTOGRAPHS
LIST OF PHOTOGRAPHS

Photo 1. A regenerating/recently burned forest stand, August 2018

Photo 2. A mature/old-growth jack pine (*Pinus banksiana*) stand, June 2018

Photo 3. Hudson Bay sedge (*Carex heleonastes*), November 2018

Photo 4. Beautiful sedge (*Carex concinna*), November 2018

Photo 5. Water lobelia (*Lobelia dortmanna*), August 2018

Photo 6. An infestation of American mistletoe (*Arceuthobium americanum*), featuring the characteristic witches' brooms, August 2018

Photo 7. A shrubby bog class type (Smith et al. 2007) and a BS18 ecosite (McLaughlin et al. 2010), featuring black spruce (*Picea mariana*) as the dominant tree species with ericaceous shrubs (cover > 25%) in the understory, June 2018

Photo 8. A treed bog class type and a BS17 ecosite, featuring black spruce as the dominant tree species (cover > 25%) with ericaceous shrubs in the understory, June 2018

Photo 9. A graminoid poor fen class type and a BS24 ecosite, featuring a lack of trees/shrubs with abundant cover (> 25%) of herbs/forbs in the understory, June 2018

Photo 10. A shrubby rich fen class type and a BS23 ecosite, featuring abundant shrub cover from willows (*Salix* spp.), June 2018

Photo 11. A treed poor fen class type and a BS21 ecosite, featuring tamarack (*Larix laricina*) as the dominant tree species, June 2018

Photo 12. A black spruce swamp class type and a BS16 ecosite, featuring black spruce as the dominant tree species, June 2018

Photo 13. A hardwood swamp class type and a BS16 ecosite, featuring western river alder (*Alnus incana* ssp. *tenuifolia*) as one of the dominant tree species, June 2018

Rook I Project

Environmental Impact Statement

Annex VII.3: Vegetation Chemistry Characterization Report

VEGETATION CHEMISTRY BASELINE REPORT FOR THE ROOK I PROJECT

Prepared for:

NexGen Energy Ltd.

Prepared by:

Golder Associates Ltd.

March 2022

Executive Summary

The vegetation chemistry baseline report is a component of a comprehensive baseline program that documents the natural and socio-economic environments in the anticipated area of the Rook I Project (Project). The vegetation chemistry baseline program was undertaken to provide context from which effects on vegetation from the Project can be assessed in the Rook I Environmental Impact Statement (EIS).

The overall objective of the vegetation chemistry baseline program was to establish the existing element and radionuclide concentrations in lichen and blueberry (stems, leaves, and fruit) within the baseline study areas. Lichen and blueberry were chosen as ecological receptors as these species are important food sources for woodland caribou and local Indigenous communities, respectively. Furthermore, lichen are useful bioindicators of the deposition of airborne contaminants. Understanding existing vegetation chemistry is also important as Indigenous Peoples have expressed concerns about effects on cultural practices and vegetation from industrial facilities.

There are no existing publicly available vegetation chemistry data for the Project study areas, and there are no current guidelines for concentrations of elements or radionuclides for lichen or vascular plants (such as blueberry) to compare to the field data. In the absence of federal and provincial guidance, the vegetation chemistry baseline study incorporated assumptions around anticipated Project effects and is supported by existing scientific literature.

A field program was conducted in August 2018 and August 2019 to establish the existing concentrations of elements and radionuclides in selected plant species in the baseline study areas. During the field program, lichen and blueberry (stems, leaves, and fruit) were collected from three sampling sites within 1 km of the anticipated Project footprint (exposure area) and six sampling sites beyond 5 km from the anticipated Project footprint (reference area). Within each of the nine sampling sites, tissue samples were collected from three plot locations to account for variability within each sampling site. Vegetation samples were transported to Saskatoon, Saskatchewan, for laboratory analysis where moisture content, total extractable elements, and radionuclides were analyzed to determine baseline vegetation chemistry.

Results for vegetation chemistry were presented by calculating the mean concentration and relative standard deviation for each analyte (i.e., chemical substance being analyzed) among the three plot locations within each of the nine sampling sites. The relative standard deviation value was used as a measure of variability among plots within each of the nine sampling sites. Mean and relative standard deviation values were also calculated for the exposure areas and reference areas to identify potential differences between the exposure and reference areas at baseline.

Generally, a pattern of increased element concentrations was observed from blueberry fruit to blueberry leaves to blueberry stems to lichen. Comparison of the exposure and reference areas did not indicate any large differences in baseline values between the areas. Overall, differences observed at baseline sampling sites are likely related to natural variation in site conditions between the exposure and reference areas, annual variation in climate and microclimate, chemical composition of soil parent material, and differences in sampling tissues (e.g., variety of lichen species, age of blueberry stems). Observed concentrations of elements in lichen and blueberry tissues appear consistent with published values for other remote sites indicating that deposition from anthropogenic emission sources within the study area is limited at baseline.

The baseline field study achieved the objective of characterizing existing vegetation chemistry element and radionuclide concentrations in lichen and blueberry for the Rook I Project. Element and radionuclide concentrations measured during the field study provide a representative baseline against which potential human health and ecological risks from the Project can be assessed.

If referencing this report, please use for the following citation:

Golder (Golder Associates Ltd.). 2022. Vegetation Chemistry Baseline Report for the Rook I Project. Prepared for NexGen Energy Ltd.

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FIGURES

APPENDICES

Abbreviations and Units of Measure

Abbreviation	Definition
BNDN	Birch Narrows Dene Nation
BRDN	Buffalo River Dene Nation
CALA	Canadian Association for Laboratory Accreditation Inc.
CRDN	Clearwater River Dene Nation
DL	detection limit
EIS	Environmental Impact Statement
EXP	exposure
GPS	Global Positioning System
MN-S	Métis Nation – Saskatchewan
NexGen	NexGen Energy Ltd.
Project	Rook I Project
QA	quality assurance
QC	quality control
REF	reference
RSD	relative standard deviation
sp.	species
spp.	multiple species
SRC	Saskatchewan Research Council Environmental Analytical Laboratory
UTM	Universal Transverse Mercator
YNLRO	Ya'thi Néné Lands and Resources Office

Unit	Definition
%	percent
µg/g	micrograms per gram
g	gram
km	kilometre
m	metre

1.0 INTRODUCTION

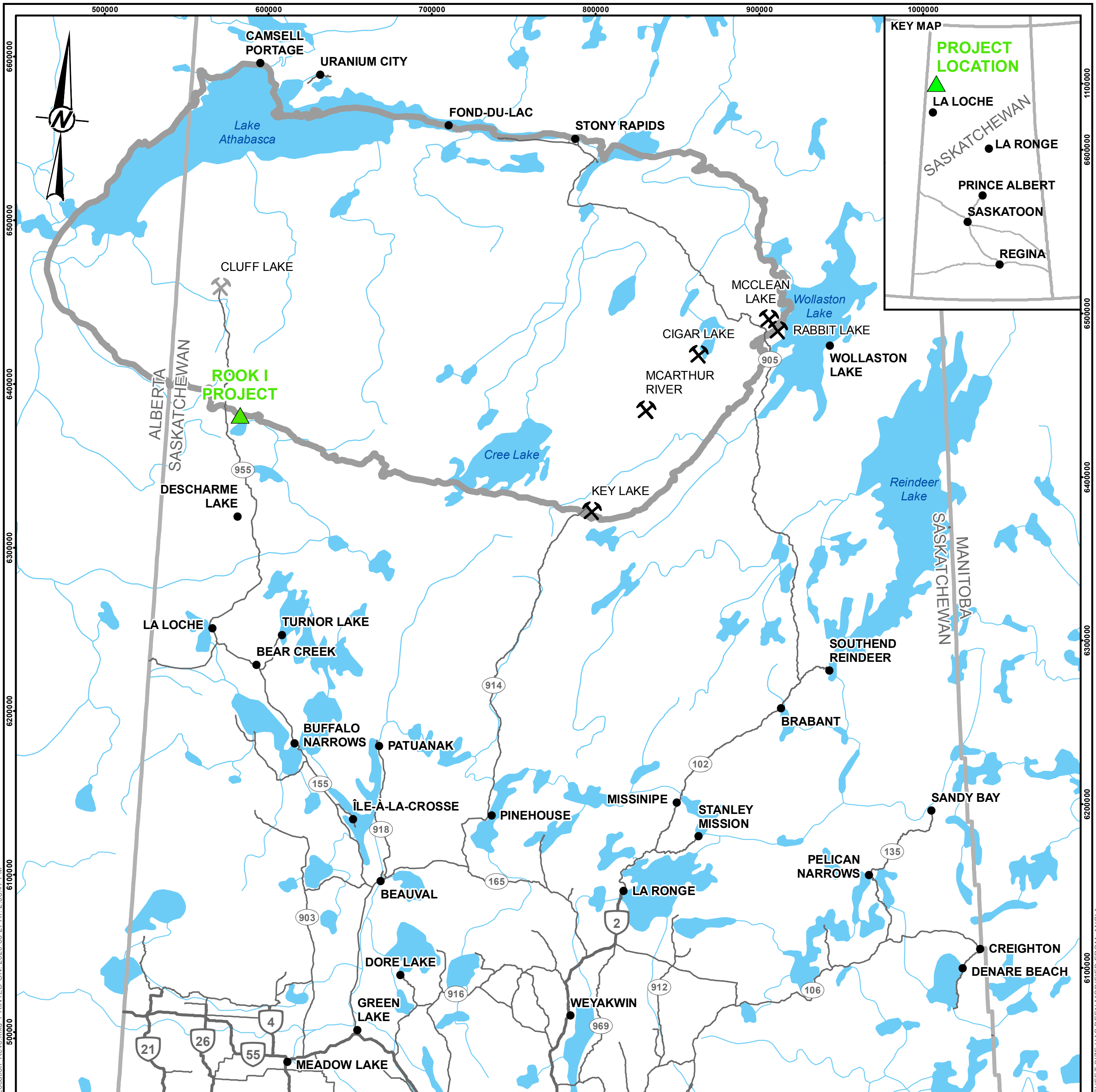
The Rook I Project (Project) is a proposed new uranium mining and milling operation that is 100% owned by NexGen Energy Ltd. (NexGen). The Project would be located in northwestern Saskatchewan, approximately 40 km east of the Saskatchewan-Alberta border, 130 km north of the town of La Loche, and 640 km northwest of the city of Saskatoon (Figure 1). The Project would reside within Treaty 8 territory and within the Métis Homeland. At a regional scale, the Project would be situated within the southern Athabasca Basin adjacent to Patterson Lake, and along the upper Clearwater River system (Figure 2). Access to the Project would be from an existing road off Highway 955. The Project would include underground and surface facilities to support the extraction and processing of uranium ore from the Arrow deposit, a land-based, basement-hosted, high-grade uranium deposit.

The vegetation chemistry baseline report is a component of a comprehensive baseline program that documents the natural and socio-economic environments in the anticipated area of the Project. The vegetation chemistry baseline program was undertaken to provide context from which Project environmental vegetation chemistry effects could be assessed in the Environmental Impact Statement (EIS).

Since exploration at the Project commenced in 2013, NexGen has engaged regularly and established relationships with local First Nation and Métis Groups (collectively referred to as Indigenous Groups) and northern communities, specifically those closest and with greatest access to the proposed Project. NexGen respects the rights of Indigenous Peoples and the unique relationship Indigenous Peoples have with the environment, and recognizes the importance of full and open discussion with interested or potentially affected Indigenous communities regarding the development, operation, and decommissioning of the proposed Project. Engagement activities to date, as well as future planned engagement activities, reflect the value NexGen places on meaningful engagement with Indigenous and northern communities who could be potentially affected by the proposed Project. Engagement mechanisms have included, but are not limited to: meetings with leadership, workshops and community information sessions, Project site tours, establishing Joint Working Groups to support the gathering and incorporation of Indigenous and Local Knowledge throughout the Environmental Assessment (process, and providing funding for Traditional Land Use (TLU) Studies[1] to understand how the proposed Project may interact with the Indigenous communities' traditional use of the anticipated area of the Project.

Feedback received during engagement activities was documented for contribution to the EIS for the Project; examples include identification of concerns, interests, potential adverse effects, mitigation, and design alternatives. Many baseline studies were initiated during exploration in advance of formal engagement on the Environmental Assessment for the Project; however, engagement during the execution of baseline studies helped inform the understanding of baseline conditions and confirmed components of the natural and socio-economic environments that required study. A summary of feedback related to the vegetation chemistry baseline program is presented in Appendix A of the Vegetation Baseline Road Map (Annex VII).

[1] Traditional Land Use (TLU) Studies include all land use studies developed by the Project's affected Indigenous Groups, including Traditional Land Use and Occupancy studies, Traditional Knowledge and Use studies, and Indigenous Rights and Knowledge studies, henceforth referred collectively as TLU Studies.



LEGEND

- POPULATED PLACE
- URANIUM MINING FACILITY (ACTIVE)
- URANIUM MINING FACILITY (DECOMMISSIONED)
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- WATERCOURSE
- WATERBODY
- ATHABASCA BASIN BOUNDARY
- PROJECT LOCATION

0 100 200

1:3,500,000 KILOMETRES

REFERENCE(S)

1. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 12 DATUM: NAD 83

CLIENT

NexGen Energy Ltd.

PROJECT

ROOK I PROJECT

TITLE

LOCATION OF THE ROOK I PROJECT, SASKATCHEWAN

CONSULTANT

GOLDER

YYYY-MM-DD	2020-03-27
DESIGNED	SS
PREPARED	NO/AK
REVIEWED	JMC
APPROVED	MM

PROJECT NO.	PHASE	REV.	FIGURE
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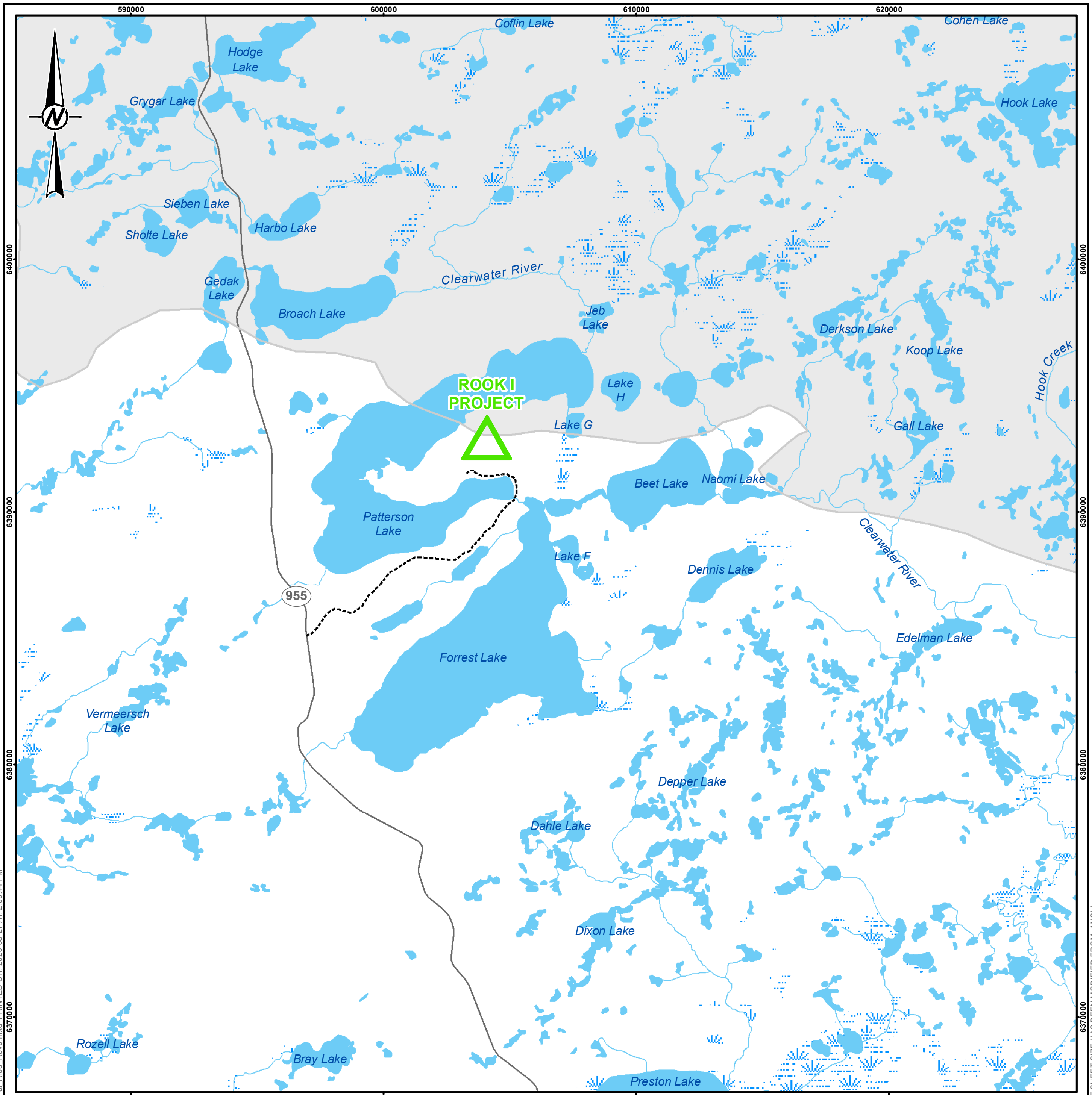

LEGEND

- SECONDARY HIGHWAY
- WATERCOURSE
- WATERBODY
- WETLAND
- ATHABASCA BASIN
- PROJECT LOCATION
- EXISTING ACCESS ROAD

0 5,000 10,000

1:225,000 METRES

REFERENCE(S)

1. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 12 DATUM: NAD 83

CLIENT

NexGen Energy Ltd.

PROJECT

ROOK I PROJECT

TITLE

REGIONAL AREA OF THE ROOK I PROJECT

CONSULTANT

GOLDER

YYYY-MM-DD	2020-03-27
DESIGNED	JMC
PREPARED	NO/AK
REVIEWED	JMC
APPROVED	MM

PROJECT NO.	PHASE	REV.	FIGURE
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2.0 STUDY OBJECTIVE

The overall objective of the vegetation chemistry baseline program was to establish the existing element and radionuclide concentrations in lichen and in blueberry stems, leaves, and fruit within the baseline study areas. This information supported the assessment of potential Project effects on vegetation, wildlife, and people by providing data for human health and ecological risk assessments.

The vegetation chemistry baseline program focused on lichen and blueberry due to the importance of these plants to caribou and to Indigenous Peoples. Lichen (i.e., *Cladonia* spp. and *Cladina* spp.) were chosen as an ecological receptor or indicator because these species are estimated to account for approximately 90% of the diet for caribou (Thomas 1998). Lichen can also bioaccumulate airborne contaminants because of the lack of roots, large surface area, long life span, and high ion exchange capacity (Naeth and Wilkinson 2009). These attributes allow lichen to provide precautionary exposure concentrations for assessment of risks to caribou in the EIS. Blueberry (i.e., *Vaccinium myrtilloides)* was selected to represent local and Indigenous use of plant resources. As noted in Appendix A of the Vegetation Baseline Road Map (Annex VII) and TLU Study reports completed by local Indigenous Groups in relation to the Project, blueberry was identified as a fruit consumed by Indigenous Peoples (TSD II: BNDN; TSD III: BRDN; TSD IV: MN-S; TSD V.1: CRDN; TSD VI: YNLRO). Studying existing vegetation chemistry conditions for lichen and blueberry was also appropriate as Indigenous Peoples have expressed concerns about food security and changes to cultural practices and wildlife from industrial activities and facilities (TSD II: BNDN; TSD III: BRDN; TSD IV: MN-S; TSD V.1: CRDN; TSD VI: YNLRO).

3.0 STUDY AREAS

The proposed Project would be located within the Firebag Hills Landscape Area, which is within the Mid-Boreal Upland Ecoregion of the Boreal Plain Ecozone of Saskatchewan (Acton et al. 1998). The Firebag Hills Landscape Area consists of mainly gently to strongly rolling morainic plains extending from the Clearwater River Valley located to the south of the Project and covering much of the area north along the Saskatchewan-Alberta border towards the Canadian Shield (Acton et al. 1998).

The following study areas were defined for the collection of the vegetation chemistry samples:

- exposure (EXP) area – within 1 km of the anticipated Project footprint; and
- reference (REF) area – beyond 5 km from the anticipated Project footprint.

The spatial extent of the exposure area was based on the potential indirect effects from the Project on vegetation (e.g., dust deposition; Figure 3). Effects from dust deposition on soil and vegetation are expected to be concentrated within 1 km of the Project footprint (Chen et al. 2017, Walker and Everett 1987). The spatial extent of the reference area was chosen to capture regionally representative vegetation chemistry data beyond the potential anticipated indirect effects of the Project. Data from the reference area may also be used for potential long-term vegetation chemistry monitoring.

4.0 METHODS

The following sub-sections describe the methods used for field data collection, data analysis, and quality assurance/quality control.

4.1 Review of Existing Information

There are no existing publicly available vegetation chemistry data in the exposure and reference areas for the Project. Although guidelines exist for soil chemistry (Soil Quality Guidelines for the Protection of Environmental and Human Heath [CCME 2014]) and the management of naturally occurring radioactive materials (Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials [Canadian NORM Working Group 2013]), there are no similar guidelines for vegetation. In the absence of federal and provincial guidance, the vegetation chemistry baseline study incorporated assumptions around anticipated Project effects and is supported by existing scientific literature. Resources include, but are not limited to:

- *Trace Elements in Berries Collected Near Upgraders and Open Pit Mines in the Athabasca Bituminous Sands Region (ABSR): Distinguishing Atmospheric Dust Deposition from Plant Uptake* (Stachiw et al. 2019).
- *A Geochemical Perspective on the Natural Abundance and Predominant Source of Trace Elements in Cranberries (Vaccinium oxycoccus) from Remote Bogs in the Boreal Region of Northern Alberta, Canada* (Shotyk et al. 2019).
- *Interactions of Lichens with Heavy Metals* (Backor and Loppi 2009).
- *Determination of Elemental Baseline Using Peltigeralean Lichens from Northeastern Canada (Québec): Initial Data Collection for Long Term Monitoring of the effect of Global Climate Change on Boreal and Subarctic Area in Canada* (Darnajoux et al. 2015).
- *An Analysis of the Element Content of Lichens from the Northwest Territories, Canada* (Puckett and Finegan 1980).
- *Background Levels of Some Major, Trace, and Rare Earth Elements in Indigenous Plant Species Growing in Norway and the Influence of Soil Acidification, Soil Parent Material, and Seasonal Variation on these Levels* (Gjengedal et al. 2015).

4.2 Study Approach

The vegetation chemistry field programs were completed from 2 August 2018 to 10 August 2018 and 6 August 2019 to 12 August 2019 by two field personnel per program. The programs included the collection of vegetation samples, and analysis of the samples for concentrations of elements and radionuclides.

4.3 Sample Locations

An initial desktop review of satellite imagery and available Ecological Landscape Classification data for the exposure and reference areas (ENV Forestry Branch 2016; SDLC 2009) was completed to identify suitable habitat most likely to support both blueberry and lichen species (e.g., BP02, Jack Pine Closed Canopy, Jack Pine Open Canopy, and Revegetating/Regenerating Burn) (Table 1; Figure 3).

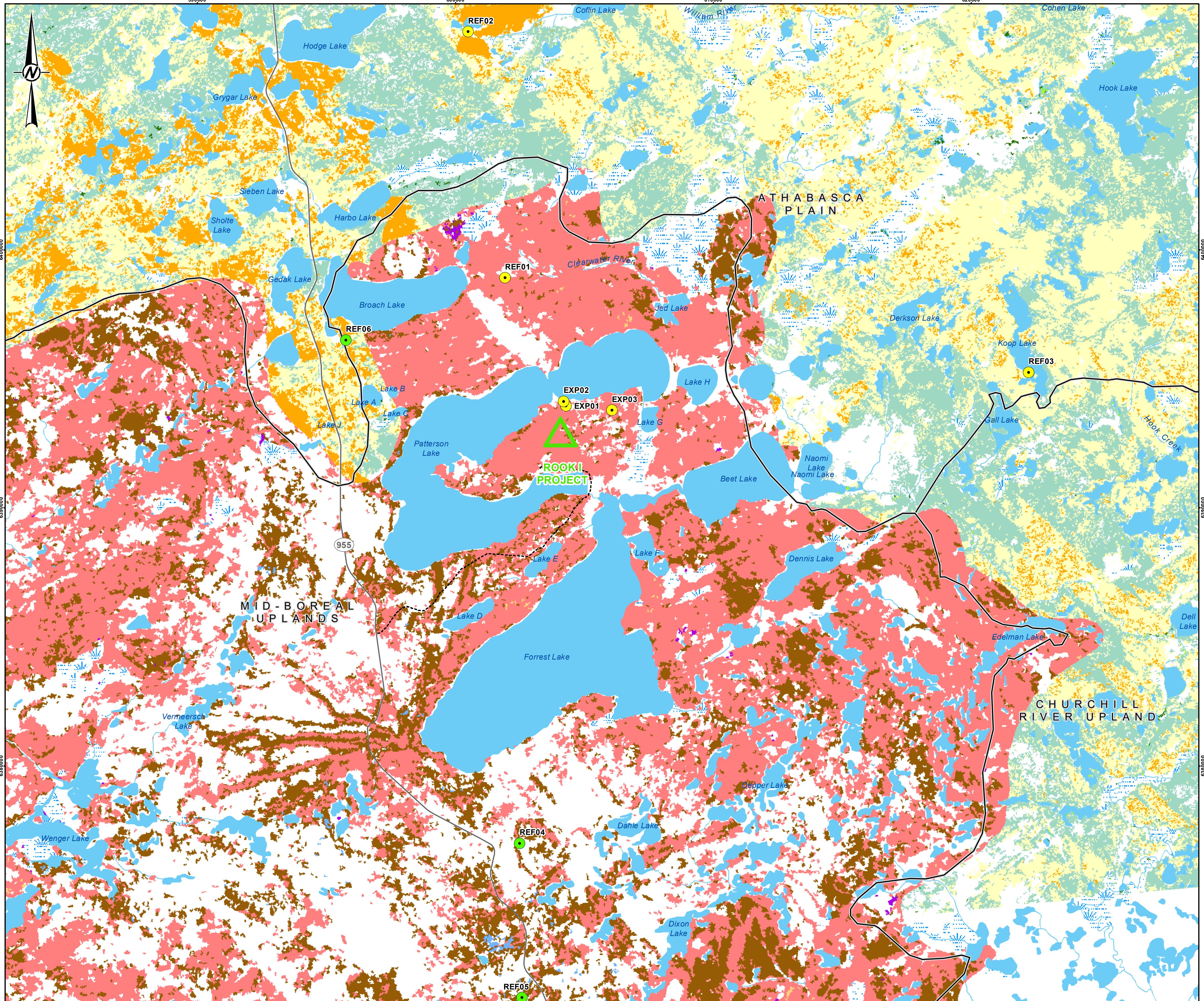
Table 1: Ecosite/Land Cover Classes with Potential to Support Target Sample Species

Ecosite/Land Cover	Description	Potential Sample Tissue
BP02[(a)]	Jack pine/lichen: Moderately fresh sand	Lichen/blueberry
BP03[(a)]	Jack pine/feathermoss: Moderately fresh loamy sand	Blueberry
BP04[(a)]	Jack pine/trembling aspen/feathermoss: Moderately fresh sand	Blueberry
BP12[(a)]	Jack pine/spruce/feathermoss: Fresh loamy sand	Blueberry
BP14[(a)]	Black spruce/Labrador tea/feathermoss: Very moist sandy clay loam	Blueberry
Jack Pine Closed Canopy[(b)]	Greater than 75% of jack pine by area; greater than 55% crown closure	Lichen/blueberry
Jack Pine Open Canopy[(b)]	Greater than 75% of jack pine by area; 10% to 55% crown closure	Lichen/blueberry
Spruce Closed Canopy[(b)]	Greater than 75% or greater black and white spruce; greater than 55% crown closure	Blueberry
Spruce Open Canopy[(b)]	Greater than 75% black and white spruce; 10% to 55% crown closure	Blueberry
Revegetating/Regenerating Burn[(b)]	An area showing evidence of natural or prescribed burning and where regeneration or revegetation is visible	Lichen/blueberry
Mixed Softwoods (Open and Closed Canopy)[(b)]	Jack pine/spruce, spruce/jack pine open and closed, an area of softwood combinations in which neither jack pine or spruce account for greater than 75% of species by area, and where crown closure is greater than 10%	Blueberry

Note: crown closure = the degree to which the forest canopy blocks sunlight or obscures the sky above the forest floor and is usually given as the percent of the total area which is occupied by the crowns of trees.
a) McLaughlan et al. 2010.
b) SDLC 2009.

Meteorological data collected from the Project site indicated that the dominant and subdominant wind directions were from the south-southeast and west, respectively. Proposed sampling sites were selected where suitable habitat types intersected either the dominant or subdominant wind directions. Final sampling sites were adjusted in the field where required, based on available plant material, access, and disturbance (i.e., recent fire burns). Three sampling sites (i.e., EXP01, EXP02, EXP03) within the exposure area and three sampling sites within the reference area (i.e., REF01, REF02, REF03) were selected in 2018 (Figure 3). In discussion with NexGen, it was determined that new reference sites would be sampled in 2019 due to access limitations with the initial 2018 reference sites (i.e., restricted to helicopter access only). Therefore, 2019 sampling was completed at three new reference sampling sites (i.e., REF04, REF05, REF06) (Figure 3). No access restrictions were identified for the exposure sampling sites identified in 2018, and therefore exposure sites were not resampled in 2019 (i.e., exposure sites were suitable for long-term monitoring, if required).

Within each sampling site, tissue samples were collected from three plot locations (i.e., A, B, C) to account for variability within each sampling site (i.e., to identify the potential for site-specific elevated concentrations of elements or radionuclides within vegetation). Plot location and proximity to each other were dependent upon available sample material and all three plot locations were within a 100 m radius of each other for each sampling site. Two exposure sites (i.e., EXP01, EXP02) and two reference sites (i.e., REF01, REF02) were located downwind along the south-southeast wind direction, and the one exposure site (i.e., EXP03) and one reference site (i.e., REF03) were located downwind along the west wind direction. Reference sampling sites in 2019 were selected due to proximity to access trails and suitability for long-term monitoring and were located downwind along the north wind direction (i.e., REF04, REF05) and downwind of the east-southeast wind direction (i.e., REF06).



LEGEND

- SECONDARY HIGHWAY
- WATERCOURSE
- ECOREGION
- WATERBODY
- WETLAND

PROJECT FEATURES

- EXISTING ACCESS ROAD
- PROJECT LOCATION

- 2018 VEGETATION CHEMISTRY SAMPLE SITE
- 2019 VEGETATION CHEMISTRY SAMPLE SITE

POTENTIAL TO SUPPORT LICHEN AND/OR BLUEBERRY[1]

ECOSITES

- BP02 - LICHEN AND BLUEBERRY
- BP03 - BLUEBERRY
- BP04 - BLUEBERRY
- BP12 - BLUEBERRY
- BP14 - BLUEBERRY

SASK DIGITAL LAND COVER

- 8: JACKPINE (CLOSED CANOPY) - LICHEN AND BLUEBERRY
- 9: JACKPINE (OPEN CANOPY) - LICHEN AND BLUEBERRY
- 10: SPRUCE (CLOSED CANOPY) - BLUEBERRY
- 11: SPRUCE (OPEN CANOPY) - BLUEBERRY
- 15: REVEGETATING/ REGENERATION BURN - LICHEN AND BLUEBERRY
- 27: MIXED SOFTWOODS (OPEN AND CLOSED) - BLUEBERRY

0 3,000 6,000

1:150,000 METRES

NOTE(S)

1. ECOSITES AND LAND COVER TYPES WITH LIMITED POTENTIAL TO SUPPORT LICHEN AND/OR BLUEBERRY WERE EXCLUDED FROM THE FIGURE.

REFERENCE(S)

ECOSITES (V2.0_RF_F) AND DIGITAL LAND COVER OBTAINED FROM GOVERNMENT OF SASKATCHEWAN.
ECOREGIONS OBTAINED FROM AGRICULTURE AND AGRI-FOOD CANADA (AAFC).
BASE DATA MAY BE OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 12 DATUM: NAD 83

CLIENT

NexGen Energy Ltd.

PROJECT

ROOK I PROJECT

TITLE

VEGETATION CHEMISTRY PLOT LOCATIONS AND LAND COVER/ECOSITE CLASSIFICATION

CONSULTANT

GOLDER

YYYY-MM-DD	2021-05-12
DESIGNED	AS
PREPARED	LMS/NO
REVIEWED	AS
APPROVED	JV

PROJECT NO.	PHASE	REV.	FIGURE
20138965	2000	0	3

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4.3.1 Vegetation Chemistry Sample Collection

Twenty-seven plot locations were visited during the 2018 and 2019 vegetation chemistry field programs. Upon arriving at each plot location, Universal Transverse Mercator (UTM) coordinates were marked with a GPS device and tissue samples were collected for chemical analysis (Table 2). Several photographs were taken at each plot location to document the physical characteristics and habitat present. Photographs of collected samples were taken showing the corresponding sample identifier and sample condition. Representative photos of each of the 27 vegetation chemistry plot locations are presented in Appendix A Site Photographs.

Table 2: Vegetation Chemistry Plot Locations, 2018 and 2019

Year	Sampling Site	Plot Location	UTM Coordinate Location (Zone 12U NAD 83)	
			Easting	Northing
2018	EXP01	EXP01-A	604257	6394043
		EXP01-B	604236	6394033
		EXP01-C	604234	6394055
	EXP02	EXP02-A	604195	6394147
		EXP02-B	604201	6394134
		EXP02-C	604219	6394149
	EXP03	EXP03-A	606078	6393793
		EXP03-B	606017	6393781
		EXP03-C	606033	6393732
	REF01	REF01-A	601933	6398930
		REF01-B	601892	6398898
		REF01-C	602032	6398797
	REF02	REF02-A	600499	6408468
		REF02-B	600482	6408422
		REF02-C	600438	6408446
	REF03	REF03-A	622227	6395264
		REF03-B	622224	6395223
		REF03-C	622268	6395234
2019	REF04	REF04-A	602400	6377020
		REF04-B	602560	6376933
		REF04-C	602448	6377037
	REF05	REF05-A	602565	6371034
		REF05-B	602611	6371045
		REF05-C	602590	6371019
	REF06	REF06-A	595789	6396561
		REF06-B	595717	6396540
		REF06-C	595723	6396466

UTM = Universal Transverse Mercator; NAD = North American Datum; EXP = exposure site; REF = reference site.

Sterile sampling protocols were implemented so that samples were not contaminated by external sources. General notes regarding the sampling site and vegetation health and vigour were recorded. During the field programs, effort was made to pick berries that were considered edible (e.g., undamaged, ripe). Blueberry leaves were removed from stems by hand. Blueberry stems were collected by cutting the base of the aboveground growth with clean coated scissors (i.e., Teflon-coated [2018] or titanium-coated [2019]) and gently folding the stems. Lichen samples were cleaned as the samples were collected, by gently removing any obvious debris either by hand or trimming material with the Teflon- or titanium-coated scissors. Individual lichen species were not preferentially selected; rather, lichen collections included a variety of species available from each plot. These species included star-tipped reindeer lichen (*Cladina stellaris*), green reindeer lichen (*Cladina mitis*), gray reindeer lichen (*Cladina rangiferina*), mealy pixie-cup (*Cladonia chlorophaea*), bighorn cladonia (*Cladonia cornuta* ssp. *cornuta*), red-fruited pixie-cup (*Cladonia pleurota*), wooden soldiers (*Cladonia botrytis),* boreal pixie-cup (*Cladonia borealis*), split-peg soldiers (*Cladonia cariosa*), bronzed pixie lichen (*Cladonia gracilis* ssp. *turbinata*), greater sulphur-cup (*Cladonia sulphurina*), thorn lichen (*Cladonia uncialis*), and woolly foam lichen (*Stereocaulon tomentosum*).

Also included in the sample protocol was the use of nitrile gloves for all contact with sampled vegetation tissues. New gloves were used for each plot location and plant tissue type. Teflon- or titanium-coated scissors were used to snip the upper leafy portion from several plants within the same plot location to create a composite sample. Scissors were washed with decontamination soap and rinsed with distilled water between each plot location and tissue type. Where possible, 500 g of sample material was collected for each tissue type at each plot location and stored in clean zip-lock bags that were kept cool until they could be transported to the laboratory for analysis.

In 2018, with the exception of blueberry fruit for plots REF01-A and REF01-B, all four tissue types (i.e., lichen, and blueberry stems, leaves, and fruit) were collected from all 18 plot locations. Blueberry plants were observed to be abundant throughout plot locations REF01-A and REF01-B; however, due to a recent burn, plants were limited to the current year’s growth and therefore did not produce flowers or fruit. Three tissue types (i.e., lichen, and blueberry stems and leaves) were collected from all nine plot locations in 2019. Blueberry plants were observed to be abundant at all nine plot locations; however, fruit production was poor at the time of sampling and fruit was not available in sufficient quantities for chemical analysis.

4.3.2 Vegetation Chemistry Analysis

Laboratory analyses were performed by the Saskatchewan Research Council Environmental Analytical Laboratory (SRC) in Saskatoon, Saskatchewan. Total extractable metals in vegetation were analyzed using inductively coupled plasma mass spectrometry. Radionuclides in vegetation were analyzed using Natural Uranium Tailings Program (NUTP)-3E Alpha and Beta Spectroscopy. The laboratory certificates of analyses are provided in Appendix B Laboratory Certificates of Analysis. Samples were analyzed for the following suite of parameters:

- moisture content;
- total elements (i.e., aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, cesium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, rubidium, selenium, silver, strontium, tellurium, thallium, tin, titanium, uranium, vanadium, zinc, and zirconium); and
- radionuclides (i.e., lead-210, polonium-210, radium-226, and thorium-230).

4.4 Quality Assurance and Quality Control

Quality assurance (QA) and quality control (QC) practices determine data integrity and are relevant to all aspects of a study, from sample collection to data analysis and reporting. Quality assurance encompasses management and technical practices designed to confirm that the data generated are of consistent high quality. Quality control is an aspect of QA and includes the procedures used to measure and evaluate data quality, and the corrective actions to be taken when data quality objectives are not met.

4.4.1 Quality Assurance

Quality assurance applicable to this study covers internal and external management. One field crew member was responsible for managing the sample shipping process for the field program to confirm that samples were properly labelled, documentation was completed, and samples were delivered to the laboratory. The other member of the field crew was designated as the laboratory liaison. The laboratory selected for the analysis of samples, SRC, is accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA). Under CALA's accreditation program, performance evaluation assessments are conducted annually for laboratory procedures, methods, and internal quality control. The laboratory Quality Control Report is included in Appendix C Quality Control Report.

Internal QA included use of appropriately trained personnel for each task and senior review of work products at appropriate milestones, use of standardized data manipulation/summary tools, and filing of data and Project information according to standardized protocols.

4.4.2 Quality Control

The QC program consisted of the collection and analysis of field replicate samples and laboratory QC analysis. Laboratory QC analysis included a variety of techniques, such as the analysis of reference materials, control samples, and spike recovery measurements to verify the validity of the analytical results. If QC issues were identified, the samples were re-analyzed, or other corrective action was undertaken to demonstrate that the analytical results are within the expected measurement uncertainty.

5.0 RESULTS

Results for vegetation chemistry were obtained by calculating the mean concentration and relative standard deviation (RSD) for each analyte (i.e., chemical substance being analyzed) among the three plot locations within each of the nine sampling sites. Non-detect data were managed using a relatively simple approach following the United States Environmental Protection Agency's *Data Quality Assessment: Statistical Methods for Practitioners* (USEPA 2006). Prior to calculating the RSD, concentrations below the detection limit (DL) were replaced with the DL value in cases when at least one of the concentrations for a given parameter within a sampling site was detectable. Replacing non-detect data with the DL will bias high any measures of central tendency (i.e., mean, median) as the non-detect value is likely lower than the DL; however, replacing non-detect data with the DL instead of alternative approaches will result with a more conservative dataset. If all three plots resulted in a non-detect value, then a mean concentration and RSD were not calculated. The RSD was calculated using the following formula:

$$\text{RSD} = \frac{\text{Sample Standard Deviation}}{\text{Mean Concentration}} \times 100\%$$

The RSD value was used as a measure of variability among plots within each of the nine sampling sites. A higher value indicates a greater amount of variation observed among plots. For comparative purposes, a mean concentration and RSD value were also calculated for the exposure areas (2018) and reference areas (2018 and 2019) (where all three sampling sites were reported above detection limit) to identify any current differences between the exposure and reference areas.

Mean moisture content and the calculated RSD values are provided for each sample tissue type in the sections below. Values are used to provide data for the ecological risk assessment but provided limited descriptive analysis for the element concentrations observed during baseline. Therefore, no further discussion on moisture content is provided.

5.1 Lichen

The mean concentrations and RSDs for moisture, elements, and radionuclides for lichen are presented in Table 3. Complete analysis results are presented in Appendix D Vegetation Chemistry Laboratory Results (Table D-1).

Non-detect values in elements were observed in lichen from all nine sampling sites for antimony, tellurium, thallium, and tin. In detected values, the RSDs for sampling sites ranged from 0% to 150%.

Non-detect values in radionuclides for lichen were observed for thorium-230 in exposure and reference areas. Lead-210, polonium-210, and radium-226 were observed above non-detect values for all nine sampling sites except for two non-detect values for radium-226 (Appendix D). In detected values, the RSDs for sampling sites ranged from 8% to 99%.

The difference between the minimum and maximum concentrations for lichen were less than one order of magnitude for all elements and radionuclides except chromium and nickel indicating a consistent scale within the dataset.

Table 3: Element and Radionuclide Concentrations in Lichen Samples, 2018 and 2019

Year	2018																2019							
Sampling Site	EXP01		EXP02		EXP03		EXP Area Total		REF01		REF02		REF03		REF Area Total		REF04		REF05		REF06		REF Area Total	
Parameter	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%
% Moisture	10	57	40	9	49	12	33	55	8	8	48	26	24	46	27	72	27	30	66	3	41	26	45	44
Aluminum	313	27	233	17	593	41	380	55	533	108	373	9	460	29	456	67	290	7	253	5	270	17	271	7
Antimony	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Arsenic	0.08	18	0.06	9	0.15	43	0.10	53	0.18	111	0.11	16	0.12	22	0.14	78	0.07	20	0.05	0	0.05	11	0.06	19
Barium	12	22	12	34	15	10	13	22	12	32	17	27	12	30	14	33	8	33	8	13	7	21	7	11
Beryllium	0.01	0	n/c	n/c	0.02	35	n/c	n/c	0.01	43	0.01	43	0.01	43	0.01	38	0.01	0	n/c	n/c	0.01	0	n/c	n/c
Boron	1	0	1.3	43	1.3	43	1.2	36	1.7	69	n/c	n/c	1	0	n/c	n/c	1	0	n/c	n/c	n/c	n/c	n/c	n/c
Cadmium	0.05	11	0.04	13	0.06	9	0.05	19	0.08	99	0.06	24	0.05	12	0.06	68	0.05	11	0.03	0	0.05	12	0.04	28
Cesium	0.12	13	0.10	6	0.17	22	0.13	31	0.17	23	0.17	12	0.12	42	0.15	26	0.10	36	0.09	34	0.10	0	0.10	3
Chromium	2.4	83	1.2	13	52	132	18	229	1.9	91	9	126	16	76	9	116	1.2	12	0.9	11	1.1	18	1	16
Cobalt	0.10	30	0.09	29	0.62	109	0.27	159	0.10	82	0.11	37	0.22	51	0.15	63	0.08	8	0.07	21	0.07	25	0.07	5
Copper	1.1	12	1.1	20	1.5	29	1.2	27	1.5	68	1.6	10	1.1	11	1.4	40	1.0	12	0.9	4	0.9	14	0.9	7
Iron	217	16	170	12	587	76	324	92	363	109	293	14	313	29	323	64	160	11	187	39	160	11	169	9
Lead	0.40	38	0.26	21	0.87	46	0.51	69	0.80	129	1	27	0.51	26	0.79	75	0.22	26	0.19	23	0.23	23	0.21	10
Lithium	0.17	12	0.13	11	0.30	57	0.20	56	0.24	96	0.17	7	0.22	28	0.21	59	0.14	14	0.13	5	0.13	4	0.13	5
Manganese	183	5	202	40	169	40	185	30	63.7	49	162	13	134	15	120	41	133	10	97	5	102	18	111	18
Mercury	0.02	26	0.02	13	0.03	11	0.02	20	0.15	150	0.03	11	0.02	2	0.07	182	0.02	11	0.02	13	0.02	14	0.02	15
Molybdenum	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	0.10	0	0.10	0	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Nickel	1.2	70	0.72	18	21	132	8	224	1.1	85	3.7	112	6.5	71	3.8	104	0.70	15	0.51	7	0.60	21	0.60	16
Rubidium	4.7	7	4.3	10	5.4	23	4.8	18	5	37	4.4	15	3.9	16	4.4	25	5.6	12	5.9	6	4.9	3	5.5	9
Selenium	0.07	23	n/c	n/c	0.10	6	n/c	n/c	0.09	71	0.05	11	0.07	14	0.07	53	0.06	9	n/c	n/c	0.06	10	n/c	n/c
Silver	0.02	0	0.01	0	0.02	35	0.02	34	0.01	43	0.02	35	0.01	0	0.01	38	0.01	0	0.01	0	0.01	0	0.01	0
Strontium	3.6	29	2.7	24	6.1	36	4.1	48	5.2	10	3.7	26	4.5	24	4.5	23	3.5	4	3.7	20	2.6	28	3.3	18
Tellurium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Thallium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Tin	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Titanium	7.8	25	5.7	18	16	59	9.6	67	13	115	8.4	12	12	33	11	73	6.5	9	6.5	4	6.2	9	6.4	2
Uranium	0.14	14	0.08	18	0.04	58	0.09	51	0.03	108	0.04	87	0.02	35	0.03	90	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Vanadium	0.57	20	0.50	20	1.2	52	0.76	61	1.2	115	0.80	12	0.80	22	0.93	78	0.47	12	0.43	13	0.47	12	0.5	4
Zinc	16	6	12	5	19	24	15.7	23	16	60	16	26	17	20	16	34	17	6	10	8	15	7	14	25
Zirconium	0.26	30	0.17	15	0.58	77	0.34	87	0.34	112	0.24	17	0.55	57	0.38	75	0.16	10	0.14	7	0.16	13	0.15	6
Lead-210	0.27	17	0.25	18	0.37	9	0.30	22	0.30	57	0.32	23	0.27	8	0.30	32	0.27	16	0.24	24	0.33	18	0.28	16
Polonium-210	0.18	22	0.14	15	0.31	19	0.21	41	0.22	61	0.22	23	0.21	8	0.22	34	0.23	18	0.24	17	0.29	10	0.25	13
Radium-226	0.005	17	0.003	17	0.01	34	0.01	59	0.002	82	0.003	46	0.004	67	0.003	61	0.0006	40	0.0009	33	0.0005	12	0.0007	33
Thorium-230	0.002	35	0.001	17	n/c	n/c	n/c	n/c	0.0005	99	n/c	n/c	0.003	83	n/c	n/c	n/c	n/c	0.0007	40	0.0006	20	n/c	n/c

Note:
n/c = not calculated as concentrations were non-detect.
Element concentrations in µg/g.
Radionuclide concentrations in becquerels per gram.
RSD% = Relative Standard Deviation; EXP = exposure; REF = reference.

5.2 Blueberry Stems

The mean concentrations and RSDs for moisture, elements, and radionuclides for blueberry stems are presented in Table 4. Complete analysis results are presented in Appendix D (Table D-2).

Non-detect values in elements for blueberry stems were observed in blueberry stems from all nine sampling sites for antimony, arsenic, beryllium, molybdenum, silver, tellurium, and tin. In detected values, the RSDs for sampling sites ranged from 0% to 115%.

Thorium-230 was only detected at EXP01, EXP02, and REF06 sampling sites. Lead-210, polonium-210, and radium-226 were detected at all nine sampling sites. In detected values, the RSDs for sampling sites ranged from 5% to 160%.

The difference between the minimum and maximum concentrations for blueberry stems were less than one order of magnitude for all elements and radionuclides indicating a consistent scale within the dataset.

Table 4: Element and Radionuclide Concentrations in Blueberry Stem Samples, 2018 and 2019

Year	2018																2019							
Sampling Site	EXP01		EXP02		EXP03		EXP Area Total		REF01		REF02		REF03		REF Area Total		REF04		REF05		REF06		REF Area Total	
Parameter	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%
% Moisture	37	11	41	7	44	9	41	11	55	16	38	18	35	9	43	26	36	11	44	4	39	2	40	9
Aluminum	101	16	102	22	106	28	103	20	45	85	84	17	104	11	78	43	140	25	110	9	106	28	119	16
Antimony	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Arsenic	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Barium	61	26	78	15	71	10	70	18	77	18	77	31	69	6.7	74	19	79	5	70	10	62	12	71	12
Beryllium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Boron	7.0	0	8.3	6.9	8.3	7	7.9	10	11	22	7.3	16	7.0	0	8	26	8.3	7	6.3	9	7.7	15	7	14
Cadmium	0.02	0	0.02	0	0.03	35	0.02	36	0.04	42	0.03	46	0.02	25	0.03	41	0.02	25	0.01	43	0.02	0	0.02	27
Cesium	n/c	n/c	n/c	n/c	0.05	11	n/c	n/c	0.07	44	0.06	24	0.10	20	0.08	34	0.06	20	n/c	n/c	0.09	58	n/c	n/c
Chromium	0.77	27	0.60	29	0.63	9	0.67	24	n/c	n/c	0.53	11	n/c	n/c	n/c	n/c	0.77	30	0.53	11	0.53	11	0.61	22
Cobalt	0.05	29	0.08	20	0.04	0	0.06	34	0.02	65	0.03	43	0.02	25	0.02	41	0.05	35	0.07	8	0.04	16	0.05	35
Copper	5.1	9	5.4	15	5.3	8	5.3	10	5.8	26	5.0	7	5.1	3	5.3	16	4.7	14	5.6	2	5.2	29	5.2	9
Iron	59	18	63	27	61	25	61	21	33	75	49	28	54	8	45	38	81	32	69	4	57	28	69	17
Lead	0.08	20	0.07	25	0.07	14	0.07	18	0.03	115	0.05	45	0.05	11	0.04	53	0.08	30	0.06	9	0.05	45	0.06	28
Lithium	0.06	10	0.06	18	0.07	14	0.06	16	0.05	0	n/c	n/c	n/c	n/c	n/c	n/c	0.08	38	0.08	12	0.06	20	0.07	18
Manganese	1753	20	1920	24	1850	14	1841	18	1503	27	1303	14	1610	10	1472	19	1853	13	1243	16	1540	27	1546	20
Mercury	0.007	23	0.007	21	0.007	31	0.007	22	0.005	11	0.006	17	0.006	10	0.006	12	0.010	30	0.008	13	0.007	21	0.008	14
Molybdenum	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Nickel	1.2	27	1.0	15	0.75	20	1.0	27	0.81	42	0.77	29	0.70	25	0.76	30	0.87	13	0.83	12	0.87	24	0.86	2
Rubidium	5.3	18	4.9	4.7	4.6	7.7	4.9	13	9.2	15	4	20	4.5	17	5.9	44	6.2	48	6.4	6	6.8	54	6.5	4
Selenium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	0.05	11	n/c	n/c	n/c	n/c	n/c	n/c
Silver	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Strontium	7.7	24	10	113	4.8	20	7.7	84	9.2	9	11	25	10	10	10	17	7.6	35	9.3	16	6.4	21	7.7	19
Tellurium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Thallium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	0.07	43	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Tin	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Titanium	1.9	35	1.7	31	1.7	35	1.8	30	0.48	112	0.88	34	1.6	33	1.0	65	2.2	42	1.9	5	1.6	35	1.9	15
Uranium	0.05	0	0.04	31	0.01	43	0.03	52	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Vanadium	0.13	43	0.13	43	0.13	43	0.13	38	0.10	0	0.10	0	0.10	0	0.1	0	0.20	50	0.20	0	0.13	43	0.18	22
Zinc	32	34	42	9	43	4	39	20	43	12	47	36	45	18	45	22	33	11	20	23	34	14	29	27
Zirconium	0.07	31	0.06	0	0.05	11	0.06	22	n/c	n/c	n/c	n/c	0.06	20	n/c	n/c	0.08	18	0.05	0	0.05	11	0.06	27
Lead-210	0.07	22	0.08	26	0.09	34	0.08	29	0.04	154	0.07	16	0.07	16	0.06	57	0.13	15	0.11	10	0.08	52	0.11	26
Polonium-210	0.05	25	0.05	14	0.05	40	0.05	24	0.02	160	0.04	22	0.04	24	0.03	59	0.09	5	0.08	15	0.04	67	0.007	38
Radium-226	0.007	18	0.01	23	0.008	29	0.009	34	0.004	16	0.01	36	0.006	59	0.007	64	0.005	14	0.004	16	0.005	28	0.004	12
Thorium-230	0.001	26	0.0006	51	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	0.0005	0	n/c	n/c

Note:
n/c = not calculated as concentrations were non-detect.
Element concentrations in µg/g.
Radionuclide concentrations in becquerels per gram.
RSD% = Relative Standard Deviation; EXP = exposure; REF = reference.

5.3 Blueberry Leaves

The mean concentrations and RSDs for moisture, elements, and radionuclides for blueberry leaves are presented in Table 5. Complete analysis results are presented in Appendix D (Table D-3).

Non-detect values in elements were observed in blueberry leaves from all nine sampling sites for antimony, arsenic, beryllium, silver, tellurium, and vanadium. In detected values, the RSDs for sampling sites ranged from 0% to 76%.

Non-detect values in radionuclides for blueberry leaves were observed in all nine sampling sites for thorium-230, except EXP01 and REF05 sampling sites. In detected values, the RSDs for sampling sites ranged from 3% to 70%.

The difference between the minimum and maximum concentrations for blueberry leaves were less than one order of magnitude for all elements and radionuclides indicating the range of values appears to be consistent with results observed across all nine sampling sites.

Table 5: Element and Radionuclide Concentrations in Blueberry Leaf Samples, 2018 and 2019

Year	2018																2019							
Sampling Site	EXP01		EXP02		EXP03		EXP Area Total		REF01		REF02		REF03		REF Area Total		REF04		REF05		REF06		REF Area Total	
Parameter	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%	Mean	RSD%
% Moisture	55	3	55	7	56	8	55	5	54	9	52	12	51	1	52	8	51	7	59	7	54	5	55	7
Aluminum	93	8	90	13	100	9	94	10	68	10	80	6.6	98	2	82	17	80	4	65	11	69	10	71	10
Antimony	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Arsenic	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Barium	45	27	63	14	63	10	57	22	55	46	74	28	76	7	68	28	57	7	57	7	54	8	56	3
Beryllium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Boron	32	15	39	17	31	20	34	19	25	24	24	26	23	12	24	19	18	19	9	12	16	10	14	31
Cadmium	n/c	n/c	n/c	n/c	0.01	0	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Cesium	0.08	30	0.06	20	0.08	33	0.07	29	0.15	72	0.11	63	0.16	6	0.14	49	0.08	9	0.07	17	0.15	35	0.10	47
Chromium	0.50	0	n/c	n/c	0.50	0	n/c	n/c	n/c	n/c	0.67	43	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Cobalt	0.04	0	0.04	13	0.03	22	0.04	24	0.01	43	0.02	50	0.02	50	0.02	47	0.03	22	0.04	16	0.03	22	0.03	19
Copper	3.4	5	3.6	15	3.2	10	3.4	11	3.6	36	3.3	17	3.5	10	3.5	22	3.7	12	4.1	2	3.9	24	3.9	5
Iron	54	7	50	11	54	15	53	11	43	12	44	15	46	4	44	10	36	12	40	8	35	6	37	6
Lead	0.05	12	0.03	33	0.03	17	0.04	27	0.02	35	0.03	58	0.02	0	0.02	49	0.01	0	0.01	0	n/c	n/c	n/c	n/c
Lithium	n/c	n/c	n/c	n/c	0.05	0	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Manganese	2770	17	3017	30	3697	24	3161	25	2363	30	2297	11	3170	6	2610	22	3243	12	1963	15	3003	28	2737	25
Mercury	0.007	8	0.008	7	0.008	0	0.008	7	n/c	n/c	0.006	9.1	0.007	8	n/c	n/c	0.006	10	0.007	9	0.006	9	0.006	8
Molybdenum	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	0.10	0	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Nickel	1.0	23	0.98	19	0.69	13	0.9	25	0.70	38	0.78	27	0.77	14	0.75	24	0.74	17	0.87	7	0.88	32	0.83	9
Rubidium	9.4	3	8.57	11	7	12	8.3	15	12	22	6.4	19	7.1	3	8.5	35	9.6	47	11.3	5	10.4	30	10.4	8
Selenium	0.06	36	n/c	n/c	0.05	11	n/c	n/c	n/c	n/c	0.05	0	0.05	11	n/c	n/c	0.06	29	n/c	n/c	n/c	n/c	n/c	n/c
Silver	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Strontium	6.7	32	5.07	76	5.2	15	5.7	42	5.6	43	9.1	19	11	20	8.7	36	5.9	28	7.3	14	4.9	32	6.0	20
Tellurium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Thallium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	0.06	29	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Tin	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	0.05	11	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Titanium	1.6	20	1.1	27	1.2	14	1.3	27	0.41	48	0.57	32	0.76	35	0.58	41	0.48	22	0.57	22	0.45	5	0.50	12
Uranium	0.10	53	0.03	0	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Vanadium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Zinc	9.8	2	11.3	13	15	25	12	26	11	9	14	8.4	14	4	13	12	11	15	8	12	12	5	10	17
Zirconium	0.06	9	0.05	0	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Lead-210	0.04	7	0.03	3	0.04	28	0.04	17	0.02	70	0.03	15	0.03	4	0.03	39	0.03	13	0.04	9	0.03	16	0.03	17
Polonium-210	0.01	17	0.02	13	0.02	63	0.02	37	0.006	53	0.02	31	0.01	19	0.01	48	0.01	9	0.01	7	0.01	9	0.01	14
Radium-226	0.006	25	0.01	16	0.007	15	0.007	21	0.004	21	0.006	44	0.006	7	0.005	31	0.003	23	0.002	4	0.003	44	0.002	33
Thorium-230	0.001	43	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	0.001	36	n/c	n/c	n/c	n/c

Note:
n/c = not calculated as concentrations were non-detect.
Element concentrations in µg/g.
Radionuclide concentrations in becquerels per gram.
RSD% = Relative Standard Deviation; EXP = exposure; REF = reference.

5.4 Blueberry Fruit

The mean concentrations and RSDs for moisture, elements, and radionuclides for blueberry fruit collected in 2018 are presented in Table 6. Complete analysis results are presented in Appendix D (Table D-4). Blueberry fruit was not collected in 2019 due to lack of available ripe fruit at the time of sampling.

Non-detect values in elements were observed in blueberry fruit from all six sampling sites for antimony, arsenic, beryllium, chromium, mercury, selenium, silver, tellurium, thallium, tin, uranium, and vanadium. In detected values, the RSDs for sampling sites ranged from 0% to 160%.

Non-detect values in radionuclides for blueberry fruit were observed in all six sampling sites for thorium-230. The RSDs for sampling sites ranged from 0% to 58% for lead-210, polonium-210, and radium-226. Due to recent fire disturbance, only one fruit tissue sample (REF01-C) could be collected from sampling site REF01. Therefore, actual single sample results for REF01 are presented in Table 6; mean concentration and RSD values were not calculated.

The difference between the minimum and maximum concentrations for blueberry fruit was less than one order of magnitude for all elements and radionuclides indicating the range of values appears to be consistent with results observed across all sampling sites.

Table 6: Element and Radionuclide Concentrations in Blueberry Fruit Samples, 2018

Year	2018														
Sampling Site	**EXP01**		**EXP02**		**EXP03**		**EXP Area Total**		**REF01**	**REF02**		**REF03**		**REF Area Total**	
Parameter	**Mean**	**RSD%**	**Mean**	**RSD%**	**Mean**	**RSD%**	**Mean**	**RSD%**	**Sample Result[(a)]**	**Mean**	**RSD%**	**Mean**	**RSD%**	**Mean**	**RSD%**
% Moisture	89	10	83	1	84	1	85	6	83	84	1	83	0	83	1
Aluminum	11	11	13	38	10	41	11	32	9.1	9.5	4	11	13	10	13
Antimony	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Arsenic	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Barium	17	10	20	8	18	16	18	13	21	20	5	19	11	20	7
Beryllium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Boron	11	42	11	5	10	26	11	25	7	9	40	7	14	8	31
Cadmium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	0.13	160	n/c	n/c
Cesium	0.07	29	0.06	17	0.08	59	0.07	41	0.24	0.13	87	0.23	9.2	0.19	46
Chromium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Cobalt	0.01	0	0.01	43	n/c	n/c	n/c	n/c	n/c	n/c	n/c	0.01	0	n/c	n/c
Copper	3.3	8	4.2	11	3.2	16	3.5	17	5.1	3	12	3.5	10	3.5	23
Iron	14	4	18	20	12	29	15	24	17	12	8	13	16	13	17
Lead	0.10	93	0.01	43	0.02	50	0.04	139	n/c	0.08	90	0.03	58	n/c	n/c
Lithium	0.06	36	0.07	28	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Manganese	639	28	626	19	767	15	677	21	500	419	11	580	14	500	19
Mercury	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Molybdenum	0.10	0	0.10	0	0.10	0	0.1	0	n/c	0.10	0	n/c	n/c	n/c	n/c
Nickel	0.57	19	0.81	23	0.44	17	0.61	32	0.7	0.56	30	0.54	17	0.57	22
Rubidium	18	6	20	16	16	15	18	15	26	15	20	17	10	17	26
Selenium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Silver	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Strontium	2.3	28	3	29	1.5	14	2.3	37	2.7	3.1	24	2.8	19	2.9	19
Tellurium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Thallium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Tin	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Titanium	0.14	11	0.16	57	0.21	69	0.17	53	n/c	0.07	23	0.15	28	n/c	n/c
Uranium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Vanadium	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
Zinc	8.2	3.2	9.1	14	8.3	9	8.5	10	10	7.7	8	7.9	4	8.1	11
Zirconium	0.06	36	0.07	29	0.12	96	0.09	79	n/c	0.09	59	0.16	66	n/c	n/c
Lead-210	0.002	50	0.002	49	0.001	0	0.002	55	0.001	0.003	57	0.002	35	0.002	58
Polonium-210	0.002	36	0.002	29	0.0008	18	0.001	39	0.002	0.002	55	0.001	20	0.002	46
Radium-226	0.001	40	0.002	24	0.002	15	0.002	33	0.002	0.003	57	0.002	8	0.002	50
Thorium-230	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c

Note:
n/c = not calculated as concentrations were non-detect.
Element concentrations in µg/g.
Radionuclide concentrations in becquerels per gram.+
RSD% = Relative Standard Deviation; EXP = exposure; REF = reference.
a) Only one plot was collected from this location; therefore, a mean or RSD could not be calculated.

6.0 SUMMARY

The vegetation chemistry baseline study was undertaken to provide context from which effects on vegetation from the proposed Rook I Project (Project) can be assessed in the Environmental Impact Statement (EIS). Lichen and blueberry were chosen as ecological receptors for this study due to the importance of these plants to woodland caribou and local Indigenous communities. Understanding existing vegetation chemistry is also important for addressing concerns expressed by Indigenous Peoples regarding effects from industrial facilities on cultural practices and vegetation (TSD II: BNDN; TSD III: BRDN; TSD IV: MN-S; TSD V.1: CRDN; TSD VI: YNLRO).

The vegetation chemistry field programs were completed in August 2018 and August 2019. The programs included the collection of vegetation samples, and analysis of the samples for concentrations of elements and radionuclides. In total, lichen, blueberry stems, blueberry leaves, and blueberry fruit were collected from twenty-seven plot locations.

Feedback received during Joint Working Group meetings indicate that effects from industrial atmospheric emissions and deposition is a concern within the area of the Project with potential effects from Alberta oil sands developments raised by Métis Nation – Saskatchewan (MN-S) members. While atmospheric deposition of metals is anticipated to decrease rapidly beyond 45 km from emissions sources (Bari et al. 2014), the purpose of the baseline vegetation chemistry program was not to determine the level of existing effects, but to provide a baseline for element and radionuclide concentrations within lichen and blueberry plants within the study area. There are no current guidelines for concentrations of metals or radionuclides for lichen or vascular plants to compare to the field data.

Lichen were chosen as an ecological receptor or indicator due to their importance as a caribou forage. They are considered a sensitive receptor to environmental changes due to the tendency of these organisms to accumulate and tolerate metal concentrations that exceed physiological requirements (Backor and Loppi 2009; Carreras and Pignata 2002). However, the data suggest that these lichen attributes do not lead to a uniform uptake and/or storage of these elements among sampling sites and plot locations.

Generally, increased element concentrations were observed in lichen when compared to blueberry tissues. This may be attributable to the accumulation in lichen over a longer time frame compared to blueberry as well as the ability of lichen to accumulate and tolerate metal content in excess of physiological needs (Carreras and Pignata 2002). The greatest concentrations of lead-210, polonium-210, and thorium-230 were observed within lichen compared to blueberry stems, leaves, and fruit.

Blueberry was selected to represent Indigenous and local use of plant resources, as blueberry was identified as a fruit consumed by local Indigenous Peoples. Although berry collection was limited by site conditions (e.g., fire disturbance), data showed consistent results across sampling sites. The most common route of element uptake into plants is through the root systems (Stachiw et al. 2019), but uptake is also possible through foliar transfer (i.e., deposition on the surface of the plant).

Generally, a pattern of increased element and radionuclide concentrations was observed from blueberry fruit to blueberry leaves to blueberry stems. This pattern may be attributable to the accumulation in blueberry stems over a period of several years, rather than the seasonal growth of blueberry leaves and blueberry fruit. However, departures from this observed general pattern were observed, which are most likely associated with specific plant physiological requirements. Two exceptions include increased concentrations of boron in blueberry leaves compared to fruit and stems, and increased concentration of rubidium in blueberry fruit compared to leaves and stems. Boron is an essential element associated with meristematic tissues (i.e., undifferentiated tissue capable of cell division important for plant growth and structure) in plant cell walls and has a close relationship with cell transpiration and accumulation in leaf tissue (Reid 2014). Rubidium does not have a known physiological function in plants; however, it does share an ionic charge and similar ionic radii to potassium (Shotyk et al. 2019). Therefore, rubidium uptake and accumulation in blueberry fruit is likely associated with the role of potassium in berry growth and ripening (Rogiers et al. 2017).

Comparison of the exposure and reference areas does not indicate any large differences in baseline values between the areas, which was expected. Generally, variation between exposure and reference areas was observed within the existing range of variation of the individual sampling sites. Differences observed at sampling sites are likely related to natural variation in site conditions between the exposure and reference areas, annual variation in climate and microclimate, chemical composition of soil parent material, and differences in sampling tissues (i.e., variety of lichen species, age of blueberry stems).

Overall, observed concentrations of elements in lichen and blueberry tissues are comparable to published values from background locations in other boreal ecosystems or remote locations (Puckett and Finegan 1980; Gjengedal et al. 2015; Darnajoux et al. 2015). These concentrations are consistent with the narrative that atmospheric deposition of anthropogenic emissions is limited within the study area at baseline.

Collected baseline vegetation chemistry data provides important observations of the natural variability of element and radionuclide concentrations within the exposure and reference areas. The objectives of the vegetation chemistry baseline program, to establish the existing element and radionuclide concentrations in lichen and in blueberry stems, leaves, and fruit within the baseline study areas, have been met. The results of the vegetation chemistry baseline program will serve to provide sufficient context to the Human Health Risk Assessment, Ecological Health Risk Assessment, and potential long-term effects monitoring of the Project.

CLOSING

Golder is pleased to submit this report to NexGen in support of the environmental assessment for the Rook I Project. For details on the limitations and use of information presented in this report, please refer to the Study Limitations section following this page. If you have any questions or require additional details related to this study, please contact the undersigned.

Golder Associates Ltd.

Andrew Stewart, P.Ag.
Ecologist

John Virgl, Ph.D.
Principal, Senior Ecologist

AS/JV/pls

STUDY LIMITATIONS

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The scope and the period of Golder's services are as described in Golder's proposal, and are subject to restrictions and limitations. Golder did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the report. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by Golder in regard to it. Any assessments, designs and advice made in this report are based on the conditions indicated from published sources and the investigation described. No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this report. Where data supplied by the Client or other external sources (including without limitation, other consultants, laboratories, public databases), including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Golder for incomplete or inaccurate data supplied by others.

The passage of time affects the information and assessment provided in this report. Golder's opinions are based upon information that existed at the time of the production of the report. The Services provided allowed Golder to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be to the foregoing and to the entirety of the report. Golder cannot be responsible for use of portions of the report without reference to the entire report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client and were prepared for the specific purpose set out herein. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, is the responsibility of such third parties. Golder accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

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APPENDIX A

Site Photographs

Photo 1: Representative photo of plot EXP01-A, 4 August 2018

Photo 2: Representative photo of plot EXP01-B, 4 August 2018

Photo 3: Representative photo of plot EXP01-C, 4 August 2018

Photo 4: Representative photo of plot EXP02-A, 6 August 2018

Photo 5: Representative photo of plot EXP02-B, 4 August 2018

Photo 6: Representative photo of plot EXP02-C, 4 August 2018

Photo 7: Representative photo of plot EXP03-A, 7 August 2018

Photo 8: Representative photo of plot EXP03-B, 7 August 2018

Photo 9: Representative photo of plot REF01-A; August 5, 2018

Photo 10: Representative photo of plot REF01-B, 5 August 2018

Photo 11: Representative photo of plot REF01-C, 5 August 2018

Photo 12: Representative photo of plot REF02-A, 8 August 2018

Photo 13: Representative photo of plot REF02-B, 8 August 2018

Photo 14: Representative photo of plot REF02-C, 8 August 2018

Photo 15: Representative photo of plot REF03-A, 9 August 2018

Photo 16: Representative photo of plot REF03-B, 8 August 2018

Photo 17: Representative photo of plot REF03-C, 9 August 2018

Photo 18: Representative photo of plot REF04-A, 8 August 2019

Photo 19: Representative photo of plot REF04-B, 11 August 2019

Photo 20: Representative photo of plot REF04-C, 11 August 2019

Photo 21: Representative photo of plot REF05-A, 9 August 2019

Photo 22: Representative photo of plot REF05-B, 9 August 2019

Photo 23: Representative photo of plot REF05-C, 9 August 2019

Photo 24: Representative photo of plot REF06-A, 10 August 2019

Photo 25: Representative photo of plot REF06-B, 10 August 2019

Photo 26: Representative photo of plot REF06-C, 10 August 2019

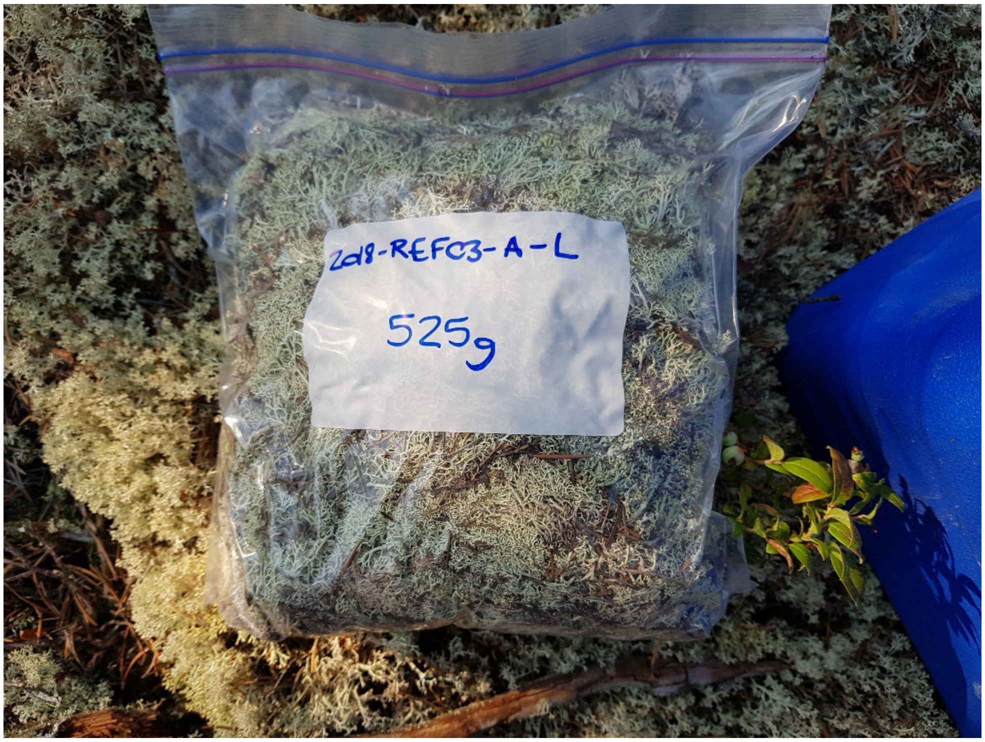

Photo 27: Representative lichen collection from plot REF03-A, 9 August 2018

Photo 28: Representative blueberry stem collection from plot EXP03-A, 7 August 2018

Photo 29: Representative blueberry leaf collection from plot EXP03-B, 7 August 2018

Photo 30: Representative blueberry fruit collection from plot REF03-A, 8 August 2018

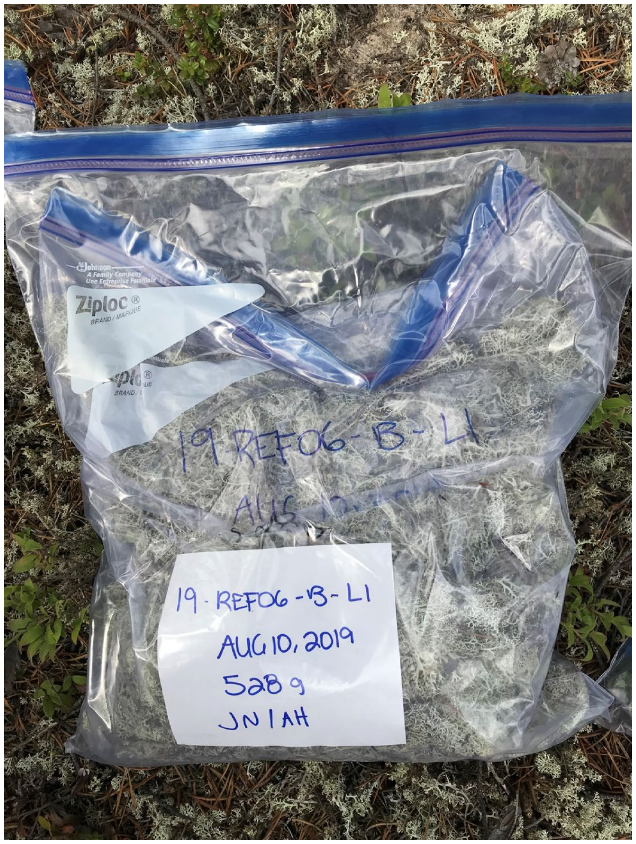

Photo 31: Representative lichen collection from plot REF06-B, 10 August 2019

Photo 32: Representative blueberry stem collection from plot REF05-C, 9 August 2019

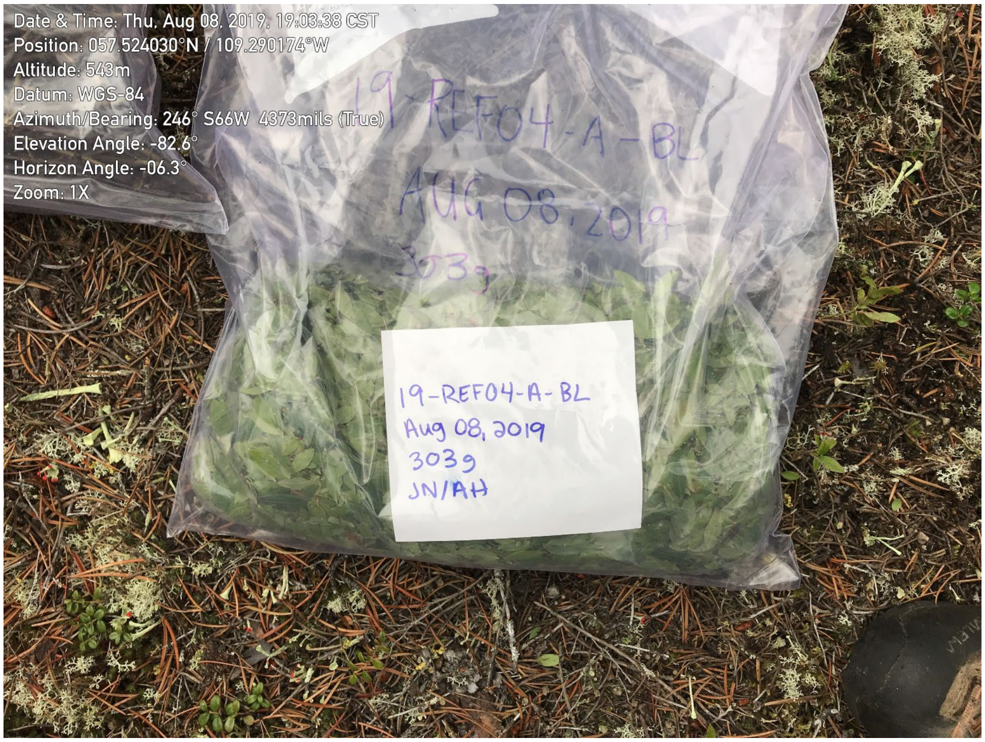

Photo 33: Representative blueberry leaf collection from plot REF04-A, 8 August 2019

APPENDIX B

Laboratory Certificates of Analysis

SASKATCHEWAN RESEARCH COUNCIL
Environmental Analytical Laboratories
143-111 Research Drive, Saskatoon, SK Canada S7N 3R2
T: 306-933-6932 F: 306-933-7922
Toll-free: 1-800-240-8808
E: analytical@src.sk.ca
www.src.sk.ca/analytical

SRC Group # 2018-9960

Oct 30, 2018

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Andrew Stewart

Date Samples Received: Aug-14-2018 Client P.O.: 1899581/2/2002

All results have been reviewed and approved by a Qualified Person in accordance with the Saskatchewan Environmental Code, Corrective Action Plan Chapter, for the purposes of certifying a laboratory analysis

Results from Lab Sections 1 and 2 have been authorized by Keith Gipman, Supervisor
Results from Lab Section 3 have been authorized by Pat Moser, Supervisor
Results from Lab Sections 4 and 5 have been authorized by Vicky Snook, Supervisor
Results from Lab Section 6 have been authorized by Marion McConnell, Supervisor

* Test methods and data are validated by the laboratory's Quality Assurance Program.

* Routine methods follow recognized procedures from sources such as
    * Standard Methods for the Examination of Water and Wastewater APHA AWWA WEF
    * Environment Canada
    * US EPA
    * CANMET

* The results reported relate only to the test samples as provided by the client.

* Samples will be kept for 30 days after the final report is sent. Please contact the lab if you have any special requirements.

* Additional information is available upon request.

This is a final report.

SRC SASKATCHEWAN RESEARCH COUNCIL
Environmental Analytical Laboratories
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SRC Group # 2018-9960

Oct 30, 2018

Golder

1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Andrew Stewart

Date Samples Received: Aug-14-2018

Client P.O.: 1899581/2/2002

31819 **08/04/2018 EXP01-A-BB *VEGETATION***
31820 **08/04/2018 EXP01-A-BL *VEGETATION***
31821 **08/04/2018 EXP01-A-BS *VEGETATION***

Analyte	Units	31819	31820	31821
Lab Section 2 (ICP)				
Aluminum	ug/g	12±2	85±8	82±8
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	<0.05
Barium	ug/g	15±2	31±3	43±4
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	16±4	29±4	7±1
Cadmium	ug/g	<0.01	<0.01	0.02±0.02
Cesium	ug/g	0.09±0.07	0.09±0.07	<0.05
Chromium	ug/g	<0.5	<0.5	0.6±0.6
Cobalt	ug/g	<0.01	0.04±0.02	0.05±0.02
Copper	ug/g	3.1±0.5	3.3±0.5	4.6±0.7
Iron	ug/g	14±2	50±5	47±7
Lead	ug/g	0.05±0.02	0.05±0.02	0.06±0.02
Lithium	ug/g	0.09±0.07	<0.05	<0.05
Manganese	ug/g	840±80	3190±300	2150±200
Mercury	ug/g	<0.005	0.007±0.006	<0.005
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.45±0.2	0.85±0.2	0.81±0.2
Rubidium	ug/g	18±3	9.3±0.9	6.2±0.6
Selenium	ug/g	<0.05	<0.05	<0.05
Silver	ug/g	<0.01	<0.01	<0.01
Strontium	ug/g	1.6±0.2	5.6±0.6	5.7±0.6
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	0.14±0.06	1.4±0.2	1.3±0.2
Uranium	ug/g	<0.01	0.06±0.02	0.05±0.02
Vanadium	ug/g	<0.1	<0.1	0.1±0.1
Zinc	ug/g	8.5±2	10±2	22±3
Zirconium	ug/g	<0.05	0.06±0.05	0.05±0.05

SRC Group # 2018-9960

Oct 30, 2018

Golder

31819 **08/04/2018 EXP01-A-BB *VEGETATION***
31820 **08/04/2018 EXP01-A-BL *VEGETATION***
31821 **08/04/2018 EXP01-A-BS *VEGETATION***

Analyte	Units	31819	31820	31821
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.001±0.001	0.036±0.005	0.049±0.007
Polonium-210	Bq/g	0.0019±0.0007	0.017±0.002	0.034±0.003
Radium-226	Bq/g	0.0020±0.0005	0.0044±0.001	0.0071±0.001
Thorium-228	Bq/g	<0.0005	0.001±0.002	0.0036±0.003
Thorium-230	Bq/g	<0.0005	0.001±0.0008	0.0013±0.0008
Thorium-232	Bq/g	<0.0005	<0.0006	<0.0004

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Results are reported on a dry basis.

SRC SASKATCHEWAN RESEARCH COUNCIL
Environmental Analytical Laboratories
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Toll-free: 1-800-240-8808
E: analytical@src.sk.ca
www.src.sk.ca/analytical

SRC Group # 2018-9960

Oct 30, 2018

Golder

31822 **08/04/2018 EXP01-A-L *VEGETATION***
31823 **08/03/2018 EXP01-B-BB *VEGETATION***
31824 **08/04/2018 EXP01-B-BL *VEGETATION***

Analyte	Units	31822	31823	31824
Lab Section 2 (ICP)				
Aluminum	ug/g	280±30	10±2	100±10
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	0.08±0.06	<0.05	<0.05
Barium	ug/g	11±1	18±2	50±5
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	<1	10±2	29±4
Cadmium	ug/g	0.05±0.03	<0.01	<0.01
Cesium	ug/g	0.13±0.08	<0.05	<0.05
Chromium	ug/g	1.4±0.8	<0.5	<0.5
Cobalt	ug/g	0.08±0.02	0.01±0.01	0.04±0.02
Copper	ug/g	0.96±0.2	3.2±0.5	3.3±0.5
Iron	ug/g	220±20	14±2	54±5
Lead	ug/g	0.26±0.04	0.20±0.03	0.05±0.02
Lithium	ug/g	0.18±0.09	<0.05	<0.05
Manganese	ug/g	185±20	590±60	2260±200
Mercury	ug/g	0.016±0.009	<0.005	0.007±0.006
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.72±0.2	0.65±0.2	1.3±0.2
Rubidium	ug/g	4.9±0.7	17±2	9.2±0.9
Selenium	ug/g	0.07±0.06	<0.05	0.09±0.07
Silver	ug/g	0.02±0.01	<0.01	<0.01
Strontium	ug/g	2.7±0.4	2.8±0.4	9.2±0.9
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	6.9±0.7	0.13±0.06	1.5±0.2
Uranium	ug/g	0.16±0.04	<0.01	0.16±0.04
Vanadium	ug/g	0.5±0.2	<0.1	<0.1
Zinc	ug/g	17±2	8.1±2	9.9±2
Zirconium	ug/g	0.22±0.05	0.09±0.05	0.06±0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.22±0.03	0.002±0.001	0.038±0.006
Polonium-210	Bq/g	0.18±0.03	0.0018±0.0006	0.015±0.002
Radium-226	Bq/g	0.0052±0.0008	0.0010±0.0006	0.0051±0.001
Thorium-228	Bq/g	0.001±0.002	<0.0005	0.002±0.002
Thorium-230	Bq/g	0.002±0.001	<0.0005	0.001±0.0008

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31822	08/04/2018 EXP01-A-L *VEGETATION*
31823	08/03/2018 EXP01-B-BB *VEGETATION*
31824	08/04/2018 EXP01-B-BL *VEGETATION*

Analyte	Units	31822	31823	31824
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	0.0008±0.02	<0.0005	<0.0006

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Note for Sample # 31823
This sample was reanalyzed for Lead. Reanalysis confirms original results are within the expected measurement uncertainty.

Results are reported on a dry basis.

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31825 08/04/2018 EXP01-B-BS *VEGETATION*
31826 08/03/2018 EXP01-B-L *VEGETATION*
31827 08/03/2018 EXP01-C-BB *VEGETATION*

Analyte	Units	31825	31826	31827
Lab Section 2 (ICP)				
Aluminum	ug/g	110±10	410±40	9.8±2
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	0.10±0.07	<0.05
Barium	ug/g	74±7	15±2	18±2
Beryllium	ug/g	<0.01	0.01±0.01	<0.01
Boron	ug/g	7±1	1±1	7±1
Cadmium	ug/g	0.02±0.02	0.06±0.03	<0.01
Cesium	ug/g	<0.05	0.10±0.07	0.07±0.06
Chromium	ug/g	0.7±0.6	4.7±1	<0.5
Cobalt	ug/g	0.07±0.02	0.13±0.03	0.01±0.01
Copper	ug/g	5.3±0.5	1.2±0.2	3.6±0.5
Iron	ug/g	65±6	250±20	15±2
Lead	ug/g	0.09±0.03	0.56±0.08	0.04±0.02
Lithium	ug/g	0.06±0.06	0.19±0.1	<0.05
Manganese	ug/g	1550±200	174±20	486±50
Mercury	ug/g	0.008±0.006	0.026±0.01	<0.005
Molybdenum	ug/g	<0.1	<0.1	0.1±0.1
Nickel	ug/g	1.3±0.2	2.1±0.3	0.61±0.2
Rubidium	ug/g	5.5±0.6	4.3±0.6	19±3
Selenium	ug/g	<0.05	0.08±0.06	<0.05
Silver	ug/g	<0.01	0.02±0.01	<0.01
Strontium	ug/g	9.4±0.9	4.7±0.7	2.6±0.4
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	1.8±0.3	10±1	0.16±0.07
Uranium	ug/g	0.05±0.02	0.12±0.03	<0.01
Vanadium	ug/g	0.1±0.1	0.7±0.2	<0.1
Zinc	ug/g	44±7	16±2	8.0±2
Zirconium	ug/g	0.06±0.05	0.35±0.05	<0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.074±0.01	0.31±0.05	0.003±0.001
Polonium-210	Bq/g	0.057±0.006	0.22±0.02	0.0009±0.0004
Radium-226	Bq/g	0.0053±0.0008	0.0039±0.001	0.0011±0.0007
Thorium-228	Bq/g	0.0056±0.004	0.002±0.002	<0.0005
Thorium-230	Bq/g	0.0008±0.0006	0.001±0.0008	<0.0005

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31825 **08/04/2018 EXP01-B-BS *VEGETATION***
31826 **08/03/2018 EXP01-B-L *VEGETATION***
31827 **08/03/2018 EXP01-C-BB *VEGETATION***

Analyte	Units	31825	31826	31827
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0004	<0.0007	<0.0005

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Note for Sample # 31826
This sample was reanalyzed for Aluminum, Chromium and Nickel. Reanalysis confirms original results are within the expected measurement uncertainty.

Results are reported on a dry basis.

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31828 **08/03/2018 EXP01-C-BL *VEGETATION***
31829 **08/03/2018 EXP01-C-BS *VEGETATION***
31830 **08/03/2018 EXP01-C-L *VEGETATION***

Analyte	Units	31828	31829	31830
Lab Section 2 (ICP)				
Aluminum	ug/g	94±9	110±10	250±20
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	0.07±0.06
Barium	ug/g	53±5	66±7	10±1
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	37±6	7±1	<1
Cadmium	ug/g	<0.01	0.02±0.02	0.05±0.03
Cesium	ug/g	0.09±0.07	<0.05	0.12±0.08
Chromium	ug/g	0.5±0.5	1.0±0.7	1.1±0.7
Cobalt	ug/g	0.04±0.02	0.04±0.02	0.08±0.02
Copper	ug/g	3.6±0.5	5.5±0.6	1.0±0.2
Iron	ug/g	58±6	65±6	180±20
Lead	ug/g	0.04±0.02	0.08±0.03	0.38±0.06
Lithium	ug/g	<0.05	0.06±0.06	0.15±0.08
Manganese	ug/g	2860±300	1560±200	190±20
Mercury	ug/g	0.008±0.006	0.007±0.006	0.018±0.009
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.93±0.2	1.4±0.2	0.67±0.2
Rubidium	ug/g	9.8±2	4.3±0.6	4.9±0.7
Selenium	ug/g	<0.05	<0.05	0.05±0.05
Silver	ug/g	<0.01	<0.01	0.02±0.01
Strontium	ug/g	5.4±0.5	8.1±0.8	3.3±0.5
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	2.0±0.3	2.6±0.4	6.4±0.6
Uranium	ug/g	0.08±0.03	0.05±0.02	0.14±0.04
Vanadium	ug/g	<0.1	0.2±0.1	0.5±0.2
Zinc	ug/g	9.6±2	31±5	15±2
Zirconium	ug/g	0.07±0.05	0.09±0.05	0.21±0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.033±0.005	0.074±0.01	0.29±0.04
Polonium-210	Bq/g	0.012±0.002	0.049±0.005	0.14±0.02
Radium-226	Bq/g	0.0071±0.001	0.0076±0.001	0.0055±0.001
Thorium-228	Bq/g	0.002±0.002	0.0041±0.003	0.002±0.002
Thorium-230	Bq/g	0.002±0.001	0.0009±0.0006	0.002±0.001

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31828 **08/03/2018 EXP01-C-BL *VEGETATION***
31829 **08/03/2018 EXP01-C-BS *VEGETATION***
31830 **08/03/2018 EXP01-C-L *VEGETATION***

Analyte	Units	31828	31829	31830
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0006	<0.0003	<0.0008

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Results are reported on a dry basis.

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31831 08/04/2018 EXP02-A-BB *VEGETATION*
31832 08/06/2018 EXP02-A-BL *VEGETATION*
31833 08/06/2018 EXP02-A-BS *VEGETATION*

Analyte	Units	31831	31832	31833
Lab Section 2 (ICP)				
Aluminum	ug/g	9.8±2	77±8	77±8
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	<0.05
Barium	ug/g	20±2	53±5	72±7
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	11±3	38±6	8±1
Cadmium	ug/g	<0.01	<0.01	0.02±0.02
Cesium	ug/g	<0.05	<0.05	<0.05
Chromium	ug/g	<0.5	<0.5	<0.5
Cobalt	ug/g	0.01±0.01	0.05±0.02	0.08±0.02
Copper	ug/g	4.2±0.6	3.0±0.4	4.7±0.7
Iron	ug/g	14±2	45±7	45±7
Lead	ug/g	0.01±0.01	0.02±0.01	0.05±0.02
Lithium	ug/g	<0.05	<0.05	<0.05
Manganese	ug/g	680±70	2250±200	1420±100
Mercury	ug/g	<0.005	0.007±0.006	0.006±0.006
Molybdenum	ug/g	0.1±0.1	<0.1	<0.1
Nickel	ug/g	0.63±0.2	0.88±0.2	0.95±0.2
Rubidium	ug/g	16±2	7.9±0.8	4.8±0.7
Selenium	ug/g	<0.05	<0.05	<0.05
Silver	ug/g	<0.01	<0.01	<0.01
Strontium	ug/g	2.3±0.3	2.9±0.4	4.2±0.6
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	0.08±0.05	0.92±0.2	1.1±0.2
Uranium	ug/g	<0.01	0.03±0.02	0.03±0.02
Vanadium	ug/g	<0.1	<0.1	<0.1
Zinc	ug/g	9.6±2	10±2	43±6
Zirconium	ug/g	0.07±0.05	<0.05	<0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.003±0.002	0.035±0.005	0.075±0.01
Polonium-210	Bq/g	0.0020±0.0009	0.015±0.002	0.047±0.005
Radium-226	Bq/g	0.0027±0.002	0.0063±0.0009	0.0097±0.001
Thorium-228	Bq/g	<0.0008	0.001±0.002	0.0047±0.003
Thorium-230	Bq/g	<0.0008	<0.0006	0.0004±0.0004

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31831 **08/04/2018 EXP02-A-BB *VEGETATION***
31832 **08/06/2018 EXP02-A-BL *VEGETATION***
31833 **08/06/2018 EXP02-A-BS *VEGETATION***

Analyte	Units	31831	31832	31833
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0008	<0.0006	<0.0004

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Results are reported on a dry basis.

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31834 **08/06/2018 EXP02-A-L *VEGETATION***
31835 **08/04/2018 EXP02-B-BB *VEGETATION***
31836 **08/06/2018 EXP02-B-BL *VEGETATION***

Analyte	Units	31834	31835	31836
Lab Section 2 (ICP)				
Aluminum	ug/g	270±30	11±2	100±10
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	0.07±0.06	<0.05	<0.05
Barium	ug/g	15±2	22±2	64±6
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	1±1	11±3	46±7
Cadmium	ug/g	0.05±0.03	<0.01	<0.01
Cesium	ug/g	0.10±0.07	0.07±0.06	<0.05
Chromium	ug/g	1.2±0.8	<0.5	<0.5
Cobalt	ug/g	0.11±0.03	0.02±0.01	0.04±0.02
Copper	ug/g	1.2±0.2	4.6±0.7	4.1±0.6
Iron	ug/g	190±20	21±3	56±6
Lead	ug/g	0.32±0.05	0.01±0.01	0.04±0.02
Lithium	ug/g	0.15±0.08	0.08±0.06	<0.05
Manganese	ug/g	163±20	710±70	4010±400
Mercury	ug/g	0.027±0.01	<0.005	0.008±0.006
Molybdenum	ug/g	<0.1	0.1±0.1	<0.1
Nickel	ug/g	0.75±0.2	1.0±0.2	0.87±0.2
Rubidium	ug/g	3.8±0.6	22±3	8.2±0.8
Selenium	ug/g	<0.05	<0.05	<0.05
Silver	ug/g	0.01±0.01	<0.01	<0.01
Strontium	ug/g	3.3±0.5	2.8±0.4	2.8±0.4
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	6.8±0.7	0.14±0.06	1.4±0.2
Uranium	ug/g	0.10±0.02	0.01±0.01	0.03±0.02
Vanadium	ug/g	0.6±0.2	<0.1	<0.1
Zinc	ug/g	12±2	10±2	13±2
Zirconium	ug/g	0.20±0.05	0.09±0.05	0.05±0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.30±0.04	0.003±0.002	0.033±0.005
Polonium-210	Bq/g	0.12±0.02	0.0016±0.0008	0.019±0.003
Radium-226	Bq/g	0.0036±0.0009	0.0029±0.002	0.0078±0.002
Thorium-228	Bq/g	0.0010±0.002	<0.0008	0.003±0.002
Thorium-230	Bq/g	0.0009±0.0006	<0.0008	<0.0007

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31834	**08/06/2018 EXP02-A-L *VEGETATION***
31835	**08/04/2018 EXP02-B-BB *VEGETATION***
31836	**08/06/2018 EXP02-B-BL *VEGETATION***

Analyte	Units	31834	31835	31836
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0003	<0.0008	<0.0007

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

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31837 **08/06/2018 EXP02-B-BS *VEGETATION***
31838 **08/06/2018 EXP02-B-L *VEGETATION***
31839 **08/06/2018 EXP02-C-BB *VEGETATION***

Analyte	Units	31837	31838	31839
Lab Section 2 (ICP)				
Aluminum	ug/g	110±10	240±20	19±3
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	0.06±0.06	<0.05
Barium	ug/g	70±7	14±1	19±2
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	8±1	2±1	12±3
Cadmium	ug/g	0.02±0.02	0.04±0.02	<0.01
Cesium	ug/g	<0.05	0.09±0.07	0.06±0.06
Chromium	ug/g	<0.5	1.3±0.8	<0.5
Cobalt	ug/g	0.06±0.02	0.10±0.02	<0.01
Copper	ug/g	6.3±0.6	1.3±0.2	3.7±0.6
Iron	ug/g	66±7	170±20	18±3
Lead	ug/g	0.08±0.03	0.23±0.03	0.02±0.01
Lithium	ug/g	0.07±0.06	0.13±0.08	0.09±0.07
Manganese	ug/g	2320±200	295±30	489±50
Mercury	ug/g	0.007±0.006	0.023±0.01	<0.005
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.91±0.2	0.83±0.2	0.80±0.2
Rubidium	ug/g	4.8±0.7	4.4±0.7	21±2
Selenium	ug/g	<0.05	<0.05	<0.05
Silver	ug/g	<0.01	<0.01	<0.01
Strontium	ug/g	3.1±0.5	2.8±0.4	4.0±0.6
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	2.0±0.3	5.3±0.5	0.26±0.09
Uranium	ug/g	0.03±0.02	0.07±0.02	<0.01
Vanadium	ug/g	0.1±0.1	0.5±0.2	<0.1
Zinc	ug/g	38±6	12±2	7.6±2
Zirconium	ug/g	0.06±0.05	0.17±0.05	<0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.10±0.01	0.21±0.03	<0.001
Polonium-210	Bq/g	0.059±0.006	0.13±0.02	0.0011±0.0005
Radium-226	Bq/g	0.011±0.002	0.0037±0.0009	0.0018±0.001
Thorium-228	Bq/g	0.010±0.005	0.0009±0.002	<0.0005
Thorium-230	Bq/g	0.0010±0.0007	0.0009±0.0006	<0.0005

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31837 **08/06/2018 EXP02-B-BS *VEGETATION***
31838 **08/06/2018 EXP02-B-L *VEGETATION***
31839 **08/06/2018 EXP02-C-BB *VEGETATION***

Analyte	Units	31837	31838	31839
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0004	<0.0004	<0.0005

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

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31840 **08/06/2018 EXP02-C-BL *VEGETATION***
31841 **08/06/2018 EXP02-C-BS *VEGETATION***
31842 **08/06/2018 EXP02-C-L *VEGETATION***

Analyte	Units	31840	31841	31842
Lab Section 2 (ICP)				
Aluminum	ug/g	94±9	120±10	190±20
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	0.06±0.06
Barium	ug/g	71±7	91±9	7.4±0.7
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	33±5	9±1	1±1
Cadmium	ug/g	<0.01	0.02±0.02	0.04±0.02
Cesium	ug/g	0.07±0.06	<0.05	0.10±0.07
Chromium	ug/g	<0.5	0.8±0.6	1.0±0.7
Cobalt	ug/g	0.04±0.02	0.09±0.02	0.06±0.02
Copper	ug/g	3.7±0.6	5.2±0.5	0.87±0.2
Iron	ug/g	50±5	78±8	150±20
Lead	ug/g	0.03±0.02	0.08±0.03	0.22±0.03
Lithium	ug/g	<0.05	0.07±0.06	0.12±0.08
Manganese	ug/g	2790±300	2020±200	149±10
Mercury	ug/g	0.008±0.006	0.009±0.007	0.021±0.01
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	1.2±0.2	1.2±0.2	0.58±0.1
Rubidium	ug/g	9.6±1	5.2±0.5	4.6±0.7
Selenium	ug/g	<0.05	<0.05	<0.05
Silver	ug/g	<0.01	<0.01	<0.01
Strontium	ug/g	9.5±1	24±2	2.0±0.3
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	0.88±0.2	2.0±0.3	4.9±0.7
Uranium	ug/g	0.03±0.02	0.05±0.02	0.08±0.03
Vanadium	ug/g	<0.1	0.2±0.1	0.4±0.2
Zinc	ug/g	11±2	45±7	13±2
Zirconium	ug/g	<0.05	0.07±0.05	0.15±0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.033±0.005	0.060±0.009	0.25±0.04
Polonium-210	Bq/g	0.019±0.003	0.047±0.005	0.16±0.02
Radium-226	Bq/g	0.0088±0.001	0.015±0.002	0.0027±0.0004
Thorium-228	Bq/g	0.001±0.002	0.005±0.003	0.0008±0.002
Thorium-230	Bq/g	<0.0006	<0.0005	0.0012±0.0006

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31840 **08/06/2018 EXP02-C-BL *VEGETATION***
31841 **08/06/2018 EXP02-C-BS *VEGETATION***
31842 **08/06/2018 EXP02-C-L *VEGETATION***

Analyte	Units	31840	31841	31842
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0006	<0.0005	0.0003±0.02

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Note for Sample # 31841
This sample was reanalyzed for Strontium. Reanalysis confirms original results are within the expected measurement uncertainty.

Results are reported on a dry basis.

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31843 **08/07/2018 EXP03-A-BB *VEGETATION***
31844 **08/07/2018 EXP03-A-BL *VEGETATION***
31845 **08/07/2018 EXP03-A-BS *VEGETATION***

Analyte	Units	31843	31844	31845
Lab Section 2 (ICP)				
Aluminum	ug/g	7.3±2	97±10	88±9
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	<0.05
Barium	ug/g	16±2	70±7	70±7
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	11±3	32±5	8±1
Cadmium	ug/g	<0.01	0.01±0.01	0.04±0.02
Cesium	ug/g	0.06±0.06	0.08±0.06	0.05±0.05
Chromium	ug/g	<0.5	0.5±0.5	0.6±0.6
Cobalt	ug/g	<0.01	0.03±0.02	0.04±0.02
Copper	ug/g	3.6±0.5	3.6±0.5	5.1±0.5
Iron	ug/g	10±2	55±6	55±6
Lead	ug/g	0.02±0.01	0.04±0.02	0.07±0.02
Lithium	ug/g	<0.05	<0.05	0.06±0.06
Manganese	ug/g	750±80	3620±400	1770±200
Mercury	ug/g	<0.005	0.008±0.006	0.006±0.006
Molybdenum	ug/g	0.1±0.1	<0.1	<0.1
Nickel	ug/g	0.36±0.1	0.59±0.1	0.62±0.2
Rubidium	ug/g	17±2	7.9±0.8	4.9±0.7
Selenium	ug/g	<0.05	<0.05	<0.05
Silver	ug/g	<0.01	<0.01	<0.01
Strontium	ug/g	1.3±0.2	4.7±0.7	3.8±0.6
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	0.33±0.1	1.0±0.2	1.7±0.2
Uranium	ug/g	<0.01	<0.01	<0.01
Vanadium	ug/g	<0.1	<0.1	0.1±0.1
Zinc	ug/g	7.5±2	18±3	45±7
Zirconium	ug/g	<0.05	<0.05	0.05±0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.001±0.001	0.036±0.005	0.093±0.01
Polonium-210	Bq/g	0.0008±0.0004	0.014±0.002	0.037±0.004
Radium-226	Bq/g	0.0023±0.0006	0.0076±0.001	0.0095±0.001
Thorium-228	Bq/g	<0.0005	0.002±0.002	0.0066±0.004
Thorium-230	Bq/g	<0.0005	<0.0006	<0.0003

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31843 **08/07/2018 EXP03-A-BB *VEGETATION***
31844 **08/07/2018 EXP03-A-BL *VEGETATION***
31845 **08/07/2018 EXP03-A-BS *VEGETATION***

Analyte	Units	31843	31844	31845
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0005	<0.0006	<0.0003

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Results are reported on a dry basis.

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31846	08/07/2018 EXP03-A-L *VEGETATION*
31847	08/07/2018 EXP03-B-BB *VEGETATION*
31848	08/07/2018 EXP03-B-BL *VEGETATION*

Analyte	Units	31846	31847	31848
Lab Section 2 (ICP)				
Aluminum	ug/g	870±90	15±2	93±9
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	0.23±0.1	<0.05	<0.05
Barium	ug/g	16±2	21±2	58±6
Beryllium	ug/g	0.02±0.01	<0.01	<0.01
Boron	ug/g	2±1	12±3	36±5
Cadmium	ug/g	0.07±0.03	<0.01	<0.01
Cesium	ug/g	0.13±0.08	<0.05	0.05±0.05
Chromium	ug/g	130±80	<0.5	<0.5
Cobalt	ug/g	1.4±0.1	<0.01	0.03±0.02
Copper	ug/g	1.3±0.2	3.3±0.5	3.0±0.4
Iron	ug/g	1100±100	16±2	46±7
Lead	ug/g	1.3±0.1	0.01±0.01	0.03±0.02
Lithium	ug/g	0.49±0.1	<0.05	<0.05
Manganese	ug/g	109±10	660±70	2840±300
Mercury	ug/g	0.031±0.01	<0.005	0.008±0.006
Molybdenum	ug/g	0.1±0.1	<0.1	<0.1
Nickel	ug/g	54±5	0.46±0.2	0.77±0.2
Rubidium	ug/g	4.0±0.6	13±2	6.2±0.6
Selenium	ug/g	0.09±0.07	<0.05	<0.05
Silver	ug/g	0.02±0.01	<0.01	<0.01
Strontium	ug/g	8.6±0.9	1.6±0.2	4.8±0.7
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	26±3	0.24±0.09	1.3±0.2
Uranium	ug/g	0.07±0.02	<0.01	<0.01
Vanadium	ug/g	1.9±0.5	<0.1	<0.1
Zinc	ug/g	14±2	8.3±2	11±2
Zirconium	ug/g	1.1±0.2	0.26±0.05	<0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.33±0.05	<0.001	0.030±0.004
Polonium-210	Bq/g	0.35±0.04	0.0010±0.0004	0.0094±0.001
Radium-226	Bq/g	0.014±0.01	0.0021±0.0005	0.0066±0.001
Thorium-228	Bq/g	<0.007	0.0005±0.002	0.002±0.002
Thorium-230	Bq/g	<0.007	<0.0005	<0.0006

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31846 **08/07/2018 EXP03-A-L *VEGETATION***
31847 **08/07/2018 EXP03-B-BB *VEGETATION***
31848 **08/07/2018 EXP03-B-BL *VEGETATION***

Analyte	Units	31846	31847	31848
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.007	<0.0005	<0.0006

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Note for Sample # 31846
This sample was reanalyzed for Lab Section 2 (ICP). Reanalysis confirms original results are within the expected measurement uncertainty.

Results are reported on a dry basis.

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31849 **08/07/2018 EXP03-B-BS *VEGETATION***
31850 **08/07/2018 EXP03-B-L *VEGETATION***
31851 **08/07/2018 EXP03-C-BB *VEGETATION***

Analyte	Units	31849	31850	31851
Lab Section 2 (ICP)				
Aluminum	ug/g	89±9	490±50	8.4±2
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	0.12±0.08	<0.05
Barium	ug/g	78±8	15±2	16±2
Beryllium	ug/g	<0.01	0.02±0.01	<0.01
Boron	ug/g	9±1	1±1	7±1
Cadmium	ug/g	0.04±0.02	0.06±0.03	<0.01
Cesium	ug/g	<0.05	0.20±0.1	0.14±0.08
Chromium	ug/g	0.6±0.6	18±9	<0.5
Cobalt	ug/g	0.04±0.02	0.31±0.05	<0.01
Copper	ug/g	5.8±0.6	2.0±0.3	2.6±0.4
Iron	ug/g	50±5	380±40	10±2
Lead	ug/g	0.06±0.02	0.78±0.1	0.03±0.02
Lithium	ug/g	0.07±0.06	0.22±0.1	<0.05
Manganese	ug/g	1640±200	155±20	890±90
Mercury	ug/g	0.005±0.005	0.028±0.01	<0.005
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.71±0.2	7.1±0.7	0.51±0.1
Rubidium	ug/g	4.6±0.7	6.1±0.6	17±2
Selenium	ug/g	<0.05	0.10±0.07	<0.05
Silver	ug/g	<0.01	0.02±0.01	<0.01
Strontium	ug/g	5.7±0.6	5.0±0.5	1.7±0.2
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	1.1±0.2	11±1	<0.05
Uranium	ug/g	<0.01	0.04±0.02	<0.01
Vanadium	ug/g	0.1±0.1	1.0±0.2	<0.1
Zinc	ug/g	43±6	19±3	9.0±2
Zirconium	ug/g	<0.05	0.36±0.05	0.06±0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.058±0.009	0.39±0.06	<0.001
Polonium-210	Bq/g	0.033±0.003	0.33±0.03	0.0007±0.0004
Radium-226	Bq/g	0.010±0.002	0.010±0.007	0.0017±0.001
Thorium-228	Bq/g	0.0072±0.004	<0.006	<0.0007
Thorium-230	Bq/g	<0.0004	<0.006	<0.0007

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31849 **08/07/2018 EXP03-B-BS *VEGETATION***
31850 **08/07/2018 EXP03-B-L *VEGETATION***
31851 **08/07/2018 EXP03-C-BB *VEGETATION***

Analyte	Units	31849	31850	31851
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0004	<0.006	<0.0007

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Results are reported on a dry basis.

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31852 **08/07/2018 EXP03-C-BL *VEGETATION***
31853 **08/07/2018 EXP03-C-BS *VEGETATION***
31854 **08/07/2018 EXP03-C-L *VEGETATION***

Analyte	Units	31852	31853	31854
Lab Section 2 (ICP)				
Aluminum	ug/g	110±10	140±10	420±40
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	0.11±0.07
Barium	ug/g	62±6	64±6	13±1
Beryllium	ug/g	<0.01	<0.01	0.01±0.01
Boron	ug/g	24±4	8±1	1±1
Cadmium	ug/g	<0.01	0.02±0.02	0.06±0.03
Cesium	ug/g	0.10±0.07	0.06±0.06	0.19±0.1
Chromium	ug/g	<0.5	0.7±0.6	7.1±2
Cobalt	ug/g	0.02±0.01	0.04±0.02	0.16±0.04
Copper	ug/g	3.1±0.5	5.1±0.5	1.2±0.2
Iron	ug/g	62±6	79±8	280±30
Lead	ug/g	0.03±0.02	0.08±0.03	0.52±0.08
Lithium	ug/g	0.05±0.05	0.08±0.06	0.18±0.09
Manganese	ug/g	4630±500	2140±200	242±20
Mercury	ug/g	0.008±0.006	0.009±0.007	0.025±0.01
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.71±0.2	0.91±0.2	3.3±0.5
Rubidium	ug/g	7.0±0.7	4.2±0.6	6.2±0.6
Selenium	ug/g	0.06±0.06	<0.05	0.10±0.07
Silver	ug/g	<0.01	<0.01	0.01±0.01
Strontium	ug/g	6.1±0.6	4.9±0.7	4.6±0.7
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	1.3±0.2	2.3±0.3	9.5±1
Uranium	ug/g	<0.01	0.02±0.01	0.02±0.01
Vanadium	ug/g	<0.1	0.2±0.1	0.7±0.2
Zinc	ug/g	17±2	42±6	23±3
Zirconium	ug/g	<0.05	0.06±0.05	0.29±0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.051±0.008	0.12±0.01	0.39±0.06
Polonium-210	Bq/g	0.031±0.003	0.066±0.007	0.24±0.02
Radium-226	Bq/g	0.0056±0.001	0.0056±0.0008	0.007±0.005
Thorium-228	Bq/g	0.002±0.002	0.0043±0.003	<0.004
Thorium-230	Bq/g	<0.0006	<0.0003	<0.004

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31852 **08/07/2018 EXP03-C-BL *VEGETATION***
31853 **08/07/2018 EXP03-C-BS *VEGETATION***
31854 **08/07/2018 EXP03-C-L *VEGETATION***

Analyte	Units	31852	31853	31854
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0006	<0.0003	<0.004

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Results are reported on a dry basis.

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31855 **08/05/2018 REF01-A-BL *VEGETATION***
31856 **08/05/2018 REF01-A-BS *VEGETATION***
31857 **08/05/2018 REF01-A-L *VEGETATION***

Analyte	Units	31855	31856	31857
Lab Section 2 (ICP)				
Aluminum	ug/g	73±7	25±4	1200±100
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	0.41±0.1
Barium	ug/g	39±4	67±7	16±2
Beryllium	ug/g	<0.01	<0.01	0.02±0.01
Boron	ug/g	26±4	12±3	3±1
Cadmium	ug/g	<0.01	0.04±0.02	0.17±0.04
Cesium	ug/g	0.08±0.06	<0.05	0.21±0.1
Chromium	ug/g	<0.5	<0.5	3.9±1
Cobalt	ug/g	0.01±0.01	0.02±0.01	0.20±0.03
Copper	ug/g	3.2±0.5	5.1±0.5	2.7±0.4
Iron	ug/g	40±6	19±3	820±80
Lead	ug/g	0.02±0.01	<0.01	2.0±0.2
Lithium	ug/g	<0.05	<0.05	0.50±0.1
Manganese	ug/g	2090±200	1180±100	51±5
Mercury	ug/g	<0.005	<0.005	0.40±0.1
Molybdenum	ug/g	0.1±0.1	<0.1	0.1±0.1
Nickel	ug/g	0.53±0.1	0.58±0.1	2.2±0.3
Rubidium	ug/g	11±2	9.9±1	5.7±0.6
Selenium	ug/g	<0.05	<0.05	0.17±0.09
Silver	ug/g	<0.01	<0.01	0.02±0.01
Strontium	ug/g	5.0±0.5	10±1	5.5±0.6
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	0.06±0.06
Titanium	ug/g	0.34±0.1	0.20±0.08	31±3
Uranium	ug/g	<0.01	<0.01	0.06±0.02
Vanadium	ug/g	<0.1	<0.1	2.8±0.4
Zinc	ug/g	11±2	41±6	27±4
Zirconium	ug/g	<0.05	<0.05	0.78±0.2
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.013±0.003	0.004±0.001	0.50±0.08
Polonium-210	Bq/g	0.0067±0.001	0.0014±0.0006	0.38±0.04
Radium-226	Bq/g	0.0035±0.0009	0.0036±0.0009	0.0037±0.0009
Thorium-228	Bq/g	0.002±0.002	0.001±0.002	0.004±0.003
Thorium-230	Bq/g	<0.0005	<0.0005	0.001±0.0008

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31855 **08/05/2018 REF01-A-BL *VEGETATION***
31856 **08/05/2018 REF01-A-BS *VEGETATION***
31857 **08/05/2018 REF01-A-L *VEGETATION***

Analyte	Units	31855	31856	31857
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0005	<0.0005	0.001±0.02

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Note for Sample # 31857
This sample was reanalyzed for Lab Section 2 (ICP). Reanalysis confirms original results are within the expected measurement uncertainty.

Results are reported on a dry basis.

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31858 **08/05/2018 REF01-B-BL *VEGETATION***
31859 **08/05/2018 REF01-B-BS *VEGETATION***
31860 **08/05/2018 REF01-B-L *VEGETATION***

Analyte	Units	31858	31859	31860
Lab Section 2 (ICP)				
Aluminum	ug/g	60±6	21±3	190±20
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	0.07±0.06
Barium	ug/g	42±4	72±7	12±1
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	19±5	12±3	<1
Cadmium	ug/g	<0.01	0.05±0.03	0.02±0.02
Cesium	ug/g	0.10±0.07	0.06±0.06	0.14±0.08
Chromium	ug/g	<0.5	<0.5	1.0±0.7
Cobalt	ug/g	0.01±0.01	0.01±0.01	0.04±0.02
Copper	ug/g	2.6±0.4	4.8±0.7	0.87±0.2
Iron	ug/g	40±6	18±3	150±20
Lead	ug/g	0.01±0.01	<0.01	0.23±0.03
Lithium	ug/g	<0.05	<0.05	0.11±0.07
Manganese	ug/g	1830±200	1370±100	41±4
Mercury	ug/g	<0.005	<0.005	0.014±0.008
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.56±0.1	0.65±0.2	0.47±0.2
Rubidium	ug/g	10±2	10±2	2.9±0.4
Selenium	ug/g	<0.05	<0.05	<0.05
Silver	ug/g	<0.01	<0.01	<0.01
Strontium	ug/g	3.6±0.5	9.2±0.9	5.5±0.6
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	0.26±0.09	0.14±0.06	5.0±0.5
Uranium	ug/g	<0.01	<0.01	<0.01
Vanadium	ug/g	<0.1	<0.1	0.4±0.2
Zinc	ug/g	10±2	39±6	9.0±2
Zirconium	ug/g	<0.05	<0.05	0.13±0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.007±0.002	0.004±0.001	0.18±0.03
Polonium-210	Bq/g	0.0029±0.0007	0.0015±0.0006	0.13±0.02
Radium-226	Bq/g	0.0034±0.0008	0.0036±0.0009	0.0010±0.0002
Thorium-228	Bq/g	0.0022±0.002	0.002±0.002	<0.0002
Thorium-230	Bq/g	<0.0004	<0.0005	<0.0002

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31858 **08/05/2018 REF01-B-BL *VEGETATION***
31859 **08/05/2018 REF01-B-BS *VEGETATION***
31860 **08/05/2018 REF01-B-L *VEGETATION***

Analyte	Units	31858	31859	31860
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0004	<0.0005	<0.0002

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Results are reported on a dry basis.

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31861 **08/05/2018 REF01-C-BB *VEGETATION***
31862 **08/05/2018 REF01-C-BL *VEGETATION***
31863 **08/05/2018 REF01-C-BS *VEGETATION***

Analyte	Units	31861	31862	31863
Lab Section 2 (ICP)				
Aluminum	ug/g	9.1±2	70±7	90±9
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	<0.05
Barium	ug/g	21±2	84±8	93±9
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	7±1	31±5	8±1
Cadmium	ug/g	<0.01	<0.01	0.02±0.02
Cesium	ug/g	0.24±0.1	0.28±0.1	0.11±0.07
Chromium	ug/g	<0.5	<0.5	<0.5
Cobalt	ug/g	<0.01	0.02±0.01	0.04±0.02
Copper	ug/g	5.1±0.5	5.1±0.5	7.5±0.8
Iron	ug/g	17±2	49±7	61±6
Lead	ug/g	<0.01	0.02±0.01	0.07±0.02
Lithium	ug/g	<0.05	<0.05	0.05±0.05
Manganese	ug/g	500±50	3170±300	1960±200
Mercury	ug/g	<0.005	0.006±0.006	0.006±0.006
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.70±0.2	1.0±0.2	1.2±0.2
Rubidium	ug/g	26±4	15±2	7.6±0.8
Selenium	ug/g	<0.05	<0.05	<0.05
Silver	ug/g	<0.01	<0.01	<0.01
Strontium	ug/g	2.7±0.4	8.3±0.8	8.3±0.8
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	<0.05	0.64±0.2	1.1±0.2
Uranium	ug/g	<0.01	<0.01	<0.01
Vanadium	ug/g	<0.1	<0.1	0.1±0.1
Zinc	ug/g	10±2	12±2	49±7
Zirconium	ug/g	<0.05	<0.05	<0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.001±0.001	0.029±0.004	0.10±0.01
Polonium-210	Bq/g	0.0015±0.0006	0.0097±0.001	0.053±0.005
Radium-226	Bq/g	0.0018±0.001	0.0049±0.001	0.0047±0.0007
Thorium-228	Bq/g	<0.0005	0.0008±0.002	0.0024±0.002
Thorium-230	Bq/g	<0.0005	<0.0006	<0.0004

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31861 **08/05/2018 REF01-C-BB *VEGETATION***
31862 **08/05/2018 REF01-C-BL *VEGETATION***
31863 **08/05/2018 REF01-C-BS *VEGETATION***

Analyte	Units	31861	31862	31863
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0005	<0.0006	<0.0004

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Note for Sample # 31862
This sample was reanalyzed for Lead 210 and Thorium 228.
Reanalysis confirms original results are within the expected measurement uncertainty.

Note for Sample # 31863
This sample was reanalyzed for Aluminum, Iron, Titanium and Nickel.
Reanalysis confirms original results are within the expected measurement uncertainty.

Results are reported on a dry basis.

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31864 **08/05/2018 REF01-C-L *VEGETATION***
31865 **08/08/2018 REF02-A-BB *VEGETATION***
31866 **08/08/2018 REF02-A-BL *VEGETATION***

Analyte	Units	31864	31865	31866
Lab Section 2 (ICP)				
Aluminum	ug/g	210±20	9.2±2	86±9
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	0.06±0.06	<0.05	<0.05
Barium	ug/g	8.3±0.8	19±2	98±10
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	1±1	6±1	17±4
Cadmium	ug/g	0.05±0.03	<0.01	<0.01
Cesium	ug/g	0.15±0.08	0.26±0.1	0.19±0.1
Chromium	ug/g	0.8±0.6	<0.5	1.0±0.7
Cobalt	ug/g	0.07±0.02	<0.01	0.03±0.02
Copper	ug/g	0.98±0.2	3.2±0.5	3.9±0.6
Iron	ug/g	120±10	12±2	51±5
Lead	ug/g	0.18±0.04	0.06±0.02	0.05±0.02
Lithium	ug/g	0.10±0.07	<0.05	<0.05
Manganese	ug/g	99±10	377±40	2350±200
Mercury	ug/g	0.025±0.01	<0.005	0.007±0.006
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.68±0.2	0.54±0.1	0.96±0.2
Rubidium	ug/g	6.3±0.6	13±2	5.4±0.5
Selenium	ug/g	0.06±0.06	<0.05	<0.05
Silver	ug/g	<0.01	<0.01	<0.01
Strontium	ug/g	4.6±0.7	4.0±0.6	11±1
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	0.06±0.06
Titanium	ug/g	4.0±0.6	0.07±0.05	0.78±0.2
Uranium	ug/g	<0.01	<0.01	<0.01
Vanadium	ug/g	0.4±0.2	<0.1	<0.1
Zinc	ug/g	12±2	8.0±2	15±2
Zirconium	ug/g	0.11±0.05	0.15±0.05	<0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.23±0.03	0.001±0.001	0.040±0.006
Polonium-210	Bq/g	0.16±0.02	0.0009±0.0004	0.024±0.002
Radium-226	Bq/g	0.0010±0.0002	0.0013±0.0008	0.0043±0.001
Thorium-228	Bq/g	0.0004±0.002	<0.0005	0.004±0.003
Thorium-230	Bq/g	<0.0002	<0.0005	<0.0009

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31864 **08/05/2018 REF01-C-L *VEGETATION***
31865 **08/08/2018 REF02-A-BB *VEGETATION***
31866 **08/08/2018 REF02-A-BL *VEGETATION***

Analyte	Units	31864	31865	31866
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0002	<0.0005	<0.0009

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31867 **08/08/2018 REF02-A-BS *VEGETATION***
31868 **08/08/2018 REF02-A-L *VEGETATION***
31869 **08/08/2018 REF02-B-BB *VEGETATION***

Analyte	Units	31867	31868	31869
Lab Section 2 (ICP)				
Aluminum	ug/g	99±10	410±40	9.5±2
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	0.13±0.08	<0.05
Barium	ug/g	104±10	20±2	20±2
Beryllium	ug/g	<0.01	0.02±0.01	<0.01
Boron	ug/g	6±1	<1	13±3
Cadmium	ug/g	0.05±0.03	0.08±0.03	<0.01
Cesium	ug/g	0.08±0.06	0.17±0.09	0.06±0.06
Chromium	ug/g	0.6±0.6	22±3	<0.5
Cobalt	ug/g	0.04±0.02	0.16±0.04	<0.01
Copper	ug/g	5.4±0.5	1.7±0.2	3.2±0.5
Iron	ug/g	63±6	340±30	11±2
Lead	ug/g	0.07±0.02	1.3±0.1	0.16±0.04
Lithium	ug/g	<0.05	0.18±0.09	<0.05
Manganese	ug/g	1300±100	139±10	414±40
Mercury	ug/g	0.006±0.006	0.030±0.01	<0.005
Molybdenum	ug/g	<0.1	<0.1	0.1±0.1
Nickel	ug/g	0.96±0.2	8.5±0.8	0.73±0.2
Rubidium	ug/g	3.2±0.5	3.6±0.5	18±3
Selenium	ug/g	<0.05	<0.05	<0.05
Silver	ug/g	<0.01	0.02±0.01	<0.01
Strontium	ug/g	14±1	4.7±0.7	2.8±0.4
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	1.2±0.2	9.2±0.9	<0.05
Uranium	ug/g	<0.01	0.02±0.01	<0.01
Vanadium	ug/g	0.1±0.1	0.9±0.3	<0.1
Zinc	ug/g	66±7	15±2	8.1±2
Zirconium	ug/g	<0.05	0.29±0.05	0.07±0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.084±0.01	0.27±0.04	0.004±0.001
Polonium-210	Bq/g	0.051±0.005	0.22±0.02	0.0020±0.0005
Radium-226	Bq/g	0.011±0.002	0.005±0.005	0.0023±0.0006
Thorium-228	Bq/g	0.011±0.005	<0.007	0.001±0.002
Thorium-230	Bq/g	<0.0004	<0.007	<0.0005

31867	**08/08/2018 REF02-A-BS *VEGETATION***
31868	**08/08/2018 REF02-A-L *VEGETATION***
31869	**08/08/2018 REF02-B-BB *VEGETATION***

Analyte	Units	31867	31868	31869
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0004	<0.007	<0.0005

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Note for Sample # 31869
This sample was reanalyzed for Lead. Reanalysis confirms original results are within the expected measurement uncertainty.

Results are reported on a dry basis.

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31870 **08/08/2018 REF02-B-BL *VEGETATION***
31871 **08/08/2018 REF02-B-BS *VEGETATION***
31872 **08/08/2018 REF02-B-L *VEGETATION***

Analyte	Units	31870	31871	31872
Lab Section 2 (ICP)				
Aluminum	ug/g	78±8	70±7	370±40
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	0.10±0.07
Barium	ug/g	64±6	62±6	20±2
Beryllium	ug/g	<0.01	<0.01	0.01±0.01
Boron	ug/g	25±4	8±1	<1
Cadmium	ug/g	<0.01	0.03±0.02	0.05±0.03
Cesium	ug/g	<0.05	<0.05	0.15±0.08
Chromium	ug/g	<0.5	<0.5	3.4±1
Cobalt	ug/g	0.02±0.01	0.02±0.01	0.10±0.02
Copper	ug/g	3.0±0.4	4.9±0.7	1.6±0.2
Iron	ug/g	40±6	36±5	270±30
Lead	ug/g	0.02±0.01	0.03±0.02	1.1±0.1
Lithium	ug/g	<0.05	<0.05	0.16±0.09
Manganese	ug/g	2020±200	1120±100	166±20
Mercury	ug/g	0.006±0.006	<0.005	0.037±0.01
Molybdenum	ug/g	<0.1	<0.1	0.1±0.1
Nickel	ug/g	0.82±0.2	0.82±0.2	1.7±0.2
Rubidium	ug/g	6.1±0.6	4.0±0.6	4.8±0.7
Selenium	ug/g	<0.05	<0.05	<0.05
Silver	ug/g	<0.01	<0.01	0.02±0.01
Strontium	ug/g	8.5±0.8	10±1	3.5±0.5
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	0.46±0.1	0.62±0.2	8.7±0.9
Uranium	ug/g	<0.01	<0.01	0.02±0.01
Vanadium	ug/g	<0.1	<0.1	0.8±0.3
Zinc	ug/g	13±2	44±7	12±2
Zirconium	ug/g	<0.05	<0.05	0.23±0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.034±0.005	0.061±0.009	0.41±0.06
Polonium-210	Bq/g	0.014±0.002	0.038±0.004	0.27±0.03
Radium-226	Bq/g	0.0040±0.001	0.0084±0.001	<0.002
Thorium-228	Bq/g	0.006±0.004	0.010±0.005	<0.005
Thorium-230	Bq/g	<0.0006	<0.0004	<0.005

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31870 **08/08/2018 REF02-B-BL *VEGETATION***
31871 **08/08/2018 REF02-B-BS *VEGETATION***
31872 **08/08/2018 REF02-B-L *VEGETATION***

Analyte	Units	31870	31871	31872
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0006	<0.0004	<0.005

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31873 **08/08/2018 REF02-C-BB *VEGETATION***
31874 **08/08/2018 REF02-C-BL *VEGETATION***
31875 **08/08/2018 REF02-C-BS *VEGETATION***

Analyte	Units	31873	31874	31875
Lab Section 2 (ICP)				
Aluminum	ug/g	9.9±2	76±8	83±8
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	<0.05
Barium	ug/g	21±2	61±6	64±6
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	8±1	29±4	8±1
Cadmium	ug/g	<0.01	<0.01	0.02±0.02
Cesium	ug/g	0.07±0.06	0.10±0.07	0.06±0.06
Chromium	ug/g	<0.5	<0.5	<0.5
Cobalt	ug/g	<0.01	0.01±0.01	0.02±0.01
Copper	ug/g	2.6±0.4	2.9±0.4	4.7±0.7
Iron	ug/g	13±2	40±6	47±7
Lead	ug/g	0.02±0.01	0.02±0.01	0.04±0.02
Lithium	ug/g	<0.05	<0.05	<0.05
Manganese	ug/g	466±50	2520±200	1490±100
Mercury	ug/g	<0.005	0.006±0.006	0.007±0.006
Molybdenum	ug/g	0.1±0.1	<0.1	<0.1
Nickel	ug/g	0.40±0.2	0.55±0.1	0.52±0.1
Rubidium	ug/g	13±2	7.8±0.8	4.8±0.7
Selenium	ug/g	<0.05	0.05±0.05	<0.05
Silver	ug/g	<0.01	<0.01	<0.01
Strontium	ug/g	2.6±0.4	7.7±0.8	8.7±0.9
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	0.08±0.05	0.47±0.1	0.81±0.2
Uranium	ug/g	<0.01	<0.01	<0.01
Vanadium	ug/g	<0.1	<0.1	<0.1
Zinc	ug/g	7.0±2	13±2	32±5
Zirconium	ug/g	<0.05	<0.05	<0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.003±0.001	0.030±0.004	0.078±0.01
Polonium-210	Bq/g	0.0031±0.0008	0.015±0.002	0.034±0.003
Radium-226	Bq/g	0.0042±0.0006	0.0084±0.001	0.017±0.002
Thorium-228	Bq/g	0.0009±0.002	0.007±0.004	0.016±0.006
Thorium-230	Bq/g	<0.0005	<0.0005	<0.0004

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31873 08/08/2018 REF02-C-BB *VEGETATION*
31874 08/08/2018 REF02-C-BL *VEGETATION*
31875 08/08/2018 REF02-C-BS *VEGETATION*

Analyte	Units	31873	31874	31875
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0005	<0.0005	<0.0004

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31876 **08/08/2018 REF02-C-L *VEGETATION***
31877 **08/09/2018 REF03-A-BB *VEGETATION***
31878 **08/09/2018 REF03-A-BL *VEGETATION***

Analyte	Units	31876	31877	31878
Lab Section 2 (ICP)				
Aluminum	ug/g	340±30	10±2	98±10
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	0.10±0.07	<0.05	<0.05
Barium	ug/g	12±1	21±2	74±7
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	<1	7±1	22±3
Cadmium	ug/g	0.06±0.03	<0.01	<0.01
Cesium	ug/g	0.19±0.1	0.25±0.1	0.16±0.09
Chromium	ug/g	1.5±0.8	<0.5	<0.5
Cobalt	ug/g	0.08±0.02	<0.01	0.02±0.01
Copper	ug/g	1.4±0.2	3.9±0.6	3.5±0.5
Iron	ug/g	270±30	12±2	48±7
Lead	ug/g	0.74±0.1	0.05±0.02	0.02±0.01
Lithium	ug/g	0.16±0.09	<0.05	<0.05
Manganese	ug/g	180±20	600±60	3380±300
Mercury	ug/g	0.036±0.01	<0.005	0.007±0.006
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.93±0.2	0.45±0.2	0.65±0.2
Rubidium	ug/g	4.7±0.7	18±3	7.2±0.7
Selenium	ug/g	0.06±0.06	<0.05	<0.05
Silver	ug/g	<0.01	<0.01	<0.01
Strontium	ug/g	2.8±0.4	3.4±0.5	10±1
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	7.3±0.7	0.19±0.08	0.48±0.1
Uranium	ug/g	0.08±0.03	<0.01	<0.01
Vanadium	ug/g	0.7±0.2	<0.1	<0.1
Zinc	ug/g	20±3	7.6±2	13±2
Zirconium	ug/g	0.21±0.05	0.15±0.05	<0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.29±0.04	0.002±0.001	0.028±0.004
Polonium-210	Bq/g	0.17±0.02	0.0011±0.0005	0.011±0.002
Radium-226	Bq/g	0.003±0.002	0.0016±0.0009	0.0056±0.001
Thorium-228	Bq/g	0.002±0.002	<0.0005	0.003±0.002
Thorium-230	Bq/g	<0.001	<0.0005	<0.0006

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31876 **08/08/2018 REF02-C-L *VEGETATION***
31877 **08/09/2018 REF03-A-BB *VEGETATION***
31878 **08/09/2018 REF03-A-BL *VEGETATION***

Analyte	Units	31876	31877	31878
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.001	<0.0005	<0.0006

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Results are reported on a dry basis.

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31879 **08/09/2018 REF03-A-BS *VEGETATION***
31880 **08/09/2018 REF03-A-L *VEGETATION***
31881 **08/09/2018 REF03-B-BB *VEGETATION***

Analyte	Units	31879	31880	31881
Lab Section 2 (ICP)				
Aluminum	ug/g	91±9	310±30	13±2
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	0.09±0.07	<0.05
Barium	ug/g	72±7	7.5±0.8	20±2
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	7±1	<1	8±1
Cadmium	ug/g	0.02±0.02	0.04±0.02	0.36±0.05
Cesium	ug/g	0.11±0.07	0.11±0.07	0.21±0.1
Chromium	ug/g	<0.5	3.7±1	<0.5
Cobalt	ug/g	0.02±0.01	0.10±0.02	0.01±0.01
Copper	ug/g	5.3±0.5	0.98±0.2	3.2±0.5
Iron	ug/g	59±6	220±20	15±2
Lead	ug/g	0.05±0.02	0.37±0.06	0.02±0.01
Lithium	ug/g	<0.05	0.15±0.08	<0.05
Manganese	ug/g	1780±200	131±10	650±60
Mercury	ug/g	0.006±0.006	0.024±0.01	<0.005
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.58±0.1	1.7±0.2	0.53±0.1
Rubidium	ug/g	5.3±0.5	3.8±0.6	18±3
Selenium	ug/g	<0.05	0.06±0.06	<0.05
Silver	ug/g	<0.01	0.01±0.01	<0.01
Strontium	ug/g	9.0±0.9	3.3±0.5	2.6±0.4
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	0.05±0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	1.0±0.2	7.4±0.7	0.14±0.06
Uranium	ug/g	<0.01	0.01±0.01	<0.01
Vanadium	ug/g	0.1±0.1	0.6±0.2	<0.1
Zinc	ug/g	44±7	15±2	8.3±2
Zirconium	ug/g	<0.05	0.19±0.05	0.27±0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.056±0.008	0.25±0.04	0.002±0.001
Polonium-210	Bq/g	0.046±0.005	0.19±0.03	0.0016±0.0006
Radium-226	Bq/g	0.0018±0.001	0.005±0.004	0.0016±0.0009
Thorium-228	Bq/g	0.0084±0.004	<0.004	<0.0005
Thorium-230	Bq/g	<0.0004	0.005±0.004	<0.0005

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31879 **08/09/2018 REF03-A-BS *VEGETATION***
31880 **08/09/2018 REF03-A-L *VEGETATION***
31881 **08/09/2018 REF03-B-BB *VEGETATION***

Analyte	Units	31879	31880	31881
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0004	<0.004	<0.0005

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Note for Sample # 31881
This sample was reanalyzed for Cadmium. Reanalysis confirms original results are within the expected measurement uncertainty.

Results are reported on a dry basis.

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31882 **08/09/2018 REF03-B-BL *VEGETATION***
31883 **08/09/2018 REF03-B-BS *VEGETATION***
31884 **08/09/2018 REF03-B-L *VEGETATION***

Analyte	Units	31882	31883	31884
Lab Section 2 (ICP)				
Aluminum	ug/g	100±10	110±10	500±50
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	0.13±0.08
Barium	ug/g	72±7	72±7	14±1
Beryllium	ug/g	<0.01	<0.01	0.01±0.01
Boron	ug/g	26±4	7±1	<1
Cadmium	ug/g	<0.01	0.03±0.02	0.05±0.03
Cesium	ug/g	0.15±0.08	0.08±0.06	0.08±0.06
Chromium	ug/g	<0.5	<0.5	16±9
Cobalt	ug/g	0.03±0.02	0.03±0.02	0.24±0.04
Copper	ug/g	3.1±0.5	5.0±0.5	1.2±0.2
Iron	ug/g	44±7	52±5	320±30
Lead	ug/g	0.02±0.01	0.06±0.02	0.64±0.1
Lithium	ug/g	<0.05	<0.05	0.23±0.1
Manganese	ug/g	2980±300	1470±100	116±10
Mercury	ug/g	0.007±0.006	0.006±0.006	0.024±0.01
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.79±0.2	0.90±0.2	6.9±0.7
Rubidium	ug/g	6.9±0.7	3.8±0.6	3.3±0.5
Selenium	ug/g	0.05±0.05	<0.05	0.07±0.06
Silver	ug/g	<0.01	<0.01	0.01±0.01
Strontium	ug/g	10±1	11±1	4.8±0.7
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	1.0±0.2	1.8±0.3	13±1
Uranium	ug/g	<0.01	<0.01	0.02±0.01
Vanadium	ug/g	<0.1	0.1±0.1	0.9±0.3
Zinc	ug/g	14±2	37±6	15±2
Zirconium	ug/g	<0.05	<0.05	0.67±0.2
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.029±0.004	0.063±0.009	0.28±0.04
Polonium-210	Bq/g	0.013±0.002	0.053±0.005	0.22±0.02
Radium-226	Bq/g	0.0058±0.001	0.0074±0.001	<0.0008
Thorium-228	Bq/g	0.003±0.002	0.0073±0.004	<0.002
Thorium-230	Bq/g	<0.0006	<0.0004	<0.002

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31882 **08/09/2018 REF03-B-BL *VEGETATION***
31883 **08/09/2018 REF03-B-BS *VEGETATION***
31884 **08/09/2018 REF03-B-L *VEGETATION***

Analyte	Units	31882	31883	31884
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0006	<0.0004	<0.002

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

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31885 08/09/2018 REF03-C-BB *VEGETATION*
31886 08/09/2018 REF03-C-BL *VEGETATION*
31887 08/09/2018 REF03-C-BS *VEGETATION*

Analyte	Units	31885	31886	31887
Lab Section 2 (ICP)				
Aluminum	ug/g	11±2	96±10	110±10
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	<0.05
Barium	ug/g	17±2	82±8	64±6
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	6±1	21±3	7±1
Cadmium	ug/g	<0.01	<0.01	0.02±0.02
Cesium	ug/g	0.22±0.1	0.17±0.09	0.12±0.08
Chromium	ug/g	<0.5	<0.5	<0.5
Cobalt	ug/g	<0.01	0.01±0.01	0.02±0.01
Copper	ug/g	3.4±0.5	3.8±0.6	5.0±0.5
Iron	ug/g	11±2	46±7	51±5
Lead	ug/g	0.02±0.01	0.02±0.01	0.05±0.02
Lithium	ug/g	<0.05	<0.05	<0.05
Manganese	ug/g	490±50	3150±300	1580±200
Mercury	ug/g	<0.005	0.008±0.006	0.005±0.005
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.63±0.2	0.87±0.2	0.61±0.2
Rubidium	ug/g	15±2	7.3±0.7	4.4±0.7
Selenium	ug/g	<0.05	0.06±0.06	<0.05
Silver	ug/g	<0.01	<0.01	<0.01
Strontium	ug/g	2.4±0.4	14±1	10±1
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	0.08±0.06	0.10±0.07
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	0.11±0.06	0.80±0.2	2.0±0.3
Uranium	ug/g	<0.01	<0.01	<0.01
Vanadium	ug/g	<0.1	<0.1	0.1±0.1
Zinc	ug/g	7.9±2	14±2	53±5
Zirconium	ug/g	0.06±0.05	<0.05	0.07±0.05
Lab Section 4 (Radiochemistry)				
Lead-210	Bq/g	0.001±0.001	0.027±0.004	0.076±0.01
Polonium-210	Bq/g	0.0012±0.0005	0.016±0.002	0.032±0.003
Radium-226	Bq/g	0.0014±0.0008	0.0051±0.001	0.0076±0.001
Thorium-228	Bq/g	<0.0005	0.002±0.002	0.0062±0.004
Thorium-230	Bq/g	<0.0005	<0.0006	<0.0004

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31885 **08/09/2018 REF03-C-BB *VEGETATION***
31886 **08/09/2018 REF03-C-BL *VEGETATION***
31887 **08/09/2018 REF03-C-BS *VEGETATION***

Analyte	Units	31885	31886	31887
Lab Section 4 (Radiochemistry)				
Thorium-232	Bq/g	<0.0005	<0.0006	<0.0004

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Results are reported on a dry basis.

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Oct 30, 2018

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31888 **08/09/2018 REF03-C-L *VEGETATION***

Analyte	Units	31888
Lab Section 2 (ICP)		
Aluminum	ug/g	570±60
Antimony	ug/g	<0.1
Arsenic	ug/g	0.14±0.08
Barium	ug/g	13±1
Beryllium	ug/g	0.02±0.01
Boron	ug/g	1±1
Cadmium	ug/g	0.05±0.03
Cesium	ug/g	0.18±0.09
Chromium	ug/g	28±10
Cobalt	ug/g	0.32±0.05
Copper	ug/g	1.2±0.2
Iron	ug/g	400±40
Lead	ug/g	0.53±0.08
Lithium	ug/g	0.27±0.1
Manganese	ug/g	156±20
Mercury	ug/g	0.025±0.01
Molybdenum	ug/g	<0.1
Nickel	ug/g	11±1
Rubidium	ug/g	4.5±0.7
Selenium	ug/g	0.08±0.06
Silver	ug/g	0.01±0.01
Strontium	ug/g	5.4±0.5
Tellurium	ug/g	<0.5
Thallium	ug/g	<0.05
Tin	ug/g	<0.05
Titanium	ug/g	15±2
Uranium	ug/g	0.02±0.01
Vanadium	ug/g	0.9±0.3
Zinc	ug/g	21±3
Zirconium	ug/g	0.78±0.2
Lab Section 4 (Radiochemistry)		
Lead-210	Bq/g	0.29±0.04
Polonium-210	Bq/g	0.22±0.02
Radium-226	Bq/g	0.0049±0.001
Thorium-228	Bq/g	0.006±0.004
Thorium-230	Bq/g	<0.0008

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31888 **08/09/2018 REF03-C-L *VEGETATION***

Analyte	Units	31888
Lab Section 4 (Radiochemistry)		
Thorium-232	Bq/g	0.002±0.02

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SRC Group # 2018-15107

Dec 04, 2018

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Andrew Stewart

Date Samples Received: Dec-03-2018 Client P.O.: 1899581/2/2002

All results have been reviewed and approved by a Qualified Person in accordance with the Saskatchewan Environmental Code, Corrective Action Plan Chapter, for the purposes of certifying a laboratory analysis

Results from Lab Sections 1 and 2 have been authorized by Keith Gipman, Supervisor
Results from Lab Section 3 have been authorized by Pat Moser, Supervisor
Results from Lab Sections 4 and 5 have been authorized by Vicky Snook, Supervisor
Results from Lab Section 6 have been authorized by Marion McConnell, Supervisor

* Test methods and data are validated by the laboratory's Quality Assurance Program.

* Routine methods follow recognized procedures from sources such as
    * Standard Methods for the Examination of Water and Wastewater APHA AWWA WEF
    * Environment Canada
    * US EPA
    * CANMET

* The results reported relate only to the test samples as provided by the client.

* Samples will be kept for 30 days after the final report is sent. Please contact the lab if you have any special requirements.

* Additional information is available upon request.

This is a final report.

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SRC Group # 2018-15107

Dec 04, 2018

Golder

1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Andrew Stewart

Date Samples Received: Dec-03-2018

Client P.O.: 1899581/2/2002

50587 **08/04/2018 EXP01-A-BB (PREV. SRC GR 18-9960-31819) *VEGETATION***
50588 **08/04/2018 EXP01-A-BL (PREV. SRC GR 18-9960-31820) *VEGETATION***
50589 **08/04/2018 EXP01-A-BS (PREV. SRC GR 18-9960-31821) *VEGETATION***

Analyte	Units	50587	50588	50589
Lab Section 6 (SPTP)				
Moisture	%	84.06	54.00	38.67

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Dec 04, 2018

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50590 **08/04/2018 EXP01-A-L (PREV. SRC GR 18-9960-31822) *VEGETATION***
50591 **08/03/2018 EXP01-B-BB (PREV. SRC GR 18-9960-31823) *VEGETATION***
50592 **08/04/2018 EXP01-B-BL (PREV. SRC GR 18-9960-31824) *VEGETATION***

Analyte	Units	50590	50591	50592
Lab Section 6 (SPTP)				
Moisture	%	16.72	83.46	55.29

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50593 **08/04/2018 EXP01-B-BS (PREV. SRC GR 18-9960-31825) *VEGETATION***
50594 **08/03/2018 EXP01-B-L (PREV. SRC GR 18-9960-31826) *VEGETATION***
50595 **08/03/2018 EXP01-C-BB (PREV. SRC GR 18-9960-31827) *VEGETATION***

Analyte	Units	50593	50594	50595
Lab Section 6 (SPTP)				
Moisture	%	39.82	6.96	99.11

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50596	**08/03/2018 EXP01-C-BL (PREV. SRC GR 18-9960-31828) *VEGETATION***
50597	**08/03/2018 EXP01-C-BS (PREV. SRC GR 18-9960-31829) *VEGETATION***
50598	**08/03/2018 EXP01-C-L (PREV. SRC GR 18-9960-31830) *VEGETATION***

Analyte	Units	50596	50597	50598
Lab Section 6 (SPTP)				
Moisture	%	56.98	32.11	6.58

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Dec 04, 2018

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50599 **08/04/2018 EXP02-A-BB (PREV. SRC GR 18-9960-31831) *VEGETATION***
50600 **08/06/2018 EXP02-A-BL (PREV. SRC GR 18-9960-31832) *VEGETATION***
50601 **08/06/2018 EXP02-A-BS (PREV. SRC GR 18-9960-31833) *VEGETATION***

Analyte	Units	50599	50600	50601
Lab Section 6 (SPTP)				
Moisture	%	83.11	53.16	38.81

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50602 **08/06/2018 EXP02-A-L (PREV. SRC GR 18-9960-31834) *VEGETATION***
50603 **08/04/2018 EXP02-B-BB (PREV. SRC GR 18-9960-31835) *VEGETATION***
50604 **08/06/2018 EXP02-B-BL (PREV. SRC GR 18-9960-31836) *VEGETATION***

Analyte	Units	50602	50603	50604
Lab Section 6 (SPTP)				
Moisture	%	36.87	82.39	59.94

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Dec 04, 2018

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50605 **08/06/2018 EXP02-B-BS (PREV. SRC GR 18-9960-31837) *VEGETATION***
50606 **08/06/2018 EXP02-B-L (PREV. SRC GR 18-9960-31838) *VEGETATION***
50607 **08/06/2018 EXP02-C-BB (PREV. SRC GR 18-9960-31839) *VEGETATION***

Analyte	Units	50605	50606	50607
Lab Section 6 (SPTP)				
Moisture	%	44.35	43.65	83.13

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Golder

50608 **08/06/2018 EXP02-C-BL (PREV. SRC GR 18-9960-31840) *VEGETATION***
50609 **08/06/2018 EXP02-C-BS (PREV. SRC GR 18-9960-31841) *VEGETATION***
50610 **08/06/2018 EXP02-C-L (PREV. SRC GR 18-9960-31842) *VEGETATION***

Analyte	Units	50608	50609	50610
Lab Section 6 (SPTP)				
Moisture	%	52.96	39.46	38.83

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SRC Group # 2018-15107

Dec 04, 2018

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50611 **08/07/2018 EXP03-A-BB (PREV. SRC GR 18-9960-31843) *VEGETATION***
50612 **08/07/2018 EXP03-A-BL (PREV. SRC GR 18-9960-31844) *VEGETATION***
50613 **08/07/2018 EXP03-A-BS (PREV. SRC GR 18-9960-31845) *VEGETATION***

Analyte	Units	50611	50612	50613
Lab Section 6 (SPTP)				
Moisture	%	83.54	56.17	45.62

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50614 **08/07/2018 EXP03-A-L (PREV. SRC GR 18-9960-31846) *VEGETATION***
50615 **08/07/2018 EXP03-B-BB (PREV. SRC GR 18-9960-31847) *VEGETATION***
50616 **08/07/2018 EXP03-B-BL (PREV. SRC GR 18-9960-31848) *VEGETATION***

Analyte	Units	50614	50615	50616
Lab Section 6 (SPTP)				
Moisture	%	48.89	83.13	51.01

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50617 **08/07/2018 EXP03-B-BS (PREV. SRC GR 18-9960-31849) *VEGETATION***
50618 **08/07/2018 EXP03-B-L (PREV. SRC GR 18-9960-31850) *VEGETATION***
50619 **08/07/2018 EXP03-C-BB (PREV. SRC GR 18-9960-31851) *VEGETATION***

Analyte	Units	50617	50618	50619
Lab Section 6 (SPTP)				
Moisture	%	39.50	43.45	84.13

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50620 **08/07/2018 EXP03-C-BL (PREV. SRC GR 18-9960-31852) *VEGETATION***
50621 **08/07/2018 EXP03-C-BS (PREV. SRC GR 18-9960-31853) *VEGETATION***
50622 **08/07/2018 EXP03-C-L (PREV. SRC GR 18-9960-31854) *VEGETATION***

Analyte	Units	50620	50621	50622
Lab Section 6 (SPTP)				
Moisture	%	59.69	46.94	55.49

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50623 **08/05/2018 REF01-A-BL (PREV. SRC GR 18-9960-31855) *VEGETATION***
50624 **08/05/2018 REF01-A-BS (PREV. SRC GR 18-9960-31856) *VEGETATION***
50625 **08/05/2018 REF01-A-L (PREV. SRC GR 18-9960-31857) *VEGETATION***

Analyte	Units	50623	50624	50625
Lab Section 6 (SPTP)				
Moisture	%	57.00	59.94	8.89

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50626 **08/05/2018 REF01-B-BL (PREV. SRC GR 18-9960-31858) *VEGETATION***
50627 **08/05/2018 REF01-B-BS (PREV. SRC GR 18-9960-31859) *VEGETATION***
50628 **08/05/2018 REF01-B-L (PREV. SRC GR 18-9960-31860) *VEGETATION***

Analyte	Units	50626	50627	50628
Lab Section 6 (SPTP)				
Moisture	%	48.70	60.42	7.81

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50629 **08/05/2018 REF01-C-BB (PREV. SRC GR 18-9960-31861) *VEGETATION***
50630 **08/05/2018 REF01-C-BL (PREV. SRC GR 18-9960-31862) *VEGETATION***
50631 **08/05/2018 REF01-C-BS (PREV. SRC GR 18-9960-31863) *VEGETATION***

Analyte	Units	50629	50630	50631
Lab Section 6 (SPTP)				
Moisture	%	82.68	57.21	44.68

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50632 **08/05/2018 REF01-C-L (PREV. SRC GR 18-9960-31864) *VEGETATION***
50633 **08/08/2018 REF02-A-BB (PREV. SRC GR 18-9960-31865) *VEGETATION***
50634 **08/08/2018 REF02-A-BL (PREV. SRC GR 18-9960-31866) *VEGETATION***

Analyte	Units	50632	50633	50634
Lab Section 6 (SPTP)				
Moisture	%	7.61	84.49	59.15

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50635 **08/08/2018 REF02-A-BS (PREV. SRC GR 18-9960-31867) *VEGETATION***
50636 **08/08/2018 REF02-A-L (PREV. SRC GR 18-9960-31868) *VEGETATION***
50637 **08/08/2018 REF02-B-BB (PREV. SRC GR 18-9960-31869) *VEGETATION***

Analyte	Units	50635	50636	50637
Lab Section 6 (SPTP)				
Moisture	%	46.12	57.34	84.35

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50638 **08/08/2018 REF02-B-BL (PREV. SRC GR 18-9960-31870) *VEGETATION***
50639 **08/08/2018 REF02-B-BS (PREV. SRC GR 18-9960-31871) *VEGETATION***
50640 **08/08/2018 REF02-B-L (PREV. SRC GR 18-9960-31872) *VEGETATION***

Analyte	Units	50638	50639	50640
Lab Section 6 (SPTP)				
Moisture	%	48.43	33.39	53.14

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50641 **08/08/2018 REF02-C-BB (PREV. SRC GR 18-9960-31873) *VEGETATION***
50642 **08/08/2018 REF02-C-BL (PREV. SRC GR 18-9960-31874) *VEGETATION***
50643 **08/08/2018 REF02-C-BS (PREV. SRC GR 18-9960-31875) *VEGETATION***

Analyte	Units	50641	50642	50643
Lab Section 6 (SPTP)				
Moisture	%	83.54	48.72	35.22

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50644	**08/08/2018 REF02-C-L (PREV. SRC GR 18-9960-31876) *VEGETATION***
50645	**08/09/2018 REF03-A-BB (PREV. SRC GR 18-9960-31877) *VEGETATION***
50646	**08/09/2018 REF03-A-BL (PREV. SRC GR 18-9960-31878) *VEGETATION***

Analyte	Units	50644	50645	50646
Lab Section 6 (SPTP)				
Moisture	%	34.17	83.24	51.53

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50647 **08/09/2018 REF03-A-BS (PREV. SRC GR 18-9960-31879) *VEGETATION***
50648 **08/09/2018 REF03-A-L (PREV. SRC GR 18-9960-31880) *VEGETATION***
50649 **08/09/2018 REF03-B-BB (PREV. SRC GR 18-9960-31881) *VEGETATION***

Analyte	Units	50647	50648	50649
Lab Section 6 (SPTP)				
Moisture	%	37.11	33.94	83.16

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50650 **08/09/2018 REF03-B-BL (PREV. SRC GR 18-9960-31882) *VEGETATION***
50651 **08/09/2018 REF03-B-BS (PREV. SRC GR 18-9960-31883) *VEGETATION***
50652 **08/09/2018 REF03-B-L (PREV. SRC GR 18-9960-31884) *VEGETATION***

Analyte	Units	50650	50651	50652
Lab Section 6 (SPTP)				
Moisture	%	50.23	31.07	25.93

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50653 **08/09/2018 REF03-C-BB (PREV. SRC GR 18-9960-31885) *VEGETATION***
50654 **08/09/2018 REF03-C-BL (PREV. SRC GR 18-9960-31886) *VEGETATION***
50655 **08/09/2018 REF03-C-BS (PREV. SRC GR 18-9960-31887) *VEGETATION***

Analyte	Units	50653	50654	50655
Lab Section 6 (SPTP)				
Moisture	%	82.92	51.16	35.49

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50656 **08/09/2018 REF03-C-L (PREV. SRC GR 18-9960-31888) *VEGETATION***

Analyte	Units	50656
Lab Section 6 (SPTP)		
Moisture	%	12.01

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SRC Group # 2019-11321

Oct 16, 2019

Golder
1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

Date Samples Received: Aug-12-2019 Client P.O.:

All results have been reviewed and approved by a Qualified Person in accordance with the Saskatchewan Environmental Code, Corrective Action Plan Chapter, for the purposes of certifying a laboratory analysis

Results from Lab Section 2 authorized by Keith Gipman, Supervisor
Results from Lab Section 4 authorized by Vicky Snook, Supervisor
Results from Lab Section 6 authorized by Marion McConnell, Supervisor

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* Test methods and data are validated by the laboratory's Quality Assurance Program.

* Routine methods follow recognized procedures from sources such as
  * Standard Methods for the Examination of Water and Wastewater APHA AWWA WEF
  * Environment Canada
  * US EPA
  * CANMET

* The results reported relate only to the test samples as provided by the client.

* Samples will be kept for 30 days after the final report is sent. Please contact the lab if you have any special requirements.

* Additional information is available upon request.

* Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

This is a final report.

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SRC Group # 2019-11321

Oct 16, 2019

Golder

1721 8th Street East
Saskatoon, SK S7H 0T4
Attn: Kyle Hodgson

Date Samples Received: Aug-12-2019

Client P.O.:

45070 **08/08/2019 19-REF04-A-LI *VEGETATION***
45071 **08/11/2019 19-REF04-B-LI *VEGETATION***
45072 **08/11/2019 19-REF04-C-LI *VEGETATION***

Analyte	Units	45070	45071	45072
Lab Section 2				
Aluminum	ug/g	310±30	270±30	290±30
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	0.06±0.06	<0.05	0.08±0.06
Barium	ug/g	7.0±0.7	11±1	6.0±0.6
Beryllium	ug/g	0.01±0.01	<0.01	<0.01
Boron	ug/g	1±1	<1	1±1
Cadmium	ug/g	0.05±0.03	0.06±0.03	0.05±0.03
Cesium	ug/g	0.10±0.07	0.13±0.08	0.06±0.06
Chromium	ug/g	1.1±0.7	1.2±0.8	1.4±0.8
Cobalt	ug/g	0.08±0.02	0.07±0.02	0.08±0.02
Copper	ug/g	1.0±0.2	0.86±0.2	1.1±0.2
Iron	ug/g	180±20	150±20	150±20
Lead	ug/g	0.20±0.03	0.29±0.04	0.18±0.04
Lithium	ug/g	0.16±0.09	0.12±0.08	0.14±0.08
Manganese	ug/g	147±10	132±10	120±10
Mercury	ug/g	0.025±0.01	0.021±0.01	0.026±0.01
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.65±0.2	0.62±0.2	0.82±0.2
Rubidium	ug/g	5.4±0.5	5.1±0.5	6.4±0.6
Selenium	ug/g	0.06±0.06	0.06±0.06	0.07±0.06
Silver	ug/g	<0.01	0.01±0.01	<0.01
Strontium	ug/g	3.5±0.5	3.4±0.5	3.7±0.6
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	7.0±0.7	5.8±0.6	6.6±0.7
Uranium	ug/g	<0.01	<0.01	<0.01
Vanadium	ug/g	0.5±0.2	0.4±0.2	0.5±0.2
Zinc	ug/g	16±2	18±3	17±2
Zirconium	ug/g	0.17±0.05	0.14±0.05	0.16±0.05

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45070 **08/08/2019 19-REF04-A-LI *VEGETATION***
45071 **08/11/2019 19-REF04-B-LI *VEGETATION***
45072 **08/11/2019 19-REF04-C-LI *VEGETATION***

Analyte	Units	45070	45071	45072
Lab Section 4				
Lead-210	Bq/g	0.27±0.04	0.32±0.05	0.23±0.03
Polonium-210	Bq/g	0.20±0.02	0.28±0.03	0.22±0.02
Radium-226	Bq/g	0.0009±0.0005	0.0006±0.0004	0.0004±0.0003
Thorium-230	Bq/g	<0.0003	<0.0003	<0.0003
Lab Section 6				
Moisture	%	25.13±2	36.16±4	20.23±2

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

Note for Sample # 45070
This sample was reanalyzed for Polonium-210 and Lead-210. Reanalysis confirms original results are within the expected measurement uncertainty.

The temperature of the cooler was 14.9 °C upon receipt.

Results are reported on a dry basis.

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45073 **08/08/2019 19-REF04-A-BL *VEGETATION***
45074 **08/11/2019 19-REF04-B-BL *VEGETATION***
45075 **08/11/2019 19-REF04-C-BL *VEGETATION***

Analyte	Units	45073	45074	45075
Lab Section 2				
Aluminum	ug/g	81±8	76±8	82±8
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	<0.05
Barium	ug/g	53±5	57±6	61±6
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	14±4	20±3	20±3
Cadmium	ug/g	<0.01	<0.01	<0.01
Cesium	ug/g	0.08±0.06	<0.05	0.07±0.06
Chromium	ug/g	<0.5	<0.5	<0.5
Cobalt	ug/g	0.03±0.02	0.03±0.02	0.02±0.01
Copper	ug/g	3.5±0.5	3.4±0.5	4.2±0.6
Iron	ug/g	39±6	31±5	38±6
Lead	ug/g	0.01±0.01	<0.01	<0.01
Lithium	ug/g	<0.05	<0.05	<0.05
Manganese	ug/g	2930±300	3100±300	3700±400
Mercury	ug/g	0.006±0.006	0.005±0.005	0.006±0.006
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.79±0.2	0.84±0.2	0.60±0.2
Rubidium	ug/g	9.7±1	5.0±0.5	14±2
Selenium	ug/g	<0.05	0.08±0.06	<0.05
Silver	ug/g	<0.01	<0.01	<0.01
Strontium	ug/g	7.1±0.7	6.7±0.7	4.0±0.6
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	0.60±0.2	0.42±0.1	0.42±0.1
Uranium	ug/g	<0.01	<0.01	<0.01
Vanadium	ug/g	<0.1	<0.1	<0.1
Zinc	ug/g	9.1±2	12±2	12±2
Zirconium	ug/g	<0.05	<0.05	<0.05
Lab Section 4				
Lead-210	Bq/g	0.028±0.004	0.034±0.005	0.027±0.004
Polonium-210	Bq/g	0.012±0.002	0.010±0.002	0.011±0.002
Radium-226	Bq/g	0.0020±0.001	0.0031±0.0008	0.0031±0.0008
Thorium-230	Bq/g	<0.0006	<0.0005	<0.0006

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45073 **08/08/2019 19-REF04-A-BL *VEGETATION***
45074 **08/11/2019 19-REF04-B-BL *VEGETATION***
45075 **08/11/2019 19-REF04-C-BL *VEGETATION***

Analyte	Units	45073	45074	45075
Lab Section 6				
Moisture	%	53.98±5	47.58±5	52.44±5

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 14.9 °C upon receipt.

Results are reported on a dry basis.

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45076 **08/08/2019 19-REF04-A-BS *VEGETATION***
45077 **08/11/2019 19-REF04-B-BS *VEGETATION***
45078 **08/11/2019 19-REF04-C-BS *VEGETATION***

Analyte	Units	45076	45077	45078
Lab Section 2				
Aluminum	ug/g	180±20	120±10	120±10
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	<0.05
Barium	ug/g	82±8	75±8	80±8
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	8±1	8±1	9±1
Cadmium	ug/g	0.02±0.02	0.02±0.02	0.03±0.02
Cesium	ug/g	0.07±0.06	<0.05	<0.05
Chromium	ug/g	0.9±0.7	<0.5	0.9±0.7
Cobalt	ug/g	0.07±0.02	0.04±0.02	0.04±0.02
Copper	ug/g	4.6±0.7	4.1±0.6	5.4±0.5
Iron	ug/g	110±10	60±6	72±7
Lead	ug/g	0.11±0.03	0.06±0.02	0.08±0.03
Lithium	ug/g	0.11±0.07	0.06±0.06	0.06±0.06
Manganese	ug/g	1620±200	1840±200	2100±200
Mercury	ug/g	0.013±0.008	0.008±0.006	0.008±0.006
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	1.0±0.2	0.81±0.2	0.79±0.2
Rubidium	ug/g	5.8±0.6	3.5±0.5	9.4±0.9
Selenium	ug/g	<0.05	0.06±0.06	<0.05
Silver	ug/g	<0.01	<0.01	<0.01
Strontium	ug/g	7.9±0.8	10±1	4.8±0.7
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	3.2±0.5	1.4±0.2	2.0±0.3
Uranium	ug/g	<0.01	<0.01	<0.01
Vanadium	ug/g	0.3±0.2	0.1±0.1	0.2±0.1
Zinc	ug/g	30±4	32±5	37±6
Zirconium	ug/g	0.09±0.05	<0.05	0.07±0.05
Lab Section 4				
Lead-210	Bq/g	0.15±0.02	0.13±0.01	0.11±0.01
Polonium-210	Bq/g	0.089±0.009	0.084±0.008	0.093±0.009
Radium-226	Bq/g	0.0041±0.0006	0.0054±0.0008	0.0047±0.0007
Thorium-230	Bq/g	<0.0004	<0.0004	<0.0004

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45076 **08/08/2019 19-REF04-A-BS *VEGETATION***
45077 **08/11/2019 19-REF04-B-BS *VEGETATION***
45078 **08/11/2019 19-REF04-C-BS *VEGETATION***

Analyte	Units	45076	45077	45078
Lab Section 6				
Moisture	%	39.23±4	31.83±3	37.73±4

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The temperature of the cooler was 14.9 °C upon receipt.

Results are reported on a dry basis.

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45079 **08/09/2019 19-REF05-A-LI *VEGETATION***
45080 **08/09/2019 19-REF05-B-LI *VEGETATION***
45081 **08/09/2019 19-REF05-C-LI *VEGETATION***

Analyte	Units	45079	45080	45081
Lab Section 2				
Aluminum	ug/g	240±20	260±30	260±30
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	0.05±0.05	<0.05
Barium	ug/g	7.6±0.8	7.2±0.7	9.1±0.9
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	<1	<1	<1
Cadmium	ug/g	0.03±0.02	0.03±0.02	0.03±0.02
Cesium	ug/g	0.13±0.08	0.07±0.06	0.08±0.06
Chromium	ug/g	1.0±0.7	0.8±0.6	0.9±0.7
Cobalt	ug/g	0.07±0.02	0.09±0.02	0.06±0.02
Copper	ug/g	0.88±0.2	0.95±0.2	0.93±0.2
Iron	ug/g	140±10	270±30	150±20
Lead	ug/g	0.16±0.04	0.24±0.04	0.17±0.04
Lithium	ug/g	0.12±0.08	0.13±0.08	0.13±0.08
Manganese	ug/g	94±9	94±9	103±10
Mercury	ug/g	0.017±0.009	0.021±0.01	0.017±0.009
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.55±0.1	0.48±0.2	0.49±0.2
Rubidium	ug/g	6.3±0.6	5.7±0.6	5.6±0.6
Selenium	ug/g	<0.05	<0.05	<0.05
Silver	ug/g	<0.01	0.01±0.01	<0.01
Strontium	ug/g	3.6±0.5	4.5±0.7	3.0±0.4
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	6.2±0.6	6.7±0.7	6.6±0.7
Uranium	ug/g	<0.01	<0.01	<0.01
Vanadium	ug/g	0.4±0.2	0.5±0.2	0.4±0.2
Zinc	ug/g	9.6±2	11±2	9.7±2
Zirconium	ug/g	0.14±0.05	0.13±0.05	0.15±0.05
Lab Section 4				
Lead-210	Bq/g	0.22±0.03	0.31±0.05	0.20±0.03
Polonium-210	Bq/g	0.19±0.03	0.26±0.03	0.26±0.03
Radium-226	Bq/g	0.0012±0.0008	0.0009±0.0006	0.0006±0.0004
Thorium-230	Bq/g	<0.0006	0.0009±0.0006	<0.0003

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SRC Group # 2019-11321

Oct 16, 2019

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45079 **08/09/2019 19-REF05-A-LI *VEGETATION***
45080 **08/09/2019 19-REF05-B-LI *VEGETATION***
45081 **08/09/2019 19-REF05-C-LI *VEGETATION***

Analyte	Units	45079	45080	45081
Lab Section 6				
Moisture	%	66.99±7	67.73±7	64.12±6

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 14.9 °C upon receipt.

Results are reported on a dry basis.

SRC Group # 2019-11321

Oct 16, 2019

Golder

45082 **08/09/2019 19-REF05-A-BL *VEGETATION***
45083 **08/09/2019 19-REF05-B-BL *VEGETATION***
45084 **08/09/2019 19-REF05-C-BL *VEGETATION***

Analyte	Units	45082	45083	45084
Lab Section 2				
Aluminum	ug/g	73±7	64±6	59±6
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	<0.05
Barium	ug/g	61±6	53±5	58±6
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	10±2	10±2	8±1
Cadmium	ug/g	<0.01	<0.01	<0.01
Cesium	ug/g	0.08±0.06	0.06±0.06	0.06±0.06
Chromium	ug/g	<0.5	<0.5	<0.5
Cobalt	ug/g	0.03±0.02	0.04±0.02	0.04±0.02
Copper	ug/g	4.0±0.6	4.1±0.6	4.2±0.6
Iron	ug/g	41±6	42±6	36±5
Lead	ug/g	0.01±0.01	0.01±0.01	<0.01
Lithium	ug/g	<0.05	<0.05	<0.05
Manganese	ug/g	2300±200	1830±200	1760±200
Mercury	ug/g	0.006±0.006	0.007±0.006	0.007±0.006
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.90±0.2	0.80±0.2	0.90±0.2
Rubidium	ug/g	12±2	11±2	11±2
Selenium	ug/g	<0.05	<0.05	<0.05
Silver	ug/g	<0.01	<0.01	<0.01
Strontium	ug/g	7.3±0.7	6.3±0.6	8.3±0.8
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	0.64±0.2	0.64±0.2	0.42±0.1
Uranium	ug/g	<0.01	<0.01	<0.01
Vanadium	ug/g	<0.1	<0.1	<0.1
Zinc	ug/g	9.5±2	7.5±2	8.1±2
Zirconium	ug/g	<0.05	<0.05	<0.05
Lab Section 4				
Lead-210	Bq/g	0.034±0.005	0.041±0.006	0.037±0.006
Polonium-210	Bq/g	0.015±0.002	0.014±0.002	0.013±0.002
Radium-226	Bq/g	0.0015±0.001	0.0016±0.001	0.0015±0.0009
Thorium-230	Bq/g	<0.0005	<0.0005	0.0009±0.0007

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45082 **08/09/2019 19-REF05-A-BL *VEGETATION***
45083 **08/09/2019 19-REF05-B-BL *VEGETATION***
45084 **08/09/2019 19-REF05-C-BL *VEGETATION***

Analyte	Units	45082	45083	45084
Lab Section 6				
Moisture	%	62.44±6	58.88±6	54.40±5

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45085 **08/09/2019 19-REF05-A-BS *VEGETATION***
45086 **08/09/2019 19-REF05-B-BS *VEGETATION***
45087 **08/09/2019 19-REF05-C-BS *VEGETATION***

Analyte	Units	45085	45086	45087
Lab Section 2				
Aluminum	ug/g	100±10	120±10	110±10
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	<0.05
Barium	ug/g	73±7	62±6	76±8
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	7±1	6±1	6±1
Cadmium	ug/g	0.02±0.02	0.01±0.01	0.01±0.01
Cesium	ug/g	<0.05	<0.05	<0.05
Chromium	ug/g	<0.5	<0.5	0.6±0.6
Cobalt	ug/g	0.08±0.02	0.07±0.02	0.07±0.02
Copper	ug/g	5.7±0.6	5.6±0.6	5.5±0.6
Iron	ug/g	68±7	72±7	66±7
Lead	ug/g	0.06±0.02	0.07±0.02	0.06±0.02
Lithium	ug/g	0.07±0.06	0.08±0.06	0.09±0.07
Manganese	ug/g	1440±100	1240±100	1050±100
Mercury	ug/g	0.008±0.006	0.009±0.007	0.007±0.006
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.95±0.2	0.77±0.2	0.78±0.2
Rubidium	ug/g	6.5±0.6	6.0±0.6	6.7±0.7
Selenium	ug/g	<0.05	<0.05	<0.05
Silver	ug/g	<0.01	<0.01	<0.01
Strontium	ug/g	8.6±0.9	8.2±0.8	11±1
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	1.8±0.3	1.9±0.3	2.0±0.3
Uranium	ug/g	<0.01	<0.01	<0.01
Vanadium	ug/g	0.2±0.1	0.2±0.1	0.2±0.1
Zinc	ug/g	25±4	19±3	16±2
Zirconium	ug/g	<0.05	0.05±0.05	0.05±0.05
Lab Section 4				
Lead-210	Bq/g	0.12±0.01	0.12±0.01	0.10±0.01
Polonium-210	Bq/g	0.071±0.007	0.093±0.009	0.075±0.008
Radium-226	Bq/g	0.0044±0.0007	0.0032±0.0008	0.0037±0.0009
Thorium-230	Bq/g	<0.0004	<0.0004	<0.0004

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45085	**08/09/2019 19-REF05-A-BS**	***VEGETATION***
45086	**08/09/2019 19-REF05-B-BS**	***VEGETATION***
45087	**08/09/2019 19-REF05-C-BS**	***VEGETATION***

Analyte	Units	45085	45086	45087
Lab Section 6				
Moisture	%	45.42±4	44.08±4	41.84±4

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SRC Group # 2019-11321

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45088 **08/10/2019 19-REF06-A-LI *VEGETATION***
45089 **08/10/2019 19-REF06-B-LI *VEGETATION***
45090 **08/10/2019 19-REF06-C-LI *VEGETATION***

Analyte	Units	45088	45089	45090
Lab Section 2				
Aluminum	ug/g	230±20	260±30	320±30
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	0.05±0.05	0.06±0.06
Barium	ug/g	5.6±0.6	5.8±0.6	8.1±0.8
Beryllium	ug/g	<0.01	<0.01	0.01±0.01
Boron	ug/g	<1	<1	<1
Cadmium	ug/g	0.04±0.02	0.05±0.03	0.05±0.03
Cesium	ug/g	0.10±0.07	0.10±0.07	0.10±0.07
Chromium	ug/g	0.9±0.7	1.3±0.8	1.2±0.8
Cobalt	ug/g	0.06±0.02	0.06±0.02	0.09±0.02
Copper	ug/g	0.76±0.2	0.84±0.2	1.0±0.2
Iron	ug/g	150±20	150±20	180±20
Lead	ug/g	0.21±0.03	0.19±0.05	0.29±0.04
Lithium	ug/g	0.13±0.08	0.13±0.08	0.14±0.08
Manganese	ug/g	84±8	121±10	100±10
Mercury	ug/g	0.016±0.009	0.020±0.01	0.021±0.01
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.46±0.2	0.64±0.2	0.70±0.2
Rubidium	ug/g	4.8±0.7	4.9±0.7	5.1±0.5
Selenium	ug/g	0.05±0.05	0.06±0.06	0.06±0.06
Silver	ug/g	0.01±0.01	<0.01	<0.01
Strontium	ug/g	2.0±0.3	2.4±0.4	3.4±0.5
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	5.9±0.6	5.9±0.6	6.9±0.7
Uranium	ug/g	<0.01	<0.01	<0.01
Vanadium	ug/g	0.4±0.2	0.5±0.2	0.5±0.2
Zinc	ug/g	14±2	16±2	15±2
Zirconium	ug/g	0.14±0.05	0.15±0.05	0.18±0.05
Lab Section 4				
Lead-210	Bq/g	0.36±0.05	0.26±0.04	0.37±0.06
Polonium-210	Bq/g	0.31±0.03	0.26±0.03	0.31±0.03
Radium-226	Bq/g	0.0005±0.0003	0.0004±0.0003	0.0005±0.0004
Thorium-230	Bq/g	<0.0003	<0.0002	0.0007±0.0005

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45088 **08/10/2019 19-REF06-A-LI *VEGETATION***
45089 **08/10/2019 19-REF06-B-LI *VEGETATION***
45090 **08/10/2019 19-REF06-C-LI *VEGETATION***

Analyte	Units	45088	45089	45090
Lab Section 6				
Moisture	%	54.04±5	34.56±3	35.68±4

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Results are reported on a dry basis.

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45091 **08/10/2019 19-REF06-A-BL *VEGETATION***
45092 **08/10/2019 19-REF06-B-BL *VEGETATION***
45093 **08/10/2019 19-REF06-C-BL *VEGETATION***

Analyte	Units	45091	45092	45093
Lab Section 2				
Aluminum	ug/g	71±7	75±8	62±6
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	<0.05
Barium	ug/g	53±5	59±6	51±5
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	16±4	17±4	14±4
Cadmium	ug/g	<0.01	<0.01	<0.01
Cesium	ug/g	0.11±0.07	0.13±0.08	0.21±0.1
Chromium	ug/g	<0.5	<0.5	<0.5
Cobalt	ug/g	0.03±0.02	0.03±0.02	0.02±0.01
Copper	ug/g	3.3±0.5	3.5±0.5	5.0±0.5
Iron	ug/g	37±6	33±5	36±5
Lead	ug/g	<0.01	<0.01	<0.01
Lithium	ug/g	<0.05	<0.05	<0.05
Manganese	ug/g	3510±400	3460±300	2040±200
Mercury	ug/g	0.007±0.006	0.006±0.006	0.006±0.006
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.67±0.2	0.76±0.2	1.2±0.2
Rubidium	ug/g	8.3±0.8	8.8±0.9	14±2
Selenium	ug/g	<0.05	<0.05	<0.05
Silver	ug/g	<0.01	<0.01	<0.01
Strontium	ug/g	4.2±0.6	3.8±0.6	6.7±0.7
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	0.47±0.1	0.44±0.1	0.43±0.1
Uranium	ug/g	<0.01	<0.01	<0.01
Vanadium	ug/g	<0.1	<0.1	<0.1
Zinc	ug/g	11±2	12±2	12±2
Zirconium	ug/g	<0.05	<0.05	<0.05
Lab Section 4				
Lead-210	Bq/g	0.022±0.003	0.030±0.004	0.029±0.004
Polonium-210	Bq/g	0.010±0.002	0.012±0.002	0.011±0.002
Radium-226	Bq/g	0.0034±0.0008	0.0043±0.001	0.0016±0.001
Thorium-230	Bq/g	<0.0005	<0.0006	<0.0005

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45091 **08/10/2019 19-REF06-A-BL *VEGETATION***
45092 **08/10/2019 19-REF06-B-BL *VEGETATION***
45093 **08/10/2019 19-REF06-C-BL *VEGETATION***

Analyte	Units	45091	45092	45093
Lab Section 6				
Moisture	%	56.50±6	51.55±5	53.69±5

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The temperature of the cooler was 14.9 °C upon receipt.

Results are reported on a dry basis.

SRC Group # 2019-11321

Oct 16, 2019

Golder

45094 **08/10/2019 19-REF06-A-BS *VEGETATION***
45095 **08/10/2019 19-REF06-B-BS *VEGETATION***
45096 **08/10/2019 19-REF06-C-BS *VEGETATION***

Analyte	Units	45094	45095	45096
Lab Section 2				
Aluminum	ug/g	140±10	88±9	90±9
Antimony	ug/g	<0.1	<0.1	<0.1
Arsenic	ug/g	<0.05	<0.05	<0.05
Barium	ug/g	71±7	60±6	56±6
Beryllium	ug/g	<0.01	<0.01	<0.01
Boron	ug/g	9±1	7±1	7±1
Cadmium	ug/g	0.02±0.02	0.02±0.02	<0.01
Cesium	ug/g	0.06±0.06	0.06±0.06	0.15±0.08
Chromium	ug/g	0.6±0.6	<0.5	<0.5
Cobalt	ug/g	0.04±0.02	0.03±0.02	0.04±0.02
Copper	ug/g	4.6±0.7	4.1±0.6	6.9±0.7
Iron	ug/g	76±8	46±7	50±5
Lead	ug/g	0.07±0.02	0.03±0.02	0.04±0.02
Lithium	ug/g	0.07±0.06	<0.05	<0.05
Manganese	ug/g	2010±200	1420±100	1190±100
Mercury	ug/g	0.009±0.007	0.006±0.006	0.007±0.006
Molybdenum	ug/g	<0.1	<0.1	<0.1
Nickel	ug/g	0.83±0.2	0.69±0.2	1.1±0.2
Rubidium	ug/g	4.5±0.7	4.9±0.7	11±2
Selenium	ug/g	<0.05	<0.05	<0.05
Silver	ug/g	<0.01	<0.01	<0.01
Strontium	ug/g	5.6±0.6	5.6±0.6	7.9±0.8
Tellurium	ug/g	<0.5	<0.5	<0.5
Thallium	ug/g	<0.05	<0.05	<0.05
Tin	ug/g	<0.05	<0.05	<0.05
Titanium	ug/g	2.3±0.3	1.3±0.2	1.3±0.2
Uranium	ug/g	<0.01	<0.01	<0.01
Vanadium	ug/g	0.2±0.1	0.1±0.1	0.1±0.1
Zinc	ug/g	40±6	32±5	31±5
Zirconium	ug/g	0.06±0.05	<0.05	<0.05
Lab Section 4				
Lead-210	Bq/g	0.030±0.004	0.097±0.01	0.10±0.01
Polonium-210	Bq/g	0.0095±0.001	0.059±0.006	0.050±0.005
Radium-226	Bq/g	0.0045±0.0007	0.0060±0.0009	0.0034±0.0008
Thorium-230	Bq/g	0.0005±0.0004	<0.0005	<0.0004

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45094 **08/10/2019 19-REF06-A-BS *VEGETATION***
45095 **08/10/2019 19-REF06-B-BS *VEGETATION***
45096 **08/10/2019 19-REF06-C-BS *VEGETATION***

Analyte	Units	45094	45095	45096
Lab Section 6				
Moisture	%	40.31±4	38.53±4	39.30±4

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 14.9 °C upon receipt.

Results are reported on a dry basis.

APPENDIX C

Quality Control Report

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Oct 30, 2018

This report was generated for samples included in SRC Group # 2018-9960

Quality Control Report

Andrew Stewart
Golder
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Reference Materials and Standards:

A reference material of known concentration is used whenever possible as either a control sample or control standard and analyzed with each batch of samples. These "QC" results are used to assess the performance of the method and must be within clearly defined limits; otherwise corrective action is required.

QC Analysis	Units	Target Value	Obtained Value	
Aluminum	ug/g	231	147	*(1)
Aluminum	ug/g	231	213	
Aluminum	ug/g	231	222	
Antimony	ug/g	0.0200	0.0150	
Antimony	ug/g	0.0200	0.0206	
Antimony	ug/g	0.0200	0.0224	
Arsenic	ug/g	0.170	0.128	
Arsenic	ug/g	0.170	0.159	
Arsenic	ug/g	0.170	0.178	
Barium	ug/g	115	80.4	
Barium	ug/g	115	112	
Barium	ug/g	115	111	
Boron	ug/g	26.3	21.3	
Boron	ug/g	26.3	26.3	
Boron	ug/g	26.3	25.0	
Cadmium	ug/g	0.0260	0.0194	
Cadmium	ug/g	0.0260	0.0282	
Cadmium	ug/g	0.0260	0.0264	
Chromium	ug/g	0.780	0.445	*(2)
Chromium	ug/g	0.780	0.688	
Chromium	ug/g	0.780	0.701	
Cobalt	ug/g	0.0960	0.134	*(3)
Cobalt	ug/g	0.0960	0.0820	
Cobalt	ug/g	0.0960	0.0707	
Copper	ug/g	3.70	2.29	*(4)
Copper	ug/g	3.70	3.31	
Copper	ug/g	3.70	6.02	*(5)
Iron	ug/g	196	130	
Iron	ug/g	196	194	
Iron	ug/g	196	189	
Lead	ug/g	0.810	0.561	
Lead	ug/g	0.810	0.781	

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QC Analysis	Units	Target Value	Obtained Value	
Lead	ug/g	0.810	0.847	
Lead-210	Bq/L	19.2	20.6	
Lead-210	Bq	0.397	0.367	
Lead-210	Bq/L	19.2	21.1	
Lead-210	Bq	7.70	7.94	
Lead-210	Bq/L	19.2	22.5	
Lead-210	Bq	0.385	0.213	*(6)
Lead-210	Bq/L	19.2	21.2	
Lead-210	Bq	1.92	1.68	
Lead-210	Bq/L	19.2	23.8	
Lead-210	Bq	7.70	8.49	
Lead-210	Bq/L	19.2	21.2	
Lead-210	Bq	0.385	0.401	
Lead-210	Bq/L	21.8	19.8	
Lead-210	Bq	0.385	0.362	
Manganese	ug/g	98.0	60.4	*(7)
Manganese	ug/g	98.0	89.9	
Manganese	ug/g	89.0	83.9	
Mercury	ug/g	0.0320	0.0225	
Mercury	ug/g	0.0320	0.0325	
Mercury	ug/g	0.0320	0.0292	
Molybdenum	ug/g	0.0470	0.0318	
Molybdenum	ug/g	0.0470	0.0439	
Molybdenum	ug/g	0.0470	0.0432	
Nickel	ug/g	0.600	0.440	
Nickel	ug/g	0.600	0.565	
Nickel	ug/g	0.600	0.603	
Polonium-210	Bq/L	21.0	19.6	
Polonium-210	Bq	0.397	0.365	
Polonium-210	Bq/L	21.0	19.7	
Polonium-210	Bq	0.077	0.080	
Polonium-210	Bq/L	21.0	20.8	
Polonium-210	Bq	0.385	0.339	
Polonium-210	Bq/L	21.0	17.3	
Polonium-210	Bq	0.077	0.086	
Polonium-210	Bq/L	21.0	16.6	
Polonium-210	Bq	0.385	0.389	
Radium-226	Bq/L	21.4	21.4	
Radium-226	Bq	0.427	0.456	
Radium-226	Bq/L	21.4	21.7	
Radium-226	Bq	0.427	0.444	
Radium-226	Bq/L	21.4	21.9	
Radium-226	Bq	2.13	2.26	
Radium-226	Bq/L	21.4	20.0	
Radium-226	Bq	2.13	2.15	

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QC Analysis	Units	Target Value	Obtained Value	
Radium-226	Bq/L	21.4	23.0	
Radium-226	Bq	0.427	0.508	
Selenium	ug/g	0.120	0.125	
Selenium	ug/g	0.120	0.153	
Selenium	ug/g	0.120	0.158	
Strontium	ug/g	53.0	36.0	
Strontium	ug/g	53.0	51.5	
Strontium	ug/g	53.0	50.5	
Thorium-230	Bq/L	20.5	20.8	
Thorium-230	Bq/L	20.5	20.8	
Thorium-230	Bq/L	20.5	20.8	
Thorium-232	Bq	0.203	0.179	
Thorium-232	Bq	0.203	0.186	
Thorium-232	Bq	0.203	0.201	
Uranium	ug/g	0.0120	0.00678	
Uranium	ug/g	0.0120	0.00954	
Uranium	ug/g	0.0120	0.0105	
Vanadium	ug/g	0.320	0.199	*(8)
Vanadium	ug/g	0.320	0.294	
Vanadium	ug/g	0.320	0.307	
Zinc	ug/g	18.0	11.5	*(9)
Zinc	ug/g	18.0	16.3	
Zinc	ug/g	18.0	23.3	

Duplicates:

Duplicates are used to assess problems with precision and help ensure that samples within a given batch were processed appropriately. The difference between duplicates must be within strict limits, otherwise corrective action is required. Please note, the duplicate(s) in this report are duplicates analyzed within a given batch of test samples and may not be from this specific group of samples.

Duplicate Analysis	Units	Sample ID	First Result	Second Result
Silver	ug/g	31823	<0.01	<0.01
Silver	ug/g	31830	0.02	0.02
Silver	ug/g	31840	<0.01	<0.01
Silver	ug/g	31851	<0.01	<0.01
Silver	ug/g	31858	<0.01	<0.01
Silver	ug/g	31868	0.02	0.02
Silver	ug/g	31877	<0.01	<0.01
Silver	ug/g	31884	0.01	0.01
Aluminum	ug/g	31823	10	11
Aluminum	ug/g	31830	250	230
Aluminum	ug/g	31840	94	100
Aluminum	ug/g	31851	8.4	9.4
Aluminum	ug/g	31858	60	59

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Duplicate Analysis	Units	Sample ID	First Result	Second Result
Aluminum	ug/g	31868	410	380
Aluminum	ug/g	31877	10	10
Aluminum	ug/g	31884	500	500
Arsenic	ug/g	31823	<0.05	<0.05
Arsenic	ug/g	31830	0.07	0.07
Arsenic	ug/g	31840	<0.05	<0.05
Arsenic	ug/g	31851	<0.05	<0.05
Arsenic	ug/g	31858	<0.05	<0.05
Arsenic	ug/g	31868	0.13	0.13
Arsenic	ug/g	31877	<0.05	<0.05
Arsenic	ug/g	31884	0.13	0.16
Boron	ug/g	31823	10	11
Boron	ug/g	31830	<1	<1
Boron	ug/g	31840	33	32
Boron	ug/g	31851	7	7
Boron	ug/g	31858	19	19
Boron	ug/g	31868	<1	<1
Boron	ug/g	31877	7	7
Boron	ug/g	31884	<1	<1
Barium	ug/g	31823	18	20
Barium	ug/g	31830	10	9.9
Barium	ug/g	31840	71	74
Barium	ug/g	31851	16	17
Barium	ug/g	31858	42	42
Barium	ug/g	31868	20	20
Barium	ug/g	31877	21	21
Barium	ug/g	31884	14	14
Beryllium	ug/g	31823	<0.01	<0.01
Beryllium	ug/g	31830	<0.01	<0.01
Beryllium	ug/g	31840	<0.01	<0.01
Beryllium	ug/g	31851	<0.01	<0.01
Beryllium	ug/g	31858	<0.01	<0.01
Beryllium	ug/g	31868	0.02	0.01
Beryllium	ug/g	31877	<0.01	<0.01
Beryllium	ug/g	31884	0.01	0.01
Cadmium	ug/g	31823	<0.01	<0.01
Cadmium	ug/g	31830	0.05	0.05
Cadmium	ug/g	31840	<0.01	<0.01
Cadmium	ug/g	31851	<0.01	<0.01
Cadmium	ug/g	31858	<0.01	<0.01
Cadmium	ug/g	31868	0.08	0.08
Cadmium	ug/g	31877	<0.01	<0.01
Cadmium	ug/g	31884	0.05	0.05
Cobalt	ug/g	31823	0.01	0.01
Cobalt	ug/g	31830	0.08	0.08
Cobalt	ug/g	31840	0.04	0.04

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Duplicate Analysis	Units	Sample ID	First Result	Second Result
Cobalt	ug/g	31851	<0.01	<0.01
Cobalt	ug/g	31858	0.01	<0.01
Cobalt	ug/g	31868	0.16	0.21
Cobalt	ug/g	31877	<0.01	<0.01
Cobalt	ug/g	31884	0.24	0.23
Chromium	ug/g	31823	<0.5	<0.5
Chromium	ug/g	31830	1.1	0.9
Chromium	ug/g	31840	<0.5	<0.5
Chromium	ug/g	31851	<0.5	<0.5
Chromium	ug/g	31858	<0.5	<0.5
Chromium	ug/g	31868	21	24
Chromium	ug/g	31877	<0.5	<0.5
Chromium	ug/g	31884	16	15
Cesium	ug/g	31823	<0.05	<0.05
Cesium	ug/g	31830	0.12	0.12
Cesium	ug/g	31840	0.07	0.07
Cesium	ug/g	31851	0.14	0.14
Cesium	ug/g	31858	0.10	0.10
Cesium	ug/g	31868	0.17	0.18
Cesium	ug/g	31877	0.25	0.25
Cesium	ug/g	31884	0.08	0.09
Copper	ug/g	31823	3.2	3.5
Copper	ug/g	31830	1.0	1.1
Copper	ug/g	31840	3.7	3.8
Copper	ug/g	31851	2.6	2.8
Copper	ug/g	31858	2.6	2.6
Copper	ug/g	31868	1.7	1.7
Copper	ug/g	31877	3.9	3.8
Copper	ug/g	31884	1.2	1.2
Iron	ug/g	31823	14	15
Iron	ug/g	31830	180	170
Iron	ug/g	31840	50	52
Iron	ug/g	31851	10	11
Iron	ug/g	31858	40	37
Iron	ug/g	31868	340	380
Iron	ug/g	31877	12	12
Iron	ug/g	31884	320	310
Mercury	ug/g	31823	<0.005	<0.005
Mercury	ug/g	31830	0.018	0.020
Mercury	ug/g	31840	0.008	0.008
Mercury	ug/g	31851	<0.005	<0.005
Mercury	ug/g	31858	<0.005	<0.005
Mercury	ug/g	31868	0.030	0.030
Mercury	ug/g	31877	<0.005	<0.005
Mercury	ug/g	31884	0.024	0.024
Lithium	ug/g	31823	<0.05	<0.05

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Lithium	ug/g	31830	0.15	0.13
Lithium	ug/g	31840	<0.05	<0.05
Lithium	ug/g	31851	<0.05	<0.05
Lithium	ug/g	31858	<0.05	<0.05
Lithium	ug/g	31868	0.18	0.16
Lithium	ug/g	31877	<0.05	<0.05
Lithium	ug/g	31884	0.23	0.21
Manganese	ug/g	31823	590	620
Manganese	ug/g	31830	190	178
Manganese	ug/g	31840	2790	2760
Manganese	ug/g	31851	890	920
Manganese	ug/g	31858	1830	1870
Manganese	ug/g	31868	139	139
Manganese	ug/g	31877	600	630
Manganese	ug/g	31884	116	115
Molybdenum	ug/g	31823	<0.1	<0.1
Molybdenum	ug/g	31830	<0.1	<0.1
Molybdenum	ug/g	31840	<0.1	<0.1
Molybdenum	ug/g	31851	<0.1	<0.1
Molybdenum	ug/g	31858	<0.1	<0.1
Molybdenum	ug/g	31868	<0.1	<0.1
Molybdenum	ug/g	31877	<0.1	<0.1
Molybdenum	ug/g	31884	<0.1	<0.1
Nickel	ug/g	31823	0.65	0.72
Nickel	ug/g	31830	0.67	0.61
Nickel	ug/g	31840	1.2	1.2
Nickel	ug/g	31851	0.51	0.54
Nickel	ug/g	31858	0.56	0.55
Nickel	ug/g	31868	8.5	9.5
Nickel	ug/g	31877	0.45	0.44
Nickel	ug/g	31884	6.9	6.1
Lead	ug/g	31823	0.20	0.21
Lead	ug/g	31830	0.38	0.39
Lead	ug/g	31840	0.03	0.03
Lead	ug/g	31851	0.03	0.04
Lead	ug/g	31858	0.01	0.02
Lead	ug/g	31868	1.3	1.2
Lead	ug/g	31877	0.05	0.05
Lead	ug/g	31884	0.64	0.60
Lead-210	Bq/g	31821	0.046	0.053
Lead-210	Bq/g	31826	0.29	0.32
Lead-210	Bq/g	31847	0.001	<0.001
Lead-210	Bq/g	31854	0.38	0.39
Lead-210	Bq/g	31858	0.008	0.007
Lead-210	Bq/g	31870	0.034	0.035
Lead-210	Bq/g	31883	0.061	0.066

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Duplicate Analysis	Units	Sample ID	First Result	Second Result
Lead-210	Bq/g	32002	0.02	0.01
Lead-210	Bq/g	40193	<0.02	<0.02
Polonium-210	Bq/g	31821	0.033	0.035
Polonium-210	Bq/g	31826	0.23	0.21
Polonium-210	Bq/g	31847	0.0006	0.0013
Polonium-210	Bq/g	31854	0.26	0.22
Polonium-210	Bq/g	31858	0.0032	0.0027
Polonium-210	Bq/g	31883	0.055	0.052
Polonium-210	Bq/g	33002	0.007	0.006
Polonium-210	Bq/g	40193	0.009	0.01
Radium-226	Bq/g	40044	0.000023	0.000022
Radium-226	Bq/g	31820	0.0051	0.0040
Radium-226	Bq/g	31832	0.0059	0.0066
Radium-226	Bq/g	31844	0.0077	0.0076
Radium-226	Bq/g	31855	0.0031	0.0039
Radium-226	Bq/g	31866	0.0046	0.0040
Radium-226	Bq/g	31876	0.002	0.003
Radium-226	Bq/g	31881	0.0015	0.0018
Radium-226	Bq/g	39798	0.08	0.05
Radium-226	Bq/g	34794	0.06	<0.05
Radium-226	Bq/g	39114	<0.005	<0.005
Rubidium	ug/g	31823	17	18
Rubidium	ug/g	31830	4.9	4.7
Rubidium	ug/g	31840	9.6	9.8
Rubidium	ug/g	31851	17	18
Rubidium	ug/g	31858	10	10
Rubidium	ug/g	31868	3.6	3.5
Rubidium	ug/g	31877	18	19
Rubidium	ug/g	31884	3.3	3.2
Antimony	ug/g	31823	<0.1	<0.1
Antimony	ug/g	31830	<0.1	<0.1
Antimony	ug/g	31840	<0.1	<0.1
Antimony	ug/g	31851	<0.1	<0.1
Antimony	ug/g	31858	<0.1	<0.1
Antimony	ug/g	31868	<0.1	<0.1
Antimony	ug/g	31877	<0.1	<0.1
Antimony	ug/g	31884	<0.1	<0.1
Selenium	ug/g	31823	<0.05	<0.05
Selenium	ug/g	31830	0.05	0.05
Selenium	ug/g	31840	<0.05	<0.05
Selenium	ug/g	31851	<0.05	<0.05
Selenium	ug/g	31858	<0.05	<0.05
Selenium	ug/g	31868	<0.05	0.05
Selenium	ug/g	31877	<0.05	<0.05
Selenium	ug/g	31884	0.07	0.08
Tin	ug/g	31823	<0.05	<0.05

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Tin	ug/g	31830	<0.05	<0.05
Tin	ug/g	31840	<0.05	<0.05
Tin	ug/g	31851	<0.05	<0.05
Tin	ug/g	31858	<0.05	<0.05
Tin	ug/g	31868	<0.05	<0.05
Tin	ug/g	31877	<0.05	<0.05
Tin	ug/g	31884	<0.05	<0.05
Strontium	ug/g	31823	2.8	3.0
Strontium	ug/g	31830	3.3	3.3
Strontium	ug/g	31840	9.5	9.9
Strontium	ug/g	31851	1.7	1.8
Strontium	ug/g	31858	3.6	3.7
Strontium	ug/g	31868	4.7	4.5
Strontium	ug/g	31877	3.4	3.4
Strontium	ug/g	31884	4.8	4.8
Tellurium	ug/g	31823	<0.5	<0.5
Tellurium	ug/g	31830	<0.5	<0.5
Tellurium	ug/g	31840	<0.5	<0.5
Tellurium	ug/g	31851	<0.5	<0.5
Tellurium	ug/g	31858	<0.5	<0.5
Tellurium	ug/g	31868	<0.5	<0.5
Tellurium	ug/g	31877	<0.5	<0.5
Tellurium	ug/g	31884	<0.5	<0.5
Thorium-228	Bq/g	31832	0.001	0.002
Thorium-228	Bq/g	31845	0.0066	0.0066
Thorium-228	Bq/g	31855	0.002	0.003
Thorium-228	Bq/g	31866	0.003	0.005
Thorium-228	Bq/g	31876	0.002	0.002
Thorium-228	Bq/g	31885	<0.0005	<0.0005
Thorium-228	Bq/g	31886	0.001	0.002
Thorium-230	Bq/g	40197	<0.01	<0.01
Titanium	ug/g	31823	0.13	0.13
Titanium	ug/g	31830	6.4	5.8
Titanium	ug/g	31840	0.88	1.1
Titanium	ug/g	31851	<0.05	0.06
Titanium	ug/g	31858	0.26	0.37
Titanium	ug/g	31868	9.2	9.4
Titanium	ug/g	31877	0.19	0.06
Titanium	ug/g	31884	13	13
Thallium	ug/g	31823	<0.05	<0.05
Thallium	ug/g	31830	<0.05	<0.05
Thallium	ug/g	31840	<0.05	<0.05
Thallium	ug/g	31851	<0.05	<0.05
Thallium	ug/g	31858	<0.05	<0.05
Thallium	ug/g	31868	<0.05	<0.05
Thallium	ug/g	31877	<0.05	<0.05

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Duplicate Analysis	Units	Sample ID	First Result	Second Result
Thallium	ug/g	31884	<0.05	<0.05
Uranium	ug/g	31823	<0.01	<0.01
Uranium	ug/g	31830	0.14	0.14
Uranium	ug/g	31840	0.03	0.03
Uranium	ug/g	31851	<0.01	0.01
Uranium	ug/g	31858	<0.01	<0.01
Uranium	ug/g	31868	0.02	0.02
Uranium	ug/g	31877	<0.01	<0.01
Uranium	ug/g	31884	0.02	0.02
Vanadium	ug/g	31823	<0.1	<0.1
Vanadium	ug/g	31830	0.5	0.5
Vanadium	ug/g	31840	<0.1	<0.1
Vanadium	ug/g	31851	<0.1	<0.1
Vanadium	ug/g	31858	<0.1	<0.1
Vanadium	ug/g	31868	0.9	0.9
Vanadium	ug/g	31877	<0.1	<0.1
Vanadium	ug/g	31884	0.9	0.9
Zinc	ug/g	31823	8.1	9.1
Zinc	ug/g	31830	15	14
Zinc	ug/g	31840	11	12
Zinc	ug/g	31851	9.0	9.6
Zinc	ug/g	31858	10	9.8
Zinc	ug/g	31868	15	15
Zinc	ug/g	31877	7.6	12
Zinc	ug/g	31884	15	15
Zirconium	ug/g	31823	0.09	0.09
Zirconium	ug/g	31830	0.21	0.18
Zirconium	ug/g	31840	<0.05	<0.05
Zirconium	ug/g	31851	0.06	0.06
Zirconium	ug/g	31858	<0.05	<0.05
Zirconium	ug/g	31868	0.29	0.27
Zirconium	ug/g	31877	0.15	0.13
Zirconium	ug/g	31884	0.67	0.55

Spikes and/or Surrogates:

Samples spiked with a known quantity of the analyte of interest or a surrogate which is a known quantity of a compound which behaves in a similar manner to the analyte of interest, are used to assess problems with the sample processing or sample matrix. The recovery must be within clearly defined limits when the quantity of spike is comparable to the sample concentration.

Spike Analysis	Percent Recovery
Radium-226	103

*(1) (2) (3) (4) (7) (8) (9) The Aluminum, Chromium, Cobalt, Copper, Manganese, Vanadium and Zinc results

Oct 30, 2018

This report was generated for samples included in SRC Group # 2018-9960

for the quality control sample were just beyond the specified limits. The data was reviewed and a number of samples in the batch were reanalyzed. Reanalysis confirmed original results within the expected measurement uncertainty. All other quality control measures in the batch were within limits.

*(5) (6) The Copper and Lead-210 results for the quality control sample were outside the specified limits. The data was reviewed and additional quality control measures in the same batch were within specified limits.

Overall, there were no other indications of problems with the analysis and the results were considered acceptable.

Roxane Ortmann - Quality Assurance Supervisor

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Sep 04, 2019

This report was generated for samples included in SRC Group # 2019-11322

Quality Control Report

Kyle Hodgson
Golder
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Reference Materials and Standards:

A reference material of known concentration is used whenever possible as either a control sample or control standard and analyzed with each batch of samples. These "QC" results are used to assess the performance of the method and must be within clearly defined limits; otherwise corrective action is required.

QC Analysis	Units	Target Value	Obtained Value
Aluminum	ug/g	23600	23400
Arsenic	ug/g	17.0	16.8
Barium	ug/g	99.0	102
Beryllium	ug/g	0.634	0.569
Bismuth	ug/g	1.89	1.88
Cadmium	ug/g	0.244	0.242
Calcium	mg/L	63.4	63.0
Calcium	ug/g	6400	6770
Chloride	mg/L	49.8	50.5
Chloride	mg/L	308	325
Chromium	ug/g	41.4	40.4
Cobalt	ug/g	13.7	12.7
Copper	ug/g	43.6	43.3
Iron	ug/g	37600	35200
Lead	ug/g	13.3	14.1
Lead-210	Bq/L	21.6	18.4
Lead-210	Bq	7.70	6.65
Magnesium	mg/L	16.5	16.4
Magnesium	ug/g	7400	7540
Manganese	ug/g	1230	1220
Mercury	ug/g	0.412	0.349
Mercury	ug/g	0.412	0.346
Molybdenum	ug/g	0.766	0.474
Nickel	ug/g	20.5	20.8
Phosphorus	ug/g	830	769
Polonium-210	Bq/L	18.8	19.9
Polonium-210	Bq	0.077	0.096
Potassium	mg/L	163	164
Potassium	ug/g	1700	1680
Radium-226	Bq/L	18.4	14.8
Radium-226	Bq	2.13	1.87
Radium-226	Bq/L	18.4	18.6

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QC Analysis	Units	Target Value	Obtained Value
Radium-226	Bq	0.043	0.037
Selenium	ug/g	0.420	0.393
Silver	ug/g	0.200	0.219
Sodium	mg/L	100	98.3
Sodium	ug/g	893	873
Strontium	ug/g	27.3	26.8
Sulfate	mg/L	150	147
Thorium-230	Bq/L	19.9	20.6
Thorium-232	Bq	0.203	0.189
Tin	ug/g	1.52	1.46
Titanium	ug/g	1990	2250
Uranium	ug/g	1.20	1.29
Vanadium	ug/g	71.2	69.2
Zinc	ug/g	74.8	80.4

Duplicates:

Duplicates are used to assess problems with precision and help ensure that samples within a given batch were processed appropriately. The difference between duplicates must be within strict limits, otherwise corrective action is required. Please note, the duplicate(s) in this report are duplicates analyzed within a given batch of test samples and may not be from this specific group of samples.

Duplicate Analysis	Units	Sample ID	First Result	Second Result
Silver	ug/g	45051	<0.1	<0.1
Silver	ug/g	45061	<0.1	<0.1
Aluminum	ug/g	45051	3650	3640
Aluminum	ug/g	45061	2580	2680
Arsenic	ug/g	45051	0.9	0.8
Arsenic	ug/g	45061	0.8	0.7
Boron	ug/g	45051	3	4
Boron	ug/g	45061	4	3
Barium	ug/g	45051	28	29
Barium	ug/g	45061	27	29
Beryllium	ug/g	45051	<0.1	<0.1
Beryllium	ug/g	45061	<0.1	<0.1
Bismuth	ug/g	45051	<0.2	<0.2
Bismuth	ug/g	45061	<0.2	<0.2
Calcium	ug/g	45051	330	370
Calcium	ug/g	45061	130	120
Calcium	mg/L	45068	10	9
Cadmium	ug/g	45051	<0.1	<0.1
Cadmium	ug/g	45061	<0.1	<0.1
Chloride	mg/L	45068	4	5
Chloride	mg/L	45847	<1	<1
Cobalt	ug/g	45051	0.5	1.3
Cobalt	ug/g	45061	0.3	0.3

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Duplicate Analysis	Units	Sample ID	First Result	Second Result
Chromium	ug/g	45051	4.2	4.2
Chromium	ug/g	45061	5.0	5.0
Cesium	ug/g	45051	0.1	0.1
Cesium	ug/g	45061	<0.1	<0.1
Copper	ug/g	45051	0.8	1.0
Copper	ug/g	45061	0.5	0.5
Iron	ug/g	45051	2870	2840
Iron	ug/g	45061	2940	2920
Mercury	ug/g	45051	<0.05	<0.05
Mercury	ug/g	45061	<0.05	<0.05
Potassium	ug/g	45051	630	650
Potassium	ug/g	45061	580	630
Potassium	mg/L	45068	7	7
Lithium	ug/g	45051	3.9	3.8
Lithium	ug/g	45061	1.8	1.8
Magnesium	ug/g	45051	360	360
Magnesium	ug/g	45061	130	130
Magnesium	mg/L	45068	2	2
Manganese	ug/g	45051	35	33
Manganese	ug/g	45061	40	43
Molybdenum	ug/g	45051	<0.1	0.7
Molybdenum	ug/g	45061	0.1	0.1
Moisture	%	45068	4.60	4.51
Sodium	ug/g	45051	100	110
Sodium	ug/g	45061	80	80
Sodium	mg/L	45068	3	3
Nickel	ug/g	45051	1.2	1.1
Nickel	ug/g	45061	0.7	0.6
Phosphorus	ug/g	45051	70	70
Phosphorus	ug/g	45061	70	70
Lead	ug/g	45051	2.4	2.4
Lead	ug/g	45061	1.6	1.6
Lead-210	Bq/g	45051	<0.04	<0.04
pH	pH units	45068	3.57	3.61
Polonium-210	Bq/g	45051	<0.01	<0.01
Radium-226	Bq/g	45057	0.02	0.02
Radium-226	Bq/g	45067	<0.01	0.02
Radium-226	Bq/g	45729	0.02	<0.01
Rubidium	ug/g	45051	2.6	2.6
Rubidium	ug/g	45061	2.4	2.6
Antimony	ug/g	45051	<0.2	<0.2
Antimony	ug/g	45061	<0.2	<0.2
Selenium	ug/g	45051	<0.1	<0.1
Selenium	ug/g	45061	<0.1	<0.1
Tin	ug/g	45051	0.2	0.2
Tin	ug/g	45061	0.1	0.1

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Duplicate Analysis	Units	Sample ID	First Result	Second Result
Sulfate	mg/L	45068	12	13
Specific conductivity	uS/cm	45068	176	174
Strontium	ug/g	45051	32	32
Strontium	ug/g	45061	17	18
Tellurium	ug/g	45051	<0.5	<0.5
Tellurium	ug/g	45061	<0.5	<0.5
Thorium-228	Bq/g	45051	<0.02	<0.02
Thorium-230	Bq/g	45051	<0.02	<0.02
Thorium-232	Bq/g	45051	<0.02	<0.02
Titanium	ug/g	45051	280	270
Titanium	ug/g	45061	280	270
Thallium	ug/g	45051	<0.2	<0.2
Thallium	ug/g	45061	<0.2	<0.2
Uranium	ug/g	45051	0.3	0.3
Uranium	ug/g	45061	0.3	0.3
Vanadium	ug/g	45051	8.3	8.2
Vanadium	ug/g	45061	5.2	5.1
Tungsten	ug/g	45051	<0.5	<0.5
Tungsten	ug/g	45061	<0.5	<0.5
Zinc	ug/g	45051	5.4	5.0
Zinc	ug/g	45061	2.5	3.8
Zirconium	ug/g	45051	18	18
Zirconium	ug/g	45061	16	16

Spikes and/or Surrogates:

Samples spiked with a known quantity of the analyte of interest or a surrogate which is a known quantity of a compound which behaves in a similar manner to the analyte of interest, are used to assess problems with the sample processing or sample matrix. The recovery must be within clearly defined limits when the quantity of spike is comparable to the sample concentration.

Spike Analysis	Percent Recovery
Calcium	106
Chloride	100
Magnesium	107
Potassium	105
Sodium	107
Sulfate	101

All quality control results were within the specified limits and considered acceptable.

Roxane Ortmann - Quality Assurance Supervisor

APPENDIX D

Vegetation Chemistry Laboratory Results

Table D-1: Metal and Radionuclide Concentrations in Lichen Samples; Complete Analysis Results

Sampling Site	EXP01	EXP01	EXP01	EXP02	EXP02	EXP02	EXP03	EXP03	EXP03	REF01	REF01	REF01	REF02	REF02	REF02	REF03	REF03	REF03	REF04	REF04	REF04	REF05	REF05	REF05	REF06	REF06	REF06
Plot Location	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
% Moisture	16.72	6.96	6.58	36.87	43.65	38.83	48.89	43.45	55.49	7.81	7.61	8.89	57.34	53.14	34.17	33.94	25.93	12.01	25.13	36.16	20.23	66.99	67.73	64.12	54.04	34.56	35.68
Aluminum	280	410	250	270	240	190	870	490	420	190	210	1200	410	370	340	310	500	570	310	270	290	240	260	260	230	260	320
Antimony	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	0.08	0.1	0.07	0.07	0.06	0.06	0.23	0.12	0.11	0.07	0.06	0.41	0.13	0.1	0.1	0.09	0.13	0.14	0.06	<0.05	0.08	<0.05	0.05	<0.05	<0.05	0.05	0.06
Barium	11	15	10	15	14	7.4	16	15	13	12	8.3	16	20	20	12	7.5	14	13	7	11	6	7.6	7.2	9.1	5.6	5.8	8.1
Beryllium	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.02	0.01	<0.01	<0.01	0.02	0.02	0.01	<0.01	<0.01	0.01	0.02	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Boron	<1	1	<1	1	2	1	2	1	1	<1	1	3	<1	<1	<1	<1	<1	1	1	<1	1	<1	<1	<1	<1	<1	<1
Cadmium	0.05	0.06	0.05	0.05	0.04	0.04	0.07	0.06	0.06	0.02	0.05	0.17	0.08	0.05	0.06	0.04	0.05	0.05	0.05	0.06	0.05	0.03	0.03	0.03	0.04	0.05	0.05
Cesium	0.13	0.1	0.12	0.1	0.09	0.1	0.13	0.2	0.19	0.14	0.15	0.21	0.17	0.15	0.19	0.11	0.08	0.18	0.1	0.13	0.06	0.13	0.07	0.08	0.1	0.1	0.1
Chromium	1.4	4.7	1.1	1.2	1.3	1	130	18	7.1	1	0.8	3.9	22	3.4	1.5	3.7	16	28	1.1	1.2	1.4	1	0.8	0.9	0.9	1.3	1.2
Cobalt	0.08	0.13	0.08	0.11	0.1	0.06	1.4	0.31	0.16	0.04	0.07	0.2	0.16	0.1	0.08	0.1	0.24	0.32	0.08	0.07	0.08	0.07	0.09	0.06	0.06	0.06	0.09
Copper	0.96	1.2	1	1.2	1.3	0.87	1.3	2	1.2	0.87	0.98	2.7	1.7	1.6	1.4	0.98	1.2	1.2	1	0.86	1.1	0.88	0.95	0.93	0.76	0.84	1
Iron	220	250	180	190	170	150	1100	380	280	150	120	820	340	270	270	220	320	400	180	150	150	140	270	150	150	150	180
Lead	0.26	0.56	0.38	0.32	0.23	0.22	1.3	0.78	0.52	0.23	0.18	2	1.3	1.1	0.74	0.37	0.64	0.53	0.2	0.29	0.18	0.16	0.24	0.17	0.21	0.19	0.29
Lithium	0.18	0.19	0.15	0.15	0.13	0.12	0.49	0.22	0.18	0.11	0.1	0.5	0.18	0.16	0.16	0.15	0.23	0.27	0.16	0.12	0.14	0.12	0.13	0.13	0.13	0.13	0.14
Manganese	185	174	190	163	295	149	109	155	242	41	99	51	139	166	180	131	116	156	147	132	120	94	94	103	84	121	100
Mercury	0.016	0.026	0.018	0.027	0.023	0.021	0.031	0.028	0.025	0.014	0.025	0.4	0.03	0.037	0.036	0.024	0.024	0.025	0.025	0.021	0.026	0.017	0.021	0.017	0.016	0.02	0.021
Molybdenum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	0.72	2.1	0.67	0.75	0.83	0.58	54	7.1	3.3	0.47	0.68	2.2	8.5	1.7	0.93	1.7	6.9	11	0.65	0.62	0.82	0.55	0.48	0.49	0.46	0.64	0.7
Rubidium	4.9	4.3	4.9	3.8	4.4	4.6	4	6.1	6.2	2.9	6.3	5.7	3.6	4.8	4.7	3.8	3.3	4.5	5.4	5.1	6.4	6.3	5.7	5.6	4.8	4.9	5.1
Selenium	0.07	0.08	0.05	<0.05	<0.05	<0.05	0.09	0.1	0.1	<0.05	0.06	0.17	<0.05	<0.05	0.06	0.06	0.07	0.08	0.06	0.06	0.07	<0.05	<0.05	<0.05	0.05	0.06	0.06
Silver	0.02	0.02	0.02	0.01	<0.01	<0.01	0.02	0.02	0.01	<0.01	<0.01	0.02	0.02	0.02	<0.01	0.01	0.01	0.01	<0.01	0.01	<0.01	<0.01	0.01	<0.01	0.01	<0.01	<0.01
Strontium	2.7	4.7	3.3	3.3	2.8	2	8.6	5	4.6	5.5	4.6	5.5	4.7	3.5	2.8	3.3	4.8	5.4	3.5	3.4	3.7	3.6	4.5	3	2	2.4	3.4
Tellurium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Thallium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tin	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Titanium	6.9	10	6.4	6.8	5.3	4.9	26	11	9.5	5	4	31	9.2	8.7	7.3	7.4	13	15	7	5.8	6.6	6.2	6.7	6.6	5.9	5.9	6.9
Uranium	0.16	0.12	0.14	0.1	0.07	0.08	0.07	0.04	0.02	<0.01	<0.01	0.06	0.02	0.02	0.08	0.01	0.02	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	0.5	0.7	0.5	0.6	0.5	0.4	1.9	1	0.7	0.4	0.4	2.8	0.9	0.8	0.7	0.6	0.9	0.9	0.5	0.4	0.5	0.4	0.5	0.4	0.4	0.5	0.5
Zinc	17	16	15	12	12	13	14	19	23	9	12	27	15	12	20	15	15	21	16	18	17	9.6	11	9.7	14	16	15
Zirconium	0.22	0.35	0.21	0.2	0.17	0.15	1.1	0.36	0.29	0.13	0.11	0.78	0.29	0.23	0.21	0.19	0.67	0.78	0.17	0.14	0.16	0.14	0.13	0.15	0.14	0.15	0.18
Lead-210	0.22	0.31	0.29	0.3	0.21	0.25	0.33	0.39	0.39	0.18	0.23	0.5	0.27	0.41	0.29	0.25	0.28	0.29	0.27	0.32	0.23	0.22	0.31	0.2	0.36	0.26	0.37
Polonium-210	0.18	0.22	0.14	0.12	0.13	0.16	0.35	0.33	0.24	0.13	0.16	0.38	0.22	0.27	0.17	0.19	0.22	0.22	0.2	0.28	0.22	0.19	0.26	0.26	0.31	0.26	0.31
Radium-226	0.0052	0.0039	0.0055	0.0036	0.0037	0.0027	0.014	0.01	0.007	0.001	0.001	0.0037	0.005	<0.002	0.003	0.005	<0.0008	0.0049	0.0009	0.0006	0.0004	0.0012	0.0009	0.0006	0.0005	0.0004	0.0005
Thorium-230	0.002	0.001	0.002	0.0009	0.0009	0.0012	<0.007	<0.006	<0.004	<0.0002	<0.0002	0.001	<0.007	<0.005	<0.001	0.005	<0.002	<0.0008	<0.0003	<0.0003	<0.0003	<0.0006	0.0009	<0.0005	<0.0005	<0.0005	0.0007

Table D-2: Metal and Radionuclide Concentrations in Blueberry Stem Samples; Complete Analysis Results

Sampling Site	EXP01	EXP01	EXP01	EXP02	EXP02	EXP02	EXP03	EXP03	EXP03	REF01	REF01	REF01	REF02	REF02	REF02	REF03	REF03	REF03	REF04	REF04	REF04	REF05	REF05	REF05	REF06	REF06	REF06
Plot Location	A	B	C	A	B	C	A	B	C	C	A	B	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
% Moisture	38.67	39.82	32.11	38.81	44.35	39.46	45.62	39.5	46.94	59.94	60.42	44.68	46.12	33.39	35.22	37.11	31.07	35.49	39.23	31.83	37.73	45.42	44.08	41.84	40.31	38.53	39.3
Aluminum	82	110	110	77	110	120	88	89	140	25	21	90	99	70	83	91	110	110	180	120	120	100	120	110	140	88	90
Antimony	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Barium	43	74	66	72	70	91	70	78	64	67	72	93	104	62	64	72	72	64	82	75	80	73	62	76	71	60	56
Beryllium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Boron	7	7	7	8	8	9	8	9	8	12	12	8	6	8	8	7	7	7	8	8	9	7	6	6	9	7	7
Cadmium	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.04	0.02	0.04	0.05	0.02	0.05	0.03	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02	0.01	0.01	0.02	0.02	<0.01
Cesium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	0.06	<0.05	0.06	0.11	0.08	<0.05	0.06	0.11	0.08	0.12	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	0.06	0.15
Chromium	0.6	0.7	1	<0.5	<0.5	0.8	0.6	0.6	0.7	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	0.9	<0.5	0.9	<0.5	<0.5	0.6	0.6	<0.5	<0.5
Cobalt	0.05	0.07	0.04	0.08	0.06	0.09	0.04	0.04	0.04	0.02	0.01	0.04	0.04	0.02	0.02	0.02	0.03	0.02	0.07	0.04	0.04	0.08	0.07	0.07	0.04	0.03	0.04
Copper	4.6	5.3	5.5	4.7	6.3	5.2	5.1	5.8	5.1	5.1	4.8	7.5	5.4	4.9	4.7	5.3	5	5	4.6	4.1	5.4	5.7	5.6	5.5	4.6	4.1	6.9
Iron	47	65	65	45	66	78	55	50	79	19	18	61	63	36	47	59	52	51	110	60	72	68	72	66	76	46	50
Lead	0.06	0.09	0.08	0.05	0.08	0.08	0.07	0.06	0.08	<0.01	<0.01	0.07	0.07	0.03	0.04	0.05	0.06	0.05	0.11	0.06	0.08	0.06	0.07	0.06	0.07	0.03	0.04
Lithium	<0.05	0.06	0.06	<0.05	0.07	0.07	0.06	0.07	0.08	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.11	0.06	0.06	0.07	0.08	0.09	0.07	<0.05	<0.05
Manganese	2150	1550	1560	1420	2320	2020	1770	1640	2140	1180	1370	1960	1300	1120	1490	1780	1470	1580	1620	1840	2100	1440	1240	1050	2010	1420	1190
Mercury	<0.005	0.008	0.007	0.006	0.007	0.009	0.006	0.005	0.009	<0.005	<0.005	0.006	0.006	<0.005	0.007	0.006	0.006	0.005	0.013	0.008	0.008	0.008	0.009	0.007	0.009	0.006	0.007
Molybdenum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	0.81	1.3	1.4	0.95	0.91	1.2	0.62	0.71	0.91	0.58	0.65	1.2	0.96	0.82	0.52	0.58	0.9	0.61	1	0.81	0.79	0.95	0.77	0.78	0.83	0.69	1.1
Rubidium	6.2	5.5	4.3	4.8	4.8	5.2	4.9	4.6	4.2	9.9	10	7.6	3.2	4	4.8	5.3	3.8	4.4	5.8	3.5	9.4	6.5	6	6.7	4.5	4.9	11
Selenium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	5.7	9.4	8.1	4.2	3.1	24	3.8	5.7	4.9	10	9.2	8.3	14	10	8.7	9	11	10	7.9	10	4.8	8.6	8.2	11	5.6	5.6	7.9
Tellurium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Thallium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tin	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Titanium	1.3	1.8	2.6	1.1	2	2	1.7	1.1	2.3	0.2	0.14	1.1	1.2	0.62	0.81	1	1.8	2	3.2	1.4	2	1.8	1.9	2	2.3	1.3	1.3
Uranium	0.05	0.05	0.05	0.03	0.03	0.05	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	0.1	0.1	0.2	<0.1	0.1	0.2	0.1	0.1	0.2	<0.1	<0.1	0.1	0.1	<0.1	<0.1	0.1	0.1	0.1	0.3	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.1
Zinc	22	44	31	43	38	45	45	43	42	41	39	49	66	44	32	44	37	53	30	32	37	25	19	16	40	32	31
Zirconium	0.05	0.06	0.09	<0.05	0.06	0.07	0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	0.09	<0.05	0.07	<0.05	0.05	0.05	0.06	<0.05	<0.05
Lead-210	0.049	0.074	0.074	0.075	0.1	0.06	0.093	0.058	0.12	0.004	0.004	0.1	0.084	0.061	0.078	0.056	0.063	0.076	0.15	0.13	0.11	0.12	0.12	0.1	0.03	0.097	0.1
Polonium-210	0.034	0.057	0.049	0.047	0.059	0.047	0.037	0.033	0.066	0.0014	0.0015	0.053	0.051	0.038	0.034	0.046	0.053	0.032	0.089	0.084	0.093	0.071	0.093	0.075	0.0095	0.059	0.05
Radium-226	0.0071	0.0053	0.0076	0.0097	0.011	0.015	0.0095	0.01	0.0056	0.0036	0.0036	0.0047	0.011	0.0084	0.017	0.0018	0.0074	0.0076	0.0041	0.0054	0.0047	0.0044	0.0032	0.0037	0.0045	0.006	0.0034
Thorium-230	0.0013	0.0008	0.0009	0.0004	0.001	<0.0005	<0.0003	<0.0004	<0.0003	<0.0005	<0.0005	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	0.0005	<0.0005	<0.0005

Table D-3: Metal and Radionuclide Concentrations in Blueberry Leave Samples; Complete Analysis Results

Sampling Site	EXP01	EXP01	EXP01	EXP02	EXP02	EXP02	EXP03	EXP03	EXP03	REF01	REF01	REF01	REF02	REF02	REF02	REF03	REF03	REF03	REF04	REF04	REF04	REF05	REF05	REF05	REF06	REF06	REF06
Plot Location	A	B	C	A	B	C	A	B	C	C	A	B	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
% Moisture	54	55.29	56.98	53.16	59.94	52.96	56.17	51.01	59.69	57	48.7	57.21	59.15	48.43	48.72	51.53	50.23	51.16	53.98	47.58	52.44	62.44	58.88	54.4	56.5	51.55	53.69
Aluminum	85	100	94	77	100	94	97	93	110	73	60	70	86	78	76	98	100	96	81	76	82	73	64	59	71	75	62
Antimony	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Barium	31	50	53	53	64	71	70	58	62	39	42	84	98	64	61	74	72	82	53	57	61	61	53	58	53	59	51
Beryllium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Boron	29	29	37	38	46	33	32	36	24	26	19	31	17	25	29	22	26	21	14	20	20	10	10	8	16	17	14
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cesium	0.09	<0.05	0.09	<0.05	<0.05	0.07	0.08	0.05	0.1	0.08	0.1	0.28	0.19	<0.05	0.1	0.16	0.15	0.17	0.08	<0.05	0.07	0.08	0.06	0.06	0.11	0.13	0.21
Chromium	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt	0.04	0.04	0.04	0.05	0.04	0.04	0.03	0.03	0.02	0.01	0.01	0.02	0.03	0.02	0.01	0.02	0.03	0.01	0.03	0.03	0.02	0.03	0.04	0.04	0.03	0.03	0.02
Copper	3.3	3.3	3.6	3	4.1	3.7	3.6	3	3.1	3.2	2.6	5.1	3.9	3	2.9	3.5	3.1	3.8	3.5	3.4	4.2	4	4.1	4.2	3.3	3.5	5
Iron	50	54	58	45	56	50	55	46	62	40	40	49	51	40	40	48	44	46	39	31	38	41	42	36	37	33	36
Lead	0.05	0.05	0.04	0.02	0.04	0.03	0.04	0.03	0.03	0.02	0.01	0.02	0.05	0.02	0.02	0.02	0.02	0.02	0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01
Lithium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Manganese	3190	2260	2860	2250	4010	2790	3620	2840	4630	2090	1830	3170	2350	2020	2520	3380	2980	3150	2930	3100	3700	2300	1830	1760	3510	3460	2040
Mercury	0.007	0.007	0.008	0.007	0.008	0.008	0.008	0.008	0.008	<0.005	<0.005	0.006	0.007	0.006	0.006	0.007	0.007	0.008	0.006	0.005	0.006	0.006	0.007	0.007	0.007	0.006	0.006
Molybdenum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	0.85	1.3	0.93	0.88	0.87	1.2	0.59	0.77	0.71	0.53	0.56	1	0.96	0.82	0.55	0.65	0.79	0.87	0.79	0.84	0.6	0.9	0.8	0.9	0.67	0.76	1.2
Rubidium	9.3	9.2	9.8	7.9	8.2	9.6	7.9	6.2	7	11	10	15	5.4	6.1	7.8	7.2	6.9	7.3	9.7	5	14	12	11	11	8.3	8.8	14
Selenium	<0.05	0.09	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	0.05	0.06	<0.05	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	5.6	9.2	5.4	2.9	2.8	9.5	4.7	4.8	6.1	5	3.6	8.3	11	8.5	7.7	10	10	14	7.1	6.7	4	7.3	6.3	8.3	4.2	3.8	6.7
Tellurium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Thallium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tin	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Titanium	1.4	1.5	2	0.92	1.4	0.88	1	1.3	1.3	0.34	0.26	0.64	0.78	0.46	0.47	0.48	1	0.8	0.6	0.42	0.42	0.64	0.64	0.42	0.47	0.44	0.43
Uranium	0.06	0.16	0.08	0.03	0.03	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	10	9.9	9.6	10	13	11	18	11	17	11	10	12	15	13	13	13	14	14	9.1	12	12	9.5	7.5	8.1	11	12	12
Zirconium	0.06	0.06	0.07	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lead-210	0.036	0.038	0.033	0.035	0.033	0.033	0.036	0.03	0.051	0.013	0.007	0.029	0.04	0.034	0.03	0.028	0.029	0.027	0.028	0.034	0.027	0.034	0.041	0.037	0.022	0.03	0.029
Polonium-210	0.017	0.015	0.012	0.015	0.019	0.019	0.014	0.0094	0.031	0.0067	0.0029	0.0097	0.024	0.014	0.015	0.011	0.013	0.016	0.012	0.01	0.011	0.015	0.014	0.013	0.01	0.012	0.011
Radium-226	0.0044	0.0051	0.0071	0.0063	0.0078	0.0088	0.0076	0.0066	0.0056	0.0035	0.0034	0.0049	0.0043	0.004	0.0084	0.0056	0.0058	0.0051	0.002	0.0031	0.0031	0.0015	0.0016	0.0015	0.0034	0.0043	0.0016
Thorium-230	0.001	0.001	0.002	<0.0006	<0.0007	<0.0006	<0.0006	<0.0006	<0.0006	<0.0005	<0.0004	<0.0006	<0.0009	<0.0006	<0.0005	<0.0006	<0.0006	<0.0006	<0.0006	<0.0005	<0.0006	<0.0005	<0.0005	0.0009	<0.0005	<0.0006	<0.0005

Table D-4: Metal and Radionuclide Concentrations in Blueberry Fruit Samples; Complete Analysis Results

Sampling Site	EXP01	EXP01	EXP01	EXP02	EXP02	EXP02	EXP03	EXP03	EXP03	REF01	REF02	REF02	REF02	REF03	REF03	REF03
Plot Location	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
% Moisture	84.06	83.46	99.11	83.11	82.39	83.13	83.54	83.13	84.13	82.68	84.49	84.35	83.54	83.24	83.16	82.92
Aluminum	12	10	9.8	9.8	11	19	7.3	15	8.4	9.1	9.2	9.5	9.9	10	13	<0.1
Antimony	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.05
Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	17
Barium	15	18	18	20	22	19	16	21	16	21	19	20	21	21	20	<0.01
Beryllium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	6
Boron	16	10	7	11	11	12	11	12	7	7	6	13	8	7	8	<0.01
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.36	0.22
Cesium	0.09	<0.05	0.07	<0.05	0.07	0.06	0.06	<0.05	0.14	0.24	0.26	0.06	0.07	0.25	0.21	<0.5
Chromium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.01
Cobalt	<0.01	0.01	0.01	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	3.4
Copper	3.1	3.2	3.6	4.2	4.6	3.7	3.6	3.3	2.6	5.1	3.2	3.2	2.6	3.9	3.2	11
Iron	14	14	15	14	21	18	10	16	10	17	12	11	13	12	15	0.02
Lead	0.05	0.2	0.04	0.01	0.01	0.02	0.02	0.01	0.03	<0.01	0.06	0.16	0.02	0.05	0.02	<0.05
Lithium	0.09	<0.05	<0.05	<0.05	0.08	0.09	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	490
Manganese	840	590	486	680	710	489	750	660	890	500	377	414	466	600	650	<0.005
Mercury	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.1
Molybdenum	<0.1	<0.1	0.1	0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1	<0.1	0.63
Nickel	0.45	0.65	0.61	0.63	1	0.8	0.36	0.46	0.51	0.7	0.54	0.73	0.4	0.45	0.53	15
Rubidium	18	17	19	16	22	21	17	13	17	26	13	18	13	18	18	<0.05
Selenium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.01
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	2.4
Strontium	1.6	2.8	2.6	2.3	2.8	4	1.3	1.6	1.7	2.7	4	2.8	2.6	3.4	2.6	<0.5
Tellurium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.05
Thallium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tin	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.11
Titanium	0.14	0.13	0.16	0.08	0.14	0.26	0.33	0.24	<0.05	<0.05	0.07	<0.05	0.08	0.19	0.14	<0.01
Uranium	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1
Vanadium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	7.9
Zinc	8.5	8.1	8	9.6	10	7.6	7.5	8.3	9	10	8	8.1	7	7.6	8.3	0.06
Zirconium	<0.05	0.09	<0.05	0.07	0.09	<0.05	<0.05	0.26	0.06	<0.05	0.15	0.07	<0.05	0.15	0.27	
Lead-210	0.001	0.002	0.003	0.003	0.003	<0.001	0.001	<0.001	<0.001	0.001	0.001	0.004	0.003	0.002	0.002	0.0012
Polonium-210	0.0019	0.0018	0.0009	0.002	0.0016	0.0011	0.0008	0.001	0.0007	0.0015	0.0009	0.002	0.0031	0.0011	0.0016	0.0014
Radium-226	0.002	0.001	0.0011	0.0027	0.0029	0.0018	0.0023	0.0021	0.0017	0.0018	0.0013	0.0023	0.0042	0.0016	0.0016	<0.0005
Thorium-230	<0.0005	<0.0005	<0.0005	<0.0008	<0.0008	<0.0005	<0.0005	<0.0005	<0.0007	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005