Keeyask Generation Project

Terrestrial Effects Monitoring Plan

Long-Term Effects on Habitat Monitoring Report

TEMP-2024-01

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KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2024-01

LONG-TERM EFFECTS ON INLAND HABITAT MONITORING
YEAR 2 OPERATION
2023

Prepared for

Manitoba Hydro

By

ECOSTEM Ltd.

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SUMMARY

Background

Construction of the Keeyask Generation Project (the Project) at Gull Rapids began in July 2014. Most construction activities had been completed by fall 2021 and all generating units were in service by March 2022.

The Keeyask Hydropower Limited Partnership (KHLP) was required to prepare a plan to monitor the effects of construction and operation of the generating station on the terrestrial environment. Monitoring results will help the KHLP, government regulators, members of local First Nation communities, and the general public understand how construction and operation of the generating station are affecting the environment, and whether or not more needs to be done to reduce harmful effects.

This report describes the results of the first year of the Long-Term Effects on Inland Habitat monitoring conducted during 2022 and 2023, which was the first and second years of operation monitoring.

Why is the study being done?

Habitat is the place where a plant, animal or its population lives. Terrestrial habitat includes all land habitat for all species. The habitat for a particular species is named for that species (e.g., moose habitat, rusty blackbird nesting habitat or black spruce habitat). Each habitat type represents a different kind of ecosystem.

Various habitat types found throughout the Keeyask region

The partner First Nations have said that all terrestrial habitats are important. Changes to terrestrial habitat can affect many species and ecosystems. Plants and animals need habitat to exist, and having more good quality habitat helps them to be more widespread and abundant.

Because changes to terrestrial habitat can have such wide-ranging effects across the environment, terrestrial habitat monitoring provides the single best way to see important changes, and to discover any unexpected effects on that environment.

Another study, Habitat Loss and Disturbance, is monitoring direct habitat loss and disturbance from the development of the Project. The goal of this study, Long-Term Effects on Inland Habitat, is documenting the nature and extent of indirect Project effects on mature forest habitat adjacent to the Construction Footprint.

What was done?

The Long-Term Effects on Inland Habitat study conducts surveys at the same locations along the North and South Access Roads over multiple years during Project operation. Permanent transect locations were established and baseline data were collected in 2022 and 2023 within suitable mature forest stands along the access roads. These ground surveys collected detailed vegetation, soil, and environment data within nested belt transects referred to as the environment, tree, tall shrub, and low vegetation belts. Aerial surveys using drones also collected photos that were used to create digital orthographic images of a 100 m belt centered on the transect.

What was found?

It was difficult to find suitable forest stands because most of the forest along the North Access Road burned in the 2013 wildfire, and most patches of relatively similar forest along the access roads are not large. Eleven potential sample stands were identified in 2022 using information available prior to the field season. The subsequent field evaluation found that only five of these stands were suitable for this study. Photos and other information acquired in 2022 identified an additional two stands for sampling in 2023.

The sampled stands represented five forest habitat types, which were jack pine mixture on mineral soil, black spruce pure on mineral soil, black spruce pure on thin peatland, black spruce mixture on mineral soil, and black spruce mixture on thin peatland. Four transects initially sampled in 2022 had to be re-established in 2023 as they were inadvertently herbicided.

The vegetation mapping using the drone DOIs generally indicated a high degree of similarity. While the original stand-level mapping used to select stands was accurate, the portions of those stands sufficiently similar for permanent transect monitoring was often a different type than the overall stand. This outcome was not surprising as it was a natural consequence of the minimum size for mapped polygons from the habitat map of the area.

Vegetation and site data from the transects indicated that conditions were sufficiently similar across the sampled transects for the sampled portions of the seven stands.

The tree and tall shrub belts included five tree species and 13 tall shrub species. In the low vegetation belt, a total of 71 vascular plants, five moss and five lichen species were recorded. Ten species were widely distributed across all seven stands sampled.

No plant species of high conservation concern (i.e., ranked as endangered, threatened, provincially critically imperiled or imperiled by the Manitoba Conservation Data Center) was found during the surveys.

Two non-native species of low invasive concern were identified on or near the disturbed segment of sample transects.

What does it mean?

This study is monitoring changes in inland habitat over many years, and the data collected in 2022 and 2023 represents the baseline for comparison in the future. While the portions of the stands sampled met the criteria for continued monitoring, the future analyses will use the classification of the portion of the stand that was sampled rather than the overall stand.

What will be done next?

All seven stands will be re-sampled in 2024 to collect data for conditions during the third year of Project operation.

ACKNOWLEDGEMENTS

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We would also like to thank North/South Consultants Inc., in particular Ron Bretecher, Claire Hrenchuk, Rochelle Gnanapragasam and Shari Fournier, for their guidance, logistical support and other resources that made these studies possible.

STUDY TEAM

Dr. James Ehnes was the project manager and study designer.

Fieldwork in 2023 was conducted by Brock Epp, Alanna Sutton, Owen Romanchuk, Candice Collette, Anoj Subedi, Lynnae Martin, Heidi Ahrenholtz, and Alex Snitowski. Drone work was conducted by Owen Romanchuck and Alex Snitowski.

Data analysis and report writing in 2023 were completed by Alanna Sutton and Brock Epp. Brock Epp and James Ehnes reviewed the report. GIS analysis and cartography were completed by Alex Snitowski.

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1.0 INTRODUCTION

The Keeyask Generation Project (the Project) is a 695-megawatt hydroelectric generating station (GS) and the associated facilities. The Project is located at the former Gull Rapids on the lower Nelson River in northern Manitoba where Gull Lake flows into Stephens Lake, 35 km upstream of the existing Kettle GS. Project construction began in July 2014 and the vast majority of construction activities were completed by fall 2021. The reservoir was first brought to full supply level in September 2020 and the final generating unit went into service on March 9, 2022.

The *Keeyask Generation Project Response to EIS Guidelines* (the EIS), completed in June 2012, provides a summary of predicted effects and planned mitigation for the Project (KHLP 2012a). Technical supporting information for the terrestrial environment, including a description of the environmental setting, effects and mitigation, and a summary of proposed monitoring and follow-up programs is provided in the *Keeyask Generation Project Environmental Impact Statement Terrestrial Supporting Volume* (TE SV; KHLP 2012b). The *Keeyask Generation Project Terrestrial Effects Monitoring Plan* (TEMP; KHLP 2015) was developed as part of the licensing process for the Project. Monitoring activities for various components of the terrestrial environment were described, including the focus of this report, which is long-term effects on habitat monitoring.

Habitat is the place where an organism or a population lives. Because all natural areas are habitat for something, "terrestrial habitat" refers to all land habitat for all species. Habitat for a particular species is identified with the species name of interest, such as moose habitat, rusty blackbird nesting habitat or jack pine (*Pinus banksiana*) habitat. Terrestrial habitat is a keystone driver for ecosystems and, for many reasons, provides the best single indicator for Project effects on terrestrial ecosystems.

Two TEMP studies are monitoring Project effects on terrestrial habitat as a whole. The Terrestrial Habitat Loss and Disturbance study (TEMP, Section 2.1.2) focuses on direct Project effects on stand level habitat composition due to terrestrial habitat loss and disturbance. This study, Long-Term Effects on Inland Habitat, (TEMP, Section 2.1.3) focuses on the long-term indirect effects of Project clearing on inland (i.e., away from the reservoir) habitat. Long-term, indirect effects of the reservoir on terrestrial habitat are being monitored by a third study, the Long-Term Effects on Wetland Habitat study (TEMP, Section 2.5.3).

The Long-Term Effects on Inland Habitat study is the subject of this report.

The goal of the Long-Term Effects on Inland Habitat study is to determine the nature of long-term Project effects on terrestrial habitat and the extent of native habitat recovery during operation. The objectives of this study are to:

- Locate and quantify indirect Project effects on habitat;
- Locate and quantify areas recovering to native habitat; and,
- Locate and quantify long-term Project effects on habitat composition.

Monitoring under the Long-term Effects on Inland Habitat study begins during the operation phase because it is expected that such effects take several years to become substantive, and because some areas were still being impacted until the end of construction.

Indirect Project effects on habitat are effects that develop over time in response to an impact. For example, vegetation clearing will generally have numerous subsequent effects such as higher soil temperatures within the cleared area and adjacent uncleared areas. Additionally, clearing increases light and alters the microclimate in the understorey of the adjacent uncleared vegetation, which then leads to changes in soil conditions and vegetation composition.

Monitoring for this study began in 2022 and 2023 when permanent sample locations were established adjacent to Project clearing. This report describes sample locations established in 2023, and provides an overview of the habitat attributes at all the sample locations.

2.0 METHODS

2.1 APPROACH

Indirect Project effects on habitat are most likely to be observed in situations where Project impacts have created major alterations to environmental conditions. Vegetation clearing combined with site grading in mature forest was generally the predominant type of impact in native habitat. A second type of impact was flooding from the newly created reservoir. In this situation, the adjacent habitat is also affected by fluctuating water levels and wave action.

The North and South Access Roads were selected as the Project component that would be used to study long-term, indirect effects on inland (i.e., non-reservoir) terrestrial habitat. This component accounts for a high proportion of the vegetation clearing and site grading in mature forest habitat. Additionally, it is the Project component with a sufficiently long cleared edge to provide a reasonable level of replication of sample locations.

2.2 STUDY DESIGN

Project impacts and direct effects on habitat during construction were documented by the detailed mapping of Project clearing and physical disturbance as of September 2021 (i.e., the Construction Footprint; ECOSTEM 2022;Map 2-1).

The spatial limits for monitoring long-term effects on inland habitat were delineated as the Construction Footprint plus a 150 m buffer of it (Map 2-1). This was expected to capture the maximum potential extent of indirect effects of vegetation clearing and substrate grading. Indirect Project effects were expected to generally decline with distance from Project impacts. Based on research conducted in northern Manitoba, indirect habitat effects generally extended less than 25 m from the edge of the actual Project Footprint, and typically less than 15 m.

An impact-trend by time design was employed to document habitat change over time. Permanent sample locations were selected as a stratified, random sample of the most common terrestrial habitat types along the North and South access roads.

The locations and amounts of the various habitat types within the study area were obtained from the terrestrial habitat map (KHLP 2012b), which includes updates for the 2013 wildfire. The polygon areas were tabulated to determine the most common mature forest habitat types along the access roads.

Patches of mature forest along the access roads that met the following criteria were selected as potential sample locations: it was one of the most common mature forest habitat types; the patch had at least 150 m of frontage on the access road; the forest extended at least 100 m in a direction perpendicular to the access road; the patch was at least 100 m from the next closest suitable patch; and, the patch was relatively homogeneous. Patches meeting these criteria are referred to as stands.

For the geographic stratification, stands were classified as either north or south of the Nelson River. Potential sample stands were to be randomly selected from each of these two classes.

It was difficult to find stands that met the selection criteria because most of the forest along the North Access Road had burned in the 2013 wildfire, and most patches of relatively homogenous forest habitat along the roads were not large. Eleven potential sample stands were identified based on the desktop information available at the time. The habitat types represented by these stands were Jack pine (*Pinus banksiana*)/black spruce (*Picea mariana*) mixture on mineral substrate, Black spruce pure on mineral substrate, and Black spruce pure on thin peat substrate.

All eleven potential stands were selected for field evaluation to provide adequate replication for each habitat type, knowing that it was likely that some would be disqualified by the field evaluation.

The field evaluation determined that only five of the potential stands definitely met the selection criteria. These five stands were sampled in summer of 2022 (Map 2-2). The five stands included three habitat types (Table 2-1).

The suitability of the remaining six potential stands were evaluated using helicopter-based photos and other information acquired along the access roads in 2022. Using this information, an additional two stands were selected for sampling in 2023.

Table 2-1: Broad habitat types of stands sampled in 2022 and 2023 for Long-Term Effects on Inland Habitat

Fine Habitat Type	Number of Stands Sampled[1]	
	2022	2023
Jack pine mixture on mineral	1	1
Black spruce pure on mineral	1	
Black spruce pure on thin peatland	1	1
Black spruce mixture on mineral		1
Black spruce mixture on thin peatland		1

Notes: [1] Each stand sampled includes two transects. One jack pine mixture on mineral stand, and one black spruce pure on thin peatland stand was initially sampled in 2022, but had to be re-established in 2023 due to herbicide damage.

Two permanent transects were established in each sampled stand. The transect locations were determined in two steps:

1) Subdivide the stand frontage into two portions. Create two equal frontage portions if the minimum stand depth and habitat homogeneity is maintained along the entire frontage, or otherwise what the stand shape best allows; and,

2) Randomly locate one transect within each portion with the constraint that transect environment belts (see below) must be at least 20m apart to avoid overlap of tree sampling.

Each transect was subdivided into two segments: undisturbed and disturbed by the Project. Starting from the cleared edge, the undisturbed segment of the transect extended 30 m into the mature forest, while the disturbed segment extended 5 m into the clearing.

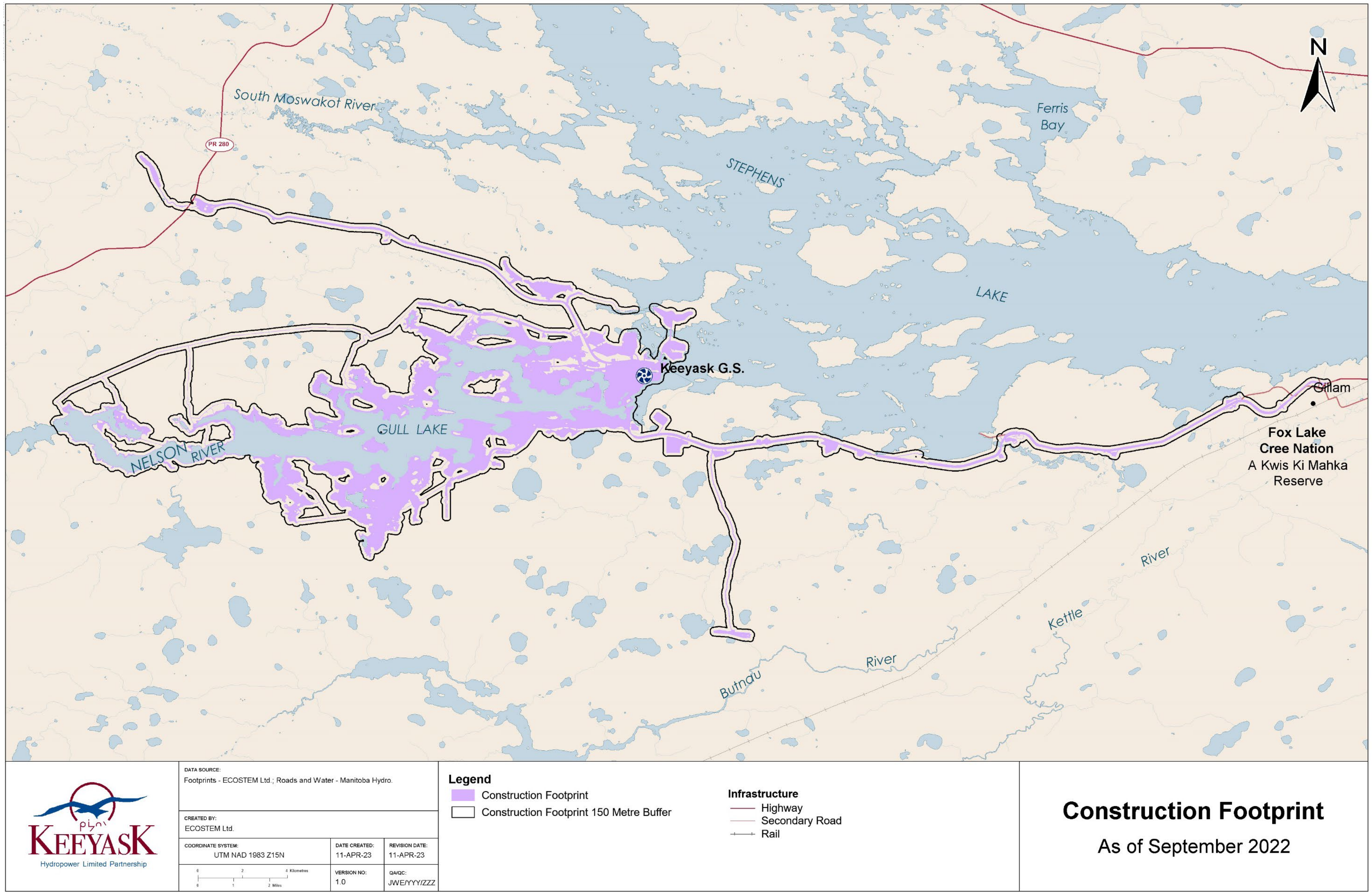
Large-scale mapping of the habitat within and surrounding the belt transects covering approximately 1.5 ha was produced to assess general conditions of the sampled stand, assess stand homogeneity, and monitor for potential Project related changes outside of the belt transect.

During the 2023 surveys it was observed that portions of four of the transects established in 2022 at two stands were inadvertently sprayed with herbicide, which killed or damaged the vegetation it contacted (Figure 2-1). As a result, all four transects were re-established at different locations within the same stands in 2023. Transect origins were shifted to a new location approximately 30m away to leave a 10m buffer between the damaged vegetation and the outer edge of the environment belt. In the field, it was confirmed that the new transect locations maintained the criteria for separation and fell within the same stand as the original locations.

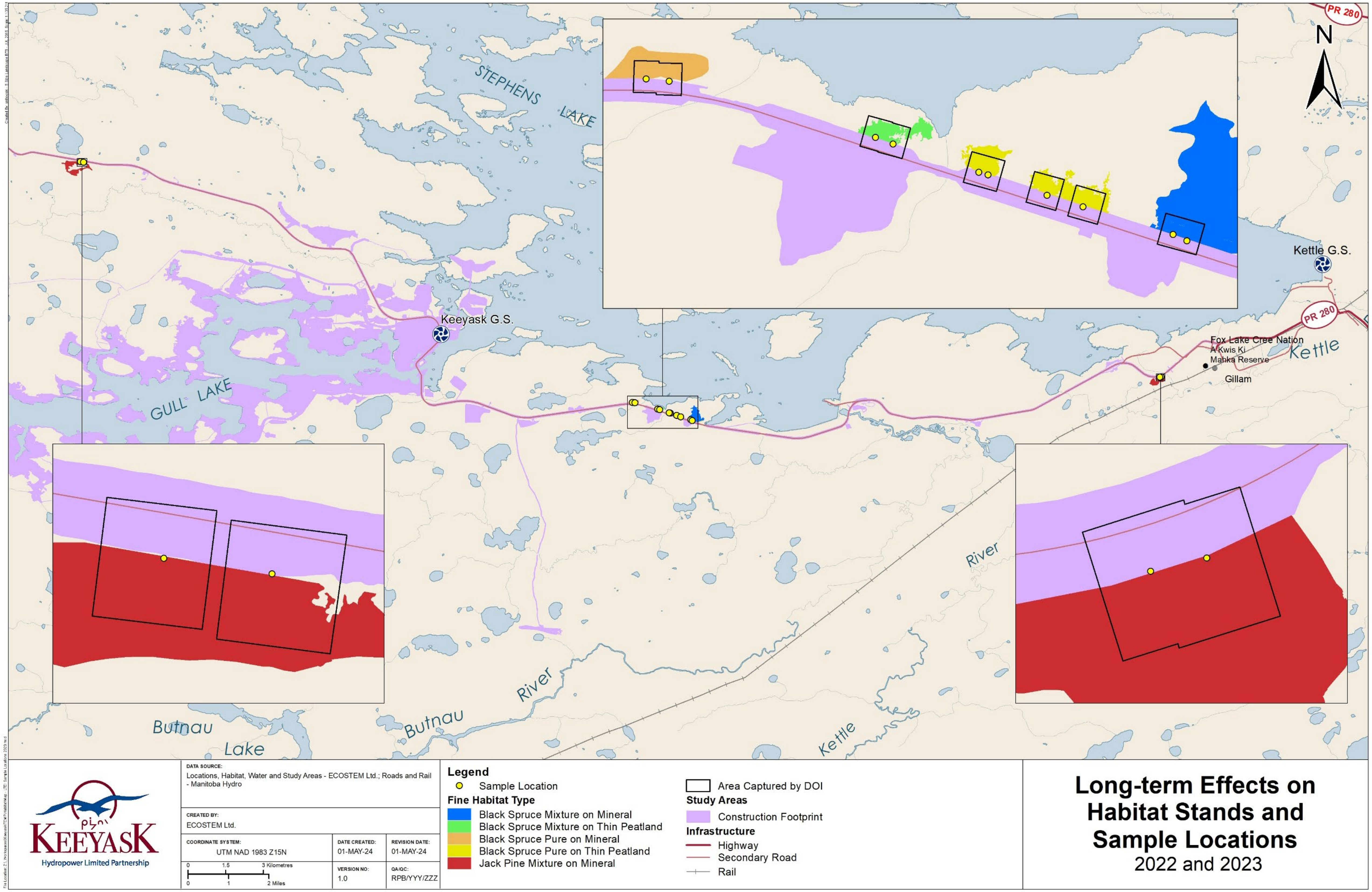
Dead jack pine saplings and tall shrubs at the disturbed segment of LTEIK042

A patch of dying vegetation around the transect origin and the disturbed segment of LTEIS061

Figure 2-1: Locations surveyed in 2022 that were accidentally herbicided, as of August 18, 2023



Map 2-1: Construction Footprint as of September 2022, and the area within a 150 m buffer



Map 2-2: **Long-Term Effects on Inland Habitat study stands and sample locations in 2022 and 2023**

2.3 DATA COLLECTION

2.3.1 DIGITAL ORTHORECTIFIED IMAGES

A drone acquired photos of the portion of the stand that included the ground transects. Photos were acquired of a 50m buffer of the transects (see Section 2.3.2). From this, a digital orthorectified image (DOI) of that portion of the transect buffer was created (i.e., the transect DOI). The imagery was used to confirm the homogeneity of the stand area that was sampled, as well as to monitor:

- Environmental conditions surrounding the transect;
- Overstorey canopy closure.

Drone photos were acquired at two altitudes above ground level. One set was acquired at 40 m to provide more detailed imagery used to identify smaller features and vegetation, and another set at 70 m to provide a wider overview, and imagery that can more accurately be georectified for mapping. Photos were acquired with forward and side overlap to produce a DOI for a 110 m wide band centred on each transect, and that extended from the center of the road (or 20 m into the infrastructure if it is not a road) to 50 m past the end of the undisturbed segment of the transect.

The photos were acquired using an Autel EVO II Pro drone equipped with a 20 MP RGB camera.

Drone photos were acquired on September 4, 2022, and September 19 and 20, 2023.

2.3.2 BELT TRANSECTS

The two transect locations for each of the selected stands were pre-determined in a geographical information system (GIS) prior to sampling using information available at the time. Each transect was centered on the frontage of homogenous patches reflecting the stand habitat type.

It was possible that the desktop information was inaccurate due to habitat changes since the habitat mapping was done, photo-interpretation errors, variations too small to map given the minimum polygon size, or subsequent disturbances.

The accuracy of the stand attributes and pre-determined transect locations were evaluated in the field. A stand that did not clearly meet the selection criteria was not sampled. The criteria that were evaluated at the transect location included the homogeneity of the localized habitat type, the general consistency of the vegetation type and the relative straightness of the forest edge. If needed and possible, the transect location was shifted along the frontage to a suitable location.

Once the transect location was determined the transect origin was established at the cleared edge (Photo 2-1). The transect was oriented perpendicular to the overall orientation of the cleared edge at the location.

Transect data were collected between July 8 and August 5, 2022 and July 29 and August 19, 2023.

2.3.2.1 UNDISTURBED TRANSECT SEGMENT

For the undisturbed segment of the transect, data were collected in four nested belts (Figure 2-2) referred to as the environment, tree, tall shrub and low vegetation belts. The nesting reflected finding a balance between the larger area needed to adequately represent the different vegetation components and sampling effort.

The attributes recorded in each belt were:

1. Environment belt
    - Used for vegetation structure and environment attributes.
    - 10 m wide belt with three consecutive 10 m X 10 m quadrats.
    - Attributes for each quadrat included structure class (Table 2-2), average canopy height, average percent slope and aspect, slope position (Figure 2-3), slope shape, and disturbance.
2. Tree belt
    - Used for trees and snags.
    - Trees and snags were tallied within a 4 m wide belt transect along the 30m transect.
    - Attributes for both trees and snags included distance along transect, perpendicular offset distance and direction (left or right), circumference at breast height (CBH, 1.3 m), and species.
    - Additional attributes for trees included tree condition (Table 2-3), and canopy position (Table 2-4).
    - Additional attributes for snags included snag condition (Table 2-5) and snag decay stage (Table 2-6).
3. Tall shrub belt
    - Used for tree recruitment and tall shrubs
    - Tree "pseudospecies": tree seedlings (height < 0.5m), tree saplings (height ≥ 0.5m), and tall shrub species (Table 2-7).
    - Stem tallies for each species within a 2 m wide belt transect for contiguous 2 m X 5 m quadrats.
4. Low vegetation belt
    - Used for plant species composition.
    - Presence by species within a 1 m wide belt transect for contiguous 25 cm X 100 cm quadrats.

2.3.2.2 DISTURBED TRANSECT SEGMENT

For the disturbed segment of the belt transect, the same attributes were recorded in the same way as for the undisturbed segment, except that the vegetation structure and environment belt was a 10 m X 5 m quadrat.

Photo 2-1: Belt transect setup showing a perpendicular view from disturbed to undisturbed segment of the transect at LTEIS064, on August 19, 2023

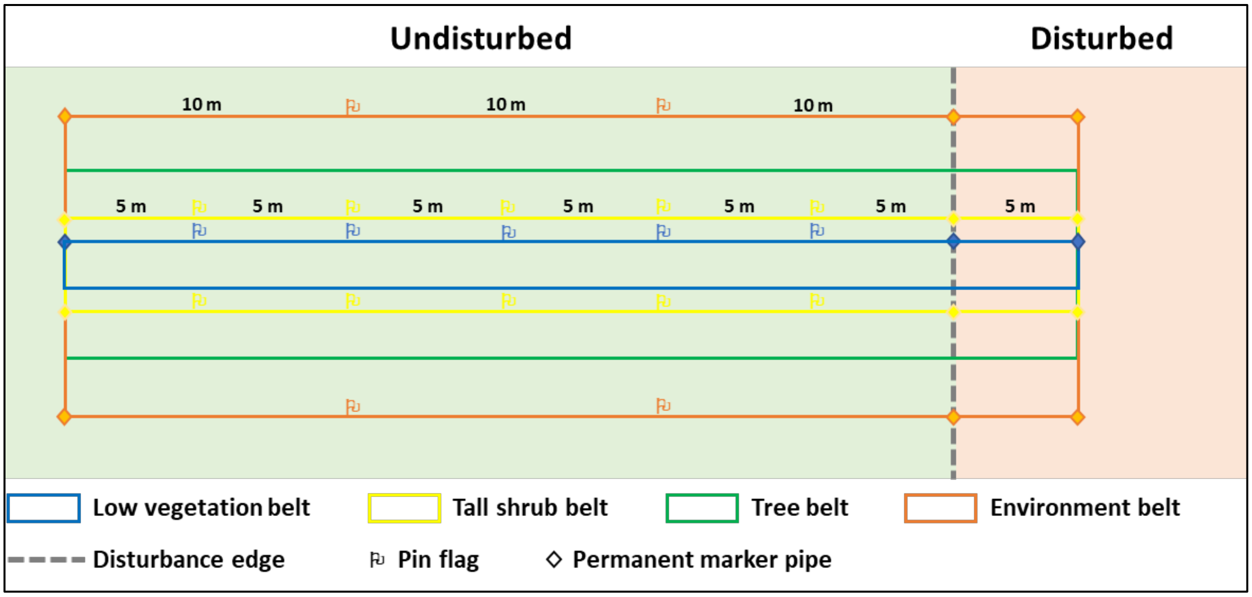


Figure 2-2: Layout of the nested belt transects

Table 2-2: Vegetation structure classes

Code	Type	Criteria
F	Forest	Dominated by trees (i.e., tree species with stems that are > 0cm in circumference) which have ≥ 75% canopy closure.
W	Woodland	Trees (i.e., tree species with stems that are > 0cm in circumference) form the canopy and trees have ≥ 25% and < 75% canopy closure.
T	Shrubland- Tall	Tall shrubs (shrub species whose height ≥ 0.5m) and/or saplings (tree species whose height > 0.5m and < 1.3m) form the canopy and have ≥ 25% cover.
L	Shrubland- Low	Low shrubs (shrub species whose height < 0.5m) or tree seedlings (tree species < 0.5m) form the canopy and have ≥ 25% cover.
G	Grassland/Herbland	Grasses and/or sedges and/or herbs form the canopy and have ≥ 25% cover.
B	Bryoid	Mosses, hepatics and/or lichens are the tallest vegetation with ≥ 25% cover.
S	Sparse	All vegetation combined has ≥ 25% cover if all of the strata are combined but no one stratum has ≥ 25% cover.
N	Barren	All vegetation combined has < 25% cover.
E	Edge	Used to identify the location of a hard edge. Occurs between two other structure types.

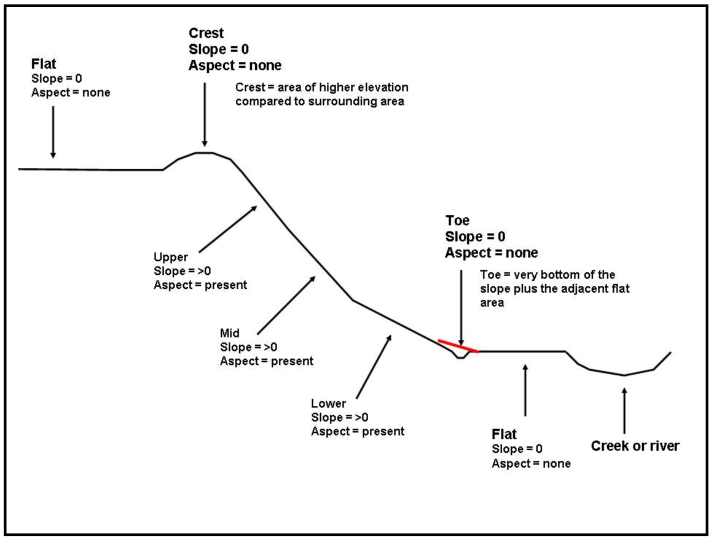


Figure 2-3: Slope Positions

Table 2-3: Tree condition

Code	Condition	Description
1	Intact	Tree has not sustained any damage (i.e. canopy and bole are intact)
2	Broken canopy	Majority of the branches in upper portion of tree are missing
3	Broken bole	Bole broken below canopy
4	Windfall	Tree uprooted by wind
5	Heart rot	Tree with evidence of heart rot
6	Disease	Evidence of other type of disease (e.g., conk)
7	Insect	Evidence of insect attack
8	Knocked down	Tree pushed over by forwarder/harvester as seen by bark scarring
9	Stump	Tree that was cut during Project Footprint clearing
10	Forked canopy	Canopy is forked
11	Browsed	Tree browsed by animals, damaged by birds (e.g. sapsuckers)
12	Dead top	Upper portion of tree canopy is dead

Table 2-4: Tree canopy position

Code	Position	Description
1	Veteran	Tree that survived last stand replacing disturbance
2	Dominant	Top of crown is not shaded by other trees
3	Sub-Dominant	Crown is in upper canopy but slightly below the crowns of dominant trees
4	Secondary	In second tier, if one exists
5	Understorey	Crown below the secondary and upper canopies
9	Not applicable	Stump or windfall

Table 2-5: Snag condition

Code	Condition	Description
1	Intact	Main stem and branches in canopy are unbroken
2	Broken canopy	Majority of the branches in upper portion of snag are missing
3	Broken bole	Entire canopy and upper portion of main stem axis broken off

Table 2-6: Snag decay stage

Code	Stage
1	Recently killed
2	Twigs and leaves lost; bark intact
3	Small branches lost; bark beginning to peel; wood hard
4	Only major branches remaining; >20% bark lost; wood condition soft to hard
5	Canopy broken; bark condition variable; wood conditions variable
6	Decomposing stump; wood soft; bark peeling

Table 2-7: Tall shrubs (includes tree saplings) identified during surveys in 2022 and 2023

Species	Common Name
Alnus alnobetula	Green alder
Betula papyrifera	Paper birch
Betula pumila	Bog birch
Larix laricina	Tamarack
Picea mariana	Black spruce
Pinus banksiana	Jack pine
Populus balsamifera	Balsam poplar
Prunus pensylvanica	Pin cherry
Rosa acicularis	Prickly rose
Rubus ideaus	Red raspberry
Salix arbusculoides	Shrubby willow
Salix bebbiana	Bebb's willow
Salix planifolia	Plane-leaved willow
Salix pseudomyrsinites	Myrtle-leaved willow
Salix spp	Other willow species
Viburnum edule	Mooseberry

The soil sampling method was intended to be sufficient, at a minimum, to detect moisture regime changes in the rooting zone. Soils were sampled in pits (Photo 2-2) and from soil cores obtained using a Dutch auger. The soil pits collected detailed soil information while the soil cores focused on moisture regime (Figure 2-4). Soil pits were dug at 1m and 10m. Soil cores was completed at 5m, 15m, 20m and 30m on the undisturbed segment of the transect, and at 1m and 5m on the disturbed segment.

Data recorded at soil pits included:

- LFH and/or organic matter depth.
- Depth to prominent mottling, gleying, ice, water table and bedrock.
- Soil horizon information, such as depth, texture and stoniness.
- Collected at 1m and 10m on the undisturbed segment of the transect.

Photo 2-2: Full soil pit from Stand 4, Transect 2

Portion of Transect	Distance (m)	Pit Type
Undisturbed	30	Moisture Regime
	20	Moisture Regime
	15	Moisture Regime
	10	Full
	5	Moisture Regime
	1	Full
Disturbed	1	Moisture Regime
	5	Moisture Regime

Figure 2-4: Locations and type of soil sampling

2.3.2.3 PLANT TAXA

Plant nomenclature followed the Manitoba Conservation Data Centre (MBCDC 2021) species and plant community database standards.

Plants recorded in the belt transects were identified to species if it was a taxon for which this was generally feasible in the field and to a taxon otherwise (Photo 2-3). Trees were recorded as pseudospecies based on growth form (Section 2.3.1). In this report, the singular "taxon" and plural "taxa" are used to refer to species, broader taxa, and pseudospecies collectively.

Additionally, plants of ecological concern (see Section 2.4.4) encountered between sampling locations were recorded as incidentals. These species were also included as incidentals in other monitoring studies (ECOSTEM 2024).

Photo 2-3: Recording plant species composition from low vegetation belt in undisturbed segment of the transect at LTEIS064, on August 19, 2023

2.4 DATA ANALYSIS

The objective of the data analysis for the permanent transect establishment (i.e., the data collected in 2022 and 2023) was to:

- Confirm the habitat type within the sampled portions of the stands;
- Confirm that the sampled portion of the stands met the criterial for homogeneity outlined in the study design (Section 2.2); and,
- Describe overall characteristics of the undisturbed and disturbed portions each the sampled stands, which will form the baseline for the evaluation of Project effects during operation.

2.4.1 HABITAT MAPPING

Analysis of the DOIs focused on confirming that the undisturbed portion of each stand met the homogeneity criteria (Section 2.2), and to map stand characteristics.

Homogeneity was assessed by interpreting the vegetation structure and canopy closure of the undisturbed portion of the habitat along each transect, and then comparing results for the two transects in a stand. The degree of homogeneity was characterized by the number of distinct patches within the undisturbed area, and the variety and proportion of distinct structure types for a given stand.

Distinct patches of vegetation structure were heads-up digitized over the transect DOI (Section 2.3.1). A minimum polygon size of 200 m^2 was used, which was small enough to capture localized differences in structure and disturbances that may be associated with possible variations in environmental conditions such as soil moisture regime.

The attributes that were interpreted included:

- Vegetation structure (Table 2-8)
- Upper canopy closure estimated to the nearest 10% class (1=10%, 2=20%, …, 10=100%)
- Recent disturbance type (e.g., windthrow, clearing)
- Recent tree mortality estimated to the nearest 10% class (1=10%, 2=20%, …, 10=100%)
- Precise location of the edge of the clearing edge

The mapped vegetation structure classes differed slightly from the vegetation structure class determined from the ground in the transects (see Section 2.3.2). This is because of the different criteria used to classify vegetation cover from above rather than below and using photo interpretation.

Table 2-8: Mapped vegetation structure classes and interpretation criteria

Division (based on dominant life form)	Code	Class	Criteria if the Dominant Stratum
Treed	F	Forest	61 - 100% cover with crowns overlapping.
	D	Woodland	26 - 60% cover with crowns generally not touching.
	S	Sparsely Treed	10 - 25% cover with crowns generally not touching.
Shrub	TS	Tall Shrub	Taller than 0.5m and cover > 25% with Trees < 10%; Cover can be less than 25% when the cover of each of the other life forms < 25% and shrub cover exceeds others.
	LS	Low Shrub	Up to 0.5m tall and cover > 25% with Trees < 10% and Tall Shrubs < 25%; Cover can be less than 25% when the cover of each of the other life forms < 25% and shrub cover exceeds others.
Herb	LG	Graminoid	Cover > 25% with Trees < 10% and Tall Shrubs < 25%; Can be less than 25% when the cover of each of the other life forms < 25% and graminoid cover exceeds others.
	LF	Forb	Cover > 25% with Trees < 10% and Tall Shrubs < 25%; Can be less than 25% when the cover of each of the other life forms < 25% and forb cover exceeds others.
Non-vascular	LB	Bryoid	Cover > 25% with Trees < 10% and Tall Shrubs < 25%; Can be less than 25% when the cover of each of the other life forms < 25% and bryoid cover exceeds others.
Bare ground	B	Sparse/Barren	All vegetation cover < 25%.

2.4.2 TRANSECT CHARACTERISTICS FROM GROUND SURVEYS

2.4.2.1 ENVIRONMENT AND SOILS

Environment attributes and soil data from both transects were pooled for each sample location pair. Descriptive statistics were generated for average slope, total quadrat occurrences for each slope position category, and total soil profile occurrences for each moisture regime and drainage regime category.

2.4.2.2 VEGETATION

Tree, snag, and tall shrub tallies were pooled for both transects for each sample location. Descriptive statistics for tree snag and tall shrub tallies included percent occurrence for each species.

Species distribution descriptive statistics were based on species data collected in the low vegetation belt. As this is the first data collection, all species occurring in at least 1 quadrat in one of the transects were retained for analysis.

Species meeting the criterion for inclusion were classified into the distribution classes shown in Table 2-9 based on the percentage of locations they were found in.

Table 2-9: Species distribution classes, calculated as a percentage of sample locations

Distribution Class	Percentage range	Generalized Distribution
Very Widespread	90% ≤ D ≤ 100%	Widely
Widespread	75% ≤ D < 90%	
Scattered	25% ≤ D < 75%	Narrowly
Localized	0% < D < 25%	
Absent	0%	Absent

2.4.3 TRANSECT HOMOGENEITY

Transect homogeneity was evaluated for each of the seven sampled stands by considering both: (1) broader-scale metrics, based on information derived from habitat mapping for the transect and the surrounding area; and (2) finer-scale metrics, based on information derived from the transect data.

Vegetation attributes for stands selected for sampling were originally mapped using 1:15,000 scale imagery, with a minimum patch size of 1,000 m^2 for most habitat types. While stands were generally homogeneous at that scale, potential indirect Project effects typically manifest at finer scales. At finer scales, stands become more heterogeneous (i.e., small openings, or changes in canopy closure or composition due to microsite conditions), the degree of which depending on the type of site, and/or the age of the stand. Vegetation structure and canopy closure mapped using the larger-scale drone DOI with a minimum polygon size of 200 m^2 was used to characterize the overall homogeneity of the undisturbed habitat within 50 m of the belt transect. Characteristics considered included:

1. Number of vegetation structure types present
2. Range of canopy closure
3. The ratio of patch edge length to total area

In order to evaluate homogeneity within the belt transect, environment, vegetation, and soil data were considered separately for each transect. Each transect was divided three 10m segments, with the first segment being adjacent to the disturbed edge (0 – 10 m into the undisturbed habitat), and the third segment being the furthest from the disturbed edge. Variables were compared for a total of six segments from two transects in each sampled stand. The transect data used to evaluate homogeneity included:

1. Number of different vegetation structure types across the segments
2. Tree species composition (as a percentage of tallied stems)
3. Number of different site types across the segments
4. Average thickness of the surface organic layer across the segments

2.4.4 PLANTS OF ECOLOGICAL CONCERN

Plant species of ecological concern were examined. These included priority and non-native plants.

Priority plants included species listed under the Manitoba *Endangered Species Act* (MESA), the *Species at Risk Act* (SARA) or the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), as well as species ranked provincially critically imperiled to vulnerable (S1 to S3 ranked).

Non-native plants included species that were categorized based on their level of invasive concern (Table 2-10 for classification criteria). Species in the level 1 and 2 concern levels were considered for immediate management within the Study Area where possible (ECOSTEM 2023).

Table 2-10: Levels of invasive concern for plants in the Project footprint

Invasive Concern Level	Plant Species Included
Level 1	Species the ISCM classifies as "Category 1" or "Category 2"
Level 2	Species the ISCM classifies as "other" or White et al. (1993) classify as "high" or "moderate" invasives
Level 3	Species that either White et al. (1993) classify as "minor" invasives, or government sources classify as noxious weeds or weed seed species[1]
Level 4	All remaining non-native plant species

Notes: [1] The government regulations list some native boreal plant species (e.g., foxtail barley) as weeds since they focus on species that are problematic for agriculture. Native boreal species appearing on these lists are not considered to be invasive for the Project area.

3.0 RESULTS

3.1 HABITAT MAPPING

The total area covered by the DOIs (Figure 3-1) for the five stands sampled in 2022 and 2023 was 20.2 ha (Table 3-1). The area covered for each stand ranged from 2.1 ha to 3.8 ha, depending on the distance between the two transects (separation less than 110 m resulted in overlap of the bands centred on each transect). The total area in undisturbed portions of the stands ranged from 1.2 ha to 2.2 ha (Table 3-1).

A total of four structure types were identified across the undisturbed portions of the stands (Table 3-2; Map 3-1), including forest structure (50% of the overall structure), woodland structure (45%), sparse treed (3%) and tall shrub structure (1%). Ninety-nine percent of the structure in the undisturbed portions of all the stands was treed. Forest was the dominant structure in all the stands, except for stand 6 and 7. Forest structure ranged from 56% to 100% of the undisturbed area where it was mapped (Table 3-2). Woodland made up the remaining structure, except for Stand 4 - where tall shrub structure and sparsely treed each formed one small patch covering 7% and 9% of the stand, respectively and Stand 8 - where a patch of sparsely treed covered 13% of the area.

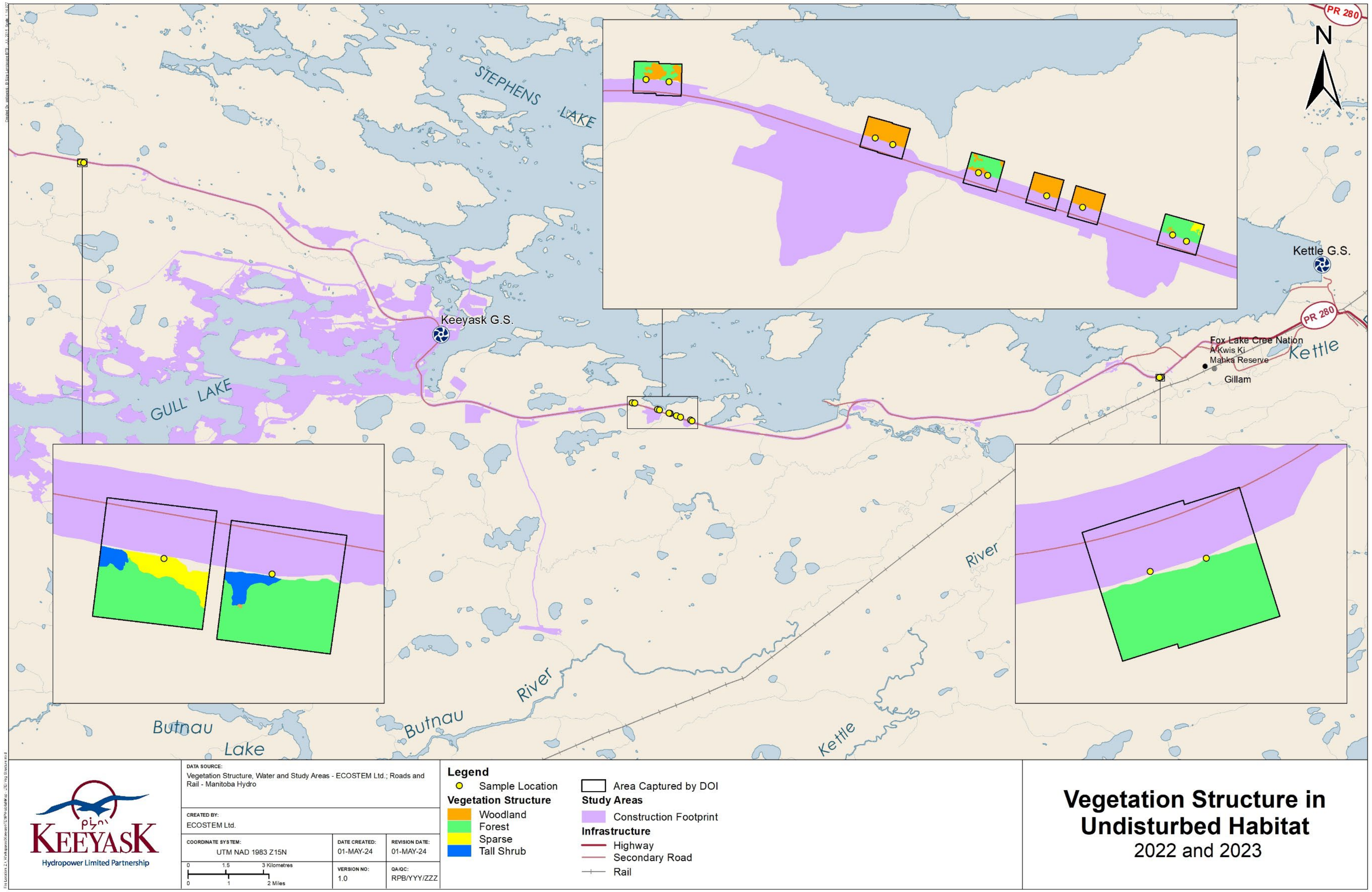
Figure 3-1: Example of DOI created for LTEIS07 (Stand 7, Transect 1 and 2) with interpreted fine-scale habitat polygons overlain. Blue outlined area is the 110m-wide band of habitat centred on the transect, with the undisturbed area subdivided by structure type and cover

Table 3-1: Total area mapped from the DOIs for the undisturbed and disturbed portions of each stand in 2022 and 2023

Stand Number	Stand Habitat Type	Area Mapped (ha)		
		Undisturbed	Disturbed	Both
1	Black spruce pure on mineral	1.6	1.3	3.0
2	Jack pine mixture on mineral	1.3	1.1	2.4
4	Jack pine mixture on mineral	2.1	1.6	3.7
5	Black spruce pure on thin peatland	1.2	1.0	2.1
6	Black spruce pure on thin peatland	2.2	1.6	3.8
7	Black spruce mixture on thin peatland	1.7	1.0	2.7
8	Black spruce mixedwood on mineral	1.5	1.0	2.5
All		*11.5*	*8.7*	*20.2*

Table 3-2: Vegetation structure composition of the undisturbed portions of stands covered by the DOIs in 2022 and 2023

Stand Number	Stand Habitat Type	Total Undisturbed Area (ha)	Percent of undisturbed area in structure type			
			Forest	Woodland	Sparse Treed	Tall Shrub
8	Black spruce mixture on mineral	1.5	83	3	13	-
7	Black spruce mixture on thin peatland	1.7	-	100	-	-
1	Black spruce pure on mineral	1.6	56	44	-	-
5	Black spruce pure on thin peatland	1.2	79	21	-	-
6	Black spruce pure on thin peatland	2.2	-	100	-	-
2	Jack pine mixture on mineral	1.3	100	-	-	-
4	Jack pine mixture on mineral	2.0	68	16	9	7
All		*11.4*	*50*	*45*	*3*	*1*



Map 3-1: Vegetation structure of habitat within 50m of the undisturbed portions of belt transects for stands sampled in 2022 and 2023

3.2 TRANSECT CHARACTERISTICS FROM GROUND SURVEYS

3.2.1 ENVIRONMENT AND SOILS

Across the seven stands, 56 10 m X 10 m environment quadrats were sampled in 2022 and 2023.

Quadrat slope varied from 0 to 17%, with 66% of quadrats having a slope of 3% or less. Most of the quadrats (41%) were in the lower slope position, while 34% were in the flat position, and the rest were split between the mid and upper slope (Table 3-3). Seventy-seven percent of the quadrats had a flat shape.

Soil data were collected at 28 full pits (two at each transect) and 84 auger pits, for a total of 112 soil profiles. For undisturbed portions of transects, the average organic matter thickness ranged from 6.3 cm to 38.2 cm, with a median average thickness of 20.3 cm (Figure 3-2). For disturbed portions of transects the average organic matter thickness ranged from 0 cm to 60 cm, with a median thickness of 8.3 cm.

Forty-five percent of the soil profiles had a moderately wet moisture regime (Table 3-4) and very poor drainage regime (Table 3-5). Most of the remaining profiles had a fresh moisture regime and were moderately well drained (43% and 42%, respectively).

Table 3-3: Environment quadrat slope position for stands sampled in 2022 and 2023

Position	Percent of quadrats
Flat	34
Lower	41
Mid	13
Upper	13
Total number of quadrats	*56*

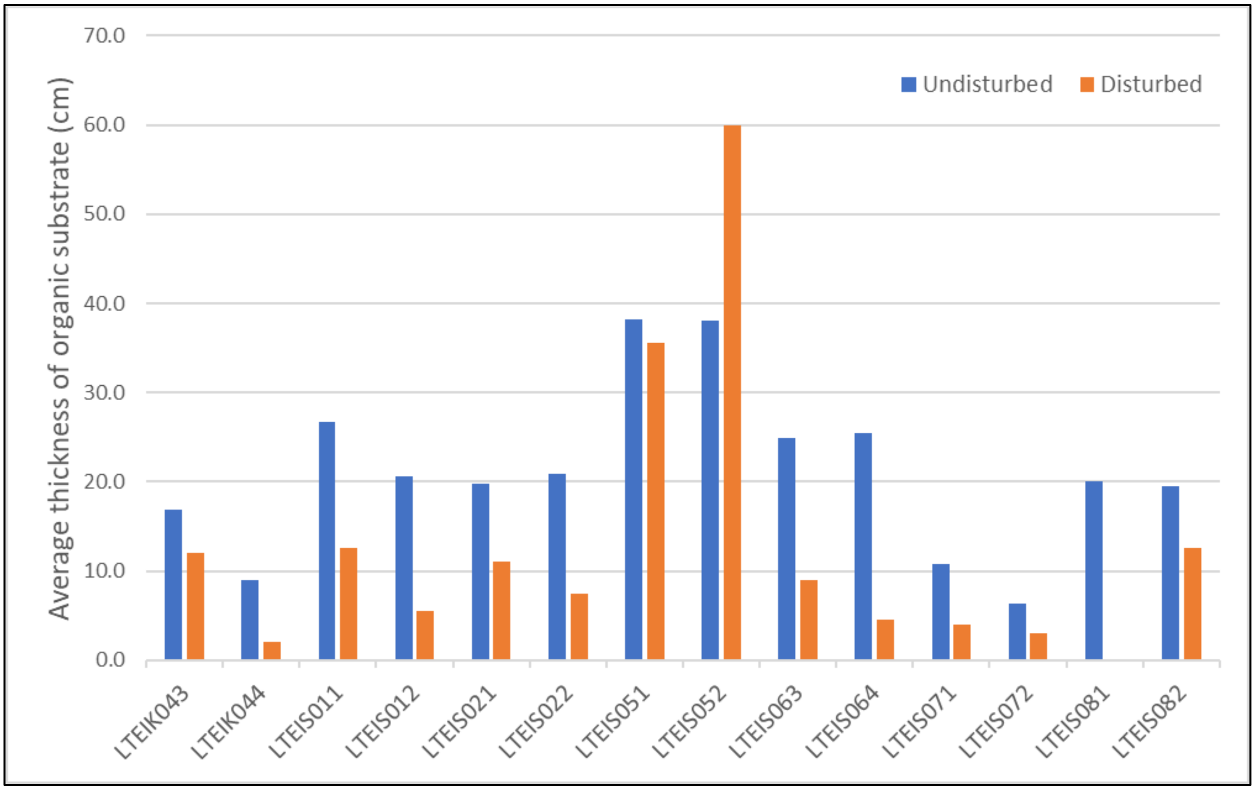


Figure 3-2: Average organic substrate thickness for undisturbed and disturbed portions of each transect sampled in 2022 and 2023

Table 3-4: Moisture regime for soil profiles sampled in 2022 and 2023

Moisture Regime	Percent of soil profiles
Moderately fresh	4
Fresh	43
Very Fresh	9
Moderately wet	45
Total number of soil profiles	*112*

Table 3-5: Drainage regime for soil profiles sampled in 2022 and 2023

Drainage Regime	Percent of soil profiles
Rapid	1
Well	13
Moderately well	42
Very poor	45
Total number of soil profiles	*112*

3.2.2 VEGETATION

Five tree species were recorded within the tree belts across all sampled stands (Table 3-6). Black spruce trees made up 88% of the trees tallied (and 52% of the snags). The next most abundant tree species were jack pine and balsam poplar (*Populus balsamifera*) at 4% each (and 30% and 4% of snags, respectively). Tree height ranged from 1.3 m to 18.5 m and maximum circumference at breast height was 75 cm. Nearly all trees were intact and 48% of the trees were dominant or co-dominant, and 33% were in the understorey.

Black spruce saplings and seedlings made up 90% of total tree recruitment (Table 3-7). In addition to the other four tree species, trembling aspen (*Populus tremuloides*) recruitment contributed a small amount to the total recruitment recorded.

Table 3-6: Tree and snag species counts within the tree belt over all transects sampled as a percentage of total stems tallied in 2022 and 2023

Common Name	Species	Percent of tree stems	Percent of snag stems
White birch	*Betula papyrifera*	3	5
Tamarack	*Larix laricina*	1	-
Black spruce	*Picea mariana*	88	52
Jack pine	*Pinus banksiana*	4	30
Balsam poplar	*Populus balsamifera*	4	4
Unknown		-	10
Total stems		*1,465*	*126*

Table 3-7: Tree recruitment species counts within the shrub belt over all transects sampled as a percentage of total stems tallied in 2022 and 2023

Pseudospecies	Percent of recruitment stems
Paper birch sapling	1
Paper birch seedling	0
Tamarack sapling	0
Tamarack seedling	0
Black spruce sapling	20
Black spruce seedling	73
Jack pine sapling	0
Jack pine seedling	1
Balsam poplar sapling	1
Balsam poplar seedling	2
Trembling aspen sapling	0
Trembling aspen seedling	0
Total stems	*1,099*

Green alder (*Alnus alnobetula*) made up 62% of the tallied shrub stems (Table 3-8). Prickly rose (*Rosa acicularis*; 17%), red raspberry (*Rubus idaeus*; 9%) and Bebb's willow (Salix *arbusculoides*; 6%) were the next most abundant shrub species, of the 13 shrub species recorded during surveys.

Table 3-8: Shrub species counts within the shrub belt during the first survey of Long-Term Effects on Inland Habitat, in 2022 and 2023

Common Name	Species	Percent of recruitment stems
Green alder	*Alnus alnobetula*	62
Bog birch	*Betula pumila*	0
Red-osier dogwood	*Cornus sericea*	0
Pin cherry	*Prunus pensylvanica*	0
Alder-leaved buckthorn	*Endotropis alnifolia*	1
Prickly rose	*Rosa acicularis*	17
Red raspberry	*Rubus ideaus*	9
Shrubby willow	*Salix arbusculoides*	0
Bebb's willow	*Salix bebbiana*	6
Plane-leaved willow	*Salix planifolia*	1
Myrtle-leaved willow	*Salix pseudomyrsinites*	0
Soapberry	*Shepherdia canadensis*	0
Mooseberry	*Viburnum edule*	3
Total stems		*1,465*

Plant taxa recorded in the low vegetation belt included 71 vascular plants, five moss and five lichen species or broader taxa (See Appendix Table 6-2 for species list). A pseudospecies is a characterisation of the tree species into their height classes. A tree pseudospecies is therefore recorded as a seedling, sapling, or tree, based on its height.

3.2.2.1 UNDISTURBED PORTION OF TRANSECTS

Tree recruitment (seedlings and saplings) in the undisturbed segment included ten species (Table 3-9). Black spruce seedlings and saplings accounted for 95% of the stems counted in the shrub belt of the undisturbed portion. Jack pine seedlings, balsam poplar saplings and seedlings accounted for 1% of the recorded stems each.

Eleven tall shrub taxa were recorded in the tall shrub belt of the undisturbed segment across all locations (Table 3-10). Green alder and prickly rose were the most abundant species in the undisturbed segment.

Table 3-9: Tree recruitment stems as a percentage of total within the tall shrub belt in the disturbed and undisturbed segments for transects sampled in 2022 and 2023

Pseudospecies	Percent of stems in undisturbed segment	Percent of stems in disturbed segment
Paper birch sapling	0	5
Paper birch seedling	-	2
Tamarack sapling	0	-
Tamarack seedling	0	1
Black spruce sapling	20	19
Black spruce seedling	75	48
Jack pine sapling	0	1
Jack pine seedling	1	-
Balsam poplar sapling	1	4
Balsam poplar seedling	1	16
Trembling aspen sapling	0	1
Trembling aspen seedling	0	2
Total tallied stems	*1,016*	*83*

Notes: [1]Numbers that round to zero shown as "0"; absences shown as "-"

Table 3-10: Tall shrub stems as a percentage of total within the tall shrub belt in the disturbed and undisturbed segments for transects sampled in 2022 and 2023

Common Name	Species	Percent of stems in undisturbed segment	Percent of stems in disturbed segment
Green alder	*Alnus alnobetula*	70	35
Bog birch	*Betula pumila*	0	-
Dogwood	*Cornus sericea*	-	0
Pin cherry	*Prunus pensylvanica*	-	0
Alder-leaved buckthorn	*Endotropis alnifolia*	1	-
Prickly rose	*Rosa acicularis*	16	21
Red raspberry	*Rubus ideaus*	2	31
Shrubby willow	*Salix arbusculoides*	0	2
Bebb's willow	*Salix bebbiana*	4	10
Plane-leaved willow	*Salix planifolia*	1	-
Myrtle-leaved willow	*Salix pseudomyrsinites*	0	-
Unidentified willow	*Salix* spp.	0	-
Mooseberry	*Viburnum edule*	4	1
Total stems		*2,251*	*643*

Notes: [1]Numbers that round to zero shown as "0"; absences shown as "-"

In the undisturbed portion of the transects, 10 taxa (Table 3-11) were found to be widely distributed, six of which were very widespread (see Table 2-9 for class definitions).

Very widespread species included black spruce (Photo 3-1), Labrador-tea (*Rhododendron groenlandicum*) (Photo 3-2), prickly rose (Photo 3-3), bog cranberry (*Vaccinium vitis-idaea*), red-stemmed feather moss (*Pleurozium schreberi*) and stairstep moss (*Hylocomium splendens*). Black spruce, bog cranberry, red-stemmed feather moss and stairstep moss were found in all undisturbed segments. All the remaining very widespread taxa were found in the undisturbed segment of all but one of the locations.

The widespread taxa in the undisturbed segment included green alder, Bebb's willow, bunchberry (*Cornus canadensis*) and leaf lichen.

Table 3-11: Distribution (presence as a percentage of all locations) of very widespread, widespread and scattered taxa during the first Long-Term Effects on Inland Habitat survey, 2022 and 2023

Distribution	Undisturbed Segment	Disturbed Segment
Very Widespread	Stairstep moss Black spruce Red-stemmed feather moss Labrador-tea Prickly rose Bog cranberry	
Widespread	Green alder Bunchberry Leaf lichen Bebb's willow	Black spruce

Photo 3-1: Black spruce trees growing along the undisturbed segment of the transect at LTEIS081 on August 8, 2023

Photo 3-2: Labrador tea growing in the undisturbed segment at LTEIS072 on July 30, 2023

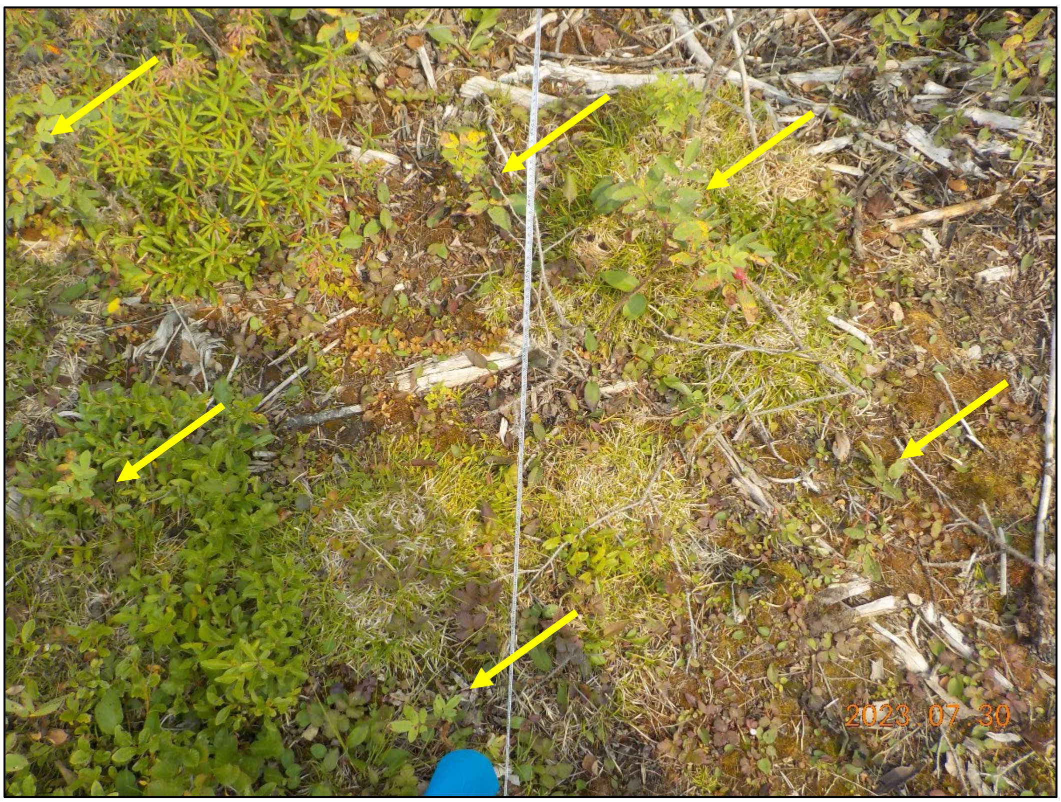


Photo 3-3: Prickly rose (shown with *yellow arrows*) growing within the disturbed segment at LTEIS072 on July 30, 2023

3.2.2.2 DISTURBED PORTION OF TRANSECTS

In the disturbed portion of the transects, tree recruitment (seedlings and saplings) included the same four species as in the undisturbed segment. Black spruce seedlings and saplings accounted for 67% of the stems counted in the disturbed portion of the transects (Table 3-9). Balsam poplar saplings and seedlings made up 20% of the tree recruitment stems (Photo 3-4).

Photo 3-4: A healthy patch of balsam poplar at the disturbed segment of LTEIS063 as of August 18, 2023

Eight tall shrub taxa were recorded in the tall shrub belt of the disturbed segment across all stands (Table 3-10). Green alder, red raspberry and prickly rose were the most abundant tall shrubs in the disturbed segment, followed by Bebb's willow.

In the disturbed segment of the transects only a single species, black spruce, was widely distributed (Table 3-11; Photo 3-5). The remaining species recorded either had a scattered or localized distribution in the disturbed portions of transects overall.

Photo 3-5: Black sprue (*yellow arrows*) and tall shrubs along the disturbed segment at LTEIS071 as of July 29, 2023

3.3 TRANSECT HOMOGENEITY

3.3.1 HOMOGENEITY WITHIN THE STAND

Most stands had some degree of variation in vegetation structure and canopy closure within the areas mapped. The number of structure types within the stands ranged from one to four (Table 3-12), although a single structure type dominated most of the stands in terms of percentage of total area (see Table 3-2). The stands with the most variety of structure types were Stands 4 and 8.

Based on mapped canopy closure classes, different stands had more or less of a range in closure. The lowest was zero in Stand 2, where the entire area had an upper canopy closure between 81% and 90%. Stands 4 and 8 had the most variation, with closures ranging from 21% to 80%.

Table 3-12: Structural type variation and canopy closure range in the mapped portions of sampled stands in 2022 and 2023

Stand Number	Stand Habitat Type	Number of structure types present	Mapped canopy closure range[1]
8	Black spruce mixedwood on mineral	3	11 - 80%
7	Black spruce mixture on thin peatland	1	21 - 60%
1	Black spruce pure on mineral	2	31 - 90%
5	Black spruce pure on thin peatland	2	21 - 80%
6	Black spruce pure on thin peatland	1	21 - 60%
2	Jack pine mixture on mineral	1	81 - 90%
4	Jack pine mixture on mineral	4	11 - 80%

Notes: [1] Based on the lower and upper bounds of the minimum and maximum 10% canopy closure classes mapped from the transect DOIs

3.3.2 HOMOGENEITY WITHIN THE BELT TRANSECT

Eighty-six percent of the 10m undisturbed segments were recorded as woodland during ground surveys (Table 3-13, Figure 3-3). Of the 14, only three had segments that were vegetation structures other than woodland. Two transects in two different stands had more than one vegetation structure type across the segments (Table 3-13). This included a single transect at Stand 4, where tree cover was high enough in the 20-30m segment to qualify as woodland structure, and one transect in Stand 7, where tree cover was low enough in the 10-20m segment to classify it as low shrub structure. For all remaining stands and transects, vegetation structure was consistent within 30m of the cleared edge.

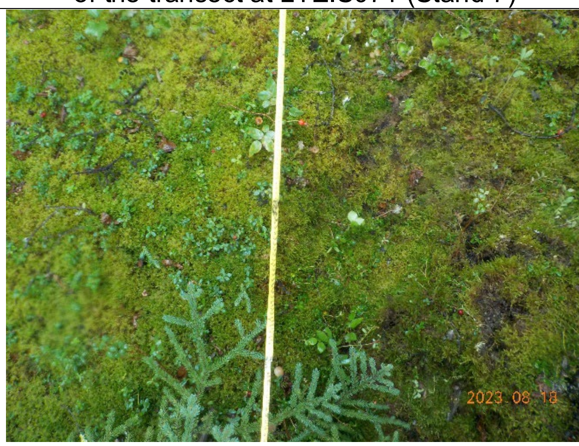
 Black sprue woodland along undisturbed segment of the transect at LTEIS071 (Stand 7)	 Mixed woodland and tall shrub structure in undisturbed segments of LTEIK043 (Stand 4)
 Ground covered by bryoid in undisturbed segment of the transect at LTEIS063 (Stand 6)	 Transition edge of the disturbed and undisturbed segment at the origin of LTEIS081 (Stand 8)

Figure 3-3: Different vegetation structure within disturbed and undisturbed segments of the transects as of July/August 2023

Table 3-13: Number of 10m segment recorded for each vegetation structure in the undisturbed portions of each stand in 2022 and 2023

Stand Number	Transect	Number of 10m segments in structure type		
		Woodland	Tall Shrub	Low Shrub
1	1	3		
	2	3		
2	1	3		
	2	3		
4	3		3	
	4	1	2	
5	1	3		
	2	3		
6	3	3		
	4	3		
7	1[1]	2		1
	2	3		
8	1	3		
	2	3		
All		*36*	*5*	*1*

Notes: [1] The first segment of this location was different than the second

Percent tree species composition was based on stem tallies for each of the 10m segments (Table 3-14). Black spruce was the leading species in all segments of all stands except for Stand 4, which was jack pine mixture on mineral soil habitat. The two black spruce pure on thin peatland stands (Stands 5 and 6) were dominated by black spruce, but some segments had a minor component of tamarack, and in one case balsam poplar. The black spruce mixture on thin peatland and black spruce mixture on mineral stands were both nearly pure black spruce within the belt transects. Four out of 12 segments in those two stands had jack pine, but not more than 5% of the stems tallied (Table 3-14).

Of the two jack pine mixture on mineral soil stands, Stand 2 was dominated by black spruce, with one transect having only black spruce stems. The other transect only had jack pine in the segments 10-30m from the cleared edge. In Stand 4, jack pine was the leading tree species only in the 10-20m segment. Broadleaf species dominated the 0-10m segment, while an even jack pine and black spruce mixture formed the needleleaf component of the 20-30m segment.

In all the above cases, composition differences were due to variability in microsite conditions, and the patchy nature of species cover in the stand as a whole.

Average organic substrate thickness was calculated for each of the 10m segments (Table 3-15). Organic matter thickness overall ranged from 6 cm to 48 cm. In general, organic substrate thickness was variable between segments within a stand. Five of the fourteen locations had a range in organic matter thickness of 10 cm or more, but organic thickness for all segments was within the range expected for the habitat type.

Site type (Table 3-16) was consistently recorded as either deep dry mineral or feathermoss bog in each of the soil pits surveyed, except for one case, where the site type was found to be moderately deep mineral (Stand 1, Transect 2). Segments within two black spruce pure on thin peatland stands were entirely typed as feathermoss bog, and three stands (Stands 4, 7 and 8) were entirely deep dry mineral. Two stands had segments that fell within both the deep dry mineral and feathermoss bog types (Stands 1 and 2). While these two site types are apparently quite different, the distinction between a deep dry mineral site and feathermoss bog is due to an organic material thickness less or more than 20cm. In both stands, average organic thickness for the segments was very close to that cutoff value.

Table 3-14: Tree composition as percent of the total number of stems tallied by segment for the undisturbed portions of each stand in 2022 and 2023

Stand	Transect	Stand Habitat Type	Segment 1 (% of stems)					Segment 2 (% of stems)					Segment 3 (% of stems)				
			Jack pine	Black spruce	Balsam poplar	White birch	Tamarack	Jack pine	Black spruce	Balsam poplar	White birch	Tamarack	Jack pine	Black spruce	Balsam poplar	White birch	Tamarack
1	1	Black spruce pure on mineral	-	100	-	-	-	-	100	-	-	-	-	100	-	-	-
	2	Black spruce pure on mineral	-	100	-	-	-	-	100	-	-	-	-	100	-	-	-
2	1	Jack pine mixture on mineral	-	100	-	-	-	-	100	-	-	-	-	100	-	-	-
	2	Jack pine mixture on mineral	-	100	-	-	-	5	90	-	5	-	13	87	-	-	-
4	3	Jack pine mixture on mineral	40	-	-	60	-	60	20	-	20	-	25	33	-	33	8
	4	Jack pine mixture on mineral	20	-	80	-	-	70	-	30	-	-	36	36	27	-	-
5	1	Black spruce pure on thin peatland	-	100	-	-	-	-	97	-	-	3	-	92	-	-	8
	2	Black spruce pure on thin peatland	-	80	-	-	20	-	100	-	-	-	-	93	-	-	7
6	3	Black spruce pure on thin peatland	-	82	18	-	-	-	100	-	-	-	-	100	-	-	-
	4	Black spruce pure on thin peatland	-	100	-	-	-	-	100	-	-	-	-	94	-	-	6
7	1	Black spruce mixture on thin peatland	-	100	-	-	-	2	98	-	-	-	-	100	-	-	-
	2	Black spruce mixture on thin peatland	5	95	-	-	-	-	100	-	-	-	-	100	-	-	-
8	1	Black spruce mixture on mineral	-	100	-	-	-	-	100	-	-	-	-	100	-	-	-
	2	Black spruce mixture on mineral	-	100	-	-	-	2	98	-	-	-	5	95	-	-	-

Table 3-15: Average organic matter thickness by segment for the undisturbed portions of each stand in 2022 and 2023

Stand	Transect	Stand Habitat Type	Average Organic Matter Thickness (cm)			Range
			1	2	3	
1	1	Black spruce pure on mineral	24	25	32	9
	2	Black spruce pure on mineral	12	22	29	17
2	1	Jack pine mixture on mineral	20	20	21	1
	2	Jack pine mixture on mineral	18	19	26	8
4	3	Jack pine mixture on mineral	12	18	21	9
	4	Jack pine mixture on mineral	6	10	12	7
5	1	Black spruce pure on thin peatland	48	35	32	16
	2	Black spruce pure on thin peatland	45	40	29	16
6	3	Black spruce pure on thin peatland	28	25	22	6
	4	Black spruce pure on thin peatland	25	24	28	4
7	1	Black spruce mixture on thin peatland	8	13	12	5
	2	Black spruce mixture on thin peatland	6	6	7	1
8	1	Black spruce mixture on mineral	13	27	21	14
	2	Black spruce mixture on mineral	14	20	25	12

Table 3-16: Number of soil pits recorded by site for the undisturbed portions of each stand in 2022 and 2023

Stand	Transect	Stand Habitat Type	Site type		
			Moderately deep mineral	Deep dry	Feathermoss Bog
1	1	Black spruce pure on mineral			6
	2	Black spruce pure on mineral	1	2	3
2	1	Jack pine mixture on mineral		3	3
	2	Jack pine mixture on mineral		3	3
4	3	Jack pine mixture on mineral		3	3
	4	Jack pine mixture on mineral		6	
5	1	Black spruce pure on thin peatland			6
	2	Black spruce pure on thin peatland			6
6	3	Black spruce pure on thin peatland		2	4
	4	Black spruce pure on thin peatland			6
7	1	Black spruce mixture on thin peatland		6	
	2	Black spruce mixture on thin peatland		6	
8	1	Black spruce mixture on mineral		4	2
	2	Black spruce mixture on mineral		3	3

3.4 PLANTS OF ECOLOGICAL CONCERN

No MESA, SARA or COSEWIC listed species (see Appendix1, Table 6-1) or provincially critically imperiled or imperiled (S1 or S2 rank) were found along any of the sample transects, nor were they incidentally found near any of the sample locations.

Bebb's willow (Photo 3-6) and thick-spike wildrye (*Elymus lanceolatus*), were the only provincially possibly imperiled (S2S3) or vulnerable species recorded during habitat surveys. One individual of each was found along two different transects during the 2023 survey. None of the remaining provincially critically imperiled to vulnerable species that had been identified in the EIS (KHLP 2012a) were found along the sampled transects, or incidentally during surveys.

Photo 3-6: Shrubby willow recorded in the disturbed segment of transect at LTEIS071 in 2023

None of the non-native Level 1 or 2 species of invasive concern were identified.

Only two Level 3 invasive species, alfalfa (*Medicago sativa*; Photo 3-7) and dandelion (*Taraxacum officinale*), were recorded on the disturbed segment of both transects in stand 8 during the 2023 surveys.

Photo 3-7: Alfalfa growing right at the end of disturbed segment at LTEIS081 on August 08, 2023

4.0 DISCUSSION

The primary purpose of monitoring for the Long-Term Effects on Inland Habitat study in 2022 and 2023 was to establish permanent sample locations and collect the baseline data needed to evaluate long-term effects following subsequent surveys. To identify potential Project effects in the analysis of change over time, it was important to document existing transect heterogeneity that was unrelated to Project clearing. High within-transect heterogeneity would reduce the statistical power of change analysis.

Based on the drone DOIs, habitat in a 110m band centered on the transects was patchy in most of the stands using one metric but not the others. The patchiness in all the stands was primarily due to variability of canopy closure. The degree of variability was typical of natural stands of the age class. All the sampled stands were mature, with the youngest being 56 years old (Stand 8), originating after a fire in 1967. As a stand matures, patchiness in cover will increase as trees die and fall creating gaps in the canopy (i.e., the “gap dynamics” successional stage). These gaps also result in patchy cover in the understorey, as light reaches the forest floor and previously supressed vegetation, including broadleaf and tall shrubs, grow to fill the gap. The within-transect variability of canopy closure fell within the range of natural variability.

Based on the transect data, the variation in vegetation structure, substrate conditions and vegetation composition within and between the transects in each stand were small, and within the range expected for a homogeneous stand at the scale of the habitat map used to select stands. Also, the conditions within the belt transects appeared to be representative of the conditions within 50m of the transects.

The baseline data collection identified a revision to the study design. While the original stand-level mapping used to select stands was accurate, the portions of those stands sufficiently homogenous for permanent transect monitoring was often a different type than the overall stand. This outcome was not surprising as it was a natural consequence of the minimum size for mapped polygons. Going forward, the analyses will focus on the classification of the portion of the stand that was sampled rather than the overall stand. At this spatial level, the descriptive analysis results confirmed that the areas selected for monitoring long-term effects on inland habitat met the criteria for homogeneity.

5.0 SUMMARY AND CONCLUSIONS

The Long-Term Effects on Inland Habitat study is monitoring the nature of long-term Project effects on inland terrestrial habitat, and the extent of native habitat recovery during operation. This report describes the methods used to establish the permanent sample locations, and provides an overview of the habitat attributes at these locations.

This study conducts periodic surveys at permanent sample locations along the North and South access roads. Fourteen permanent sample locations were established in 2022 and 2023. Permanent sample locations were selected as a stratified, random sample of the most common terrestrial habitat types along the North and South access roads. It was difficult to find mature, relatively homogenous forest stands because most of the forest along the North Access Road had burned in the 2013 wildfire, and most patches of relatively homogenous forest habitat along the roads were not large. Eleven potential sample stands were identified based on the desktop information available at the time. All eleven potential stands were selected for field evaluation to provide adequate replication for each habitat type, knowing that it was likely that some would be disqualified by the field evaluation.

A field evaluation in 2022 found that only five of the eleven potential sample stands satisfied all selection criteria. Helicopter-based photos and other information acquired along the access road in 2022 identified an additional two stands suitable for sampling, increasing the total number of potential stands to seven.

In the summers of 2022 and 2023, permanent sample transects were established and surveyed on the ground and by drone within seven mature forest stands. These stands represented five jack pine and black spruce habitat types, which were jack pine mixture on mineral soil, black spruce pure on mineral soil, black spruce pure on thin peatland, black spruce mixture on mineral soil, and black spruce mixture on thin peatland. Four transects initially sampled in 2022 had to be re-located in 2023 as they were inadvertently herbicided.

Black spruce was by far the most common tree and snag species recorded in the tree belt. Black spruce seedlings accounted for 95% of the tree recruitment stems in the undisturbed segment of the tall shrub belt, and 67% in the disturbed segment. Jack pine saplings and seedlings accounted for a combined 1% of the stems in the disturbed segment.

Green alder accounted for 70% of the tall shrub stem counts in the undisturbed segment shrub belt, followed by prickly rose which accounted for 16% of the tallied stems. Green alder accounted for 35% of the stems in the disturbed segments, followed by red raspberry at 31% and prickly rose at 21%.

Of the 81 taxa (i.e., species, species group, or tree growth form) recorded on the transects, 10 were found to be widely distributed in the undisturbed segment of the seven stands that were sampled, six of which were very widespread. In the disturbed segment, one species, black spruce, was widely distributed.

A high degree of homogeneity increases confidence that changes detected over time are Project-related because it better controls for potential confounding factors, and increases statistical power to detect effects. The DOIs created from drone photos indicated a high degree of homogeneity in all the stands sampled in 2022 and 2023. Nearly 100% of the undisturbed habitat across all stands was treed. Variation in canopy closure was within the range of natural variability for mature black spruce and jack pine stands. Openness, and variation was between two adjacent structure classes, which were forest and woodland. Three of the stands had no variation in structure class over the entire DOI area.

Comparison of vegetation and site attributes across segments along the undisturbed portions of the belt transects found that the homogeneity criteria were met. Tree species composition within the belt transects for three of the seven stands indicated that the local habitat type (within the transect) was somewhat different than the habitat type of the overall stand. This possible outcome was expected. While the original stand-level mapping used to select stands was accurate, the portions of those stands sufficiently homogenous for permanent transect monitoring was a different type than the overall stand for some stands. This finding was a natural consequence of the minimum size for mapped polygons. Going forward, the analyses will focus on the classification of the portion of the stand that was sampled rather than the overall stand. Habitat types for the sampled portion of the stands were reclassified on this basis.

No plant species of very high conservation concern (i.e., MBCDC ranked S1 or S2) were recorded either on the transects or incidentally during fieldwork.

No non-native plant species of the highest invasive concern (Level 1 or 2) were recorded along the transects, or incidentally during surveys. Two Level 3 species, alfalfa and common dandelion, were recorded in the disturbed portion of transects at Stand 8.

The second year of sampling for the Long-term Effects on Inland Habitat study will take place in summer, 2024, to collect data on conditions during the third year of Project operation. All of the transects sampled in 2022 and 2023 will be re-sampled.

6.0 LITERATURE CITED

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APPENDIX 1: SPECIES LISTS

Table 6-1: SARA, COSEWIC and MESA listed endangered species which occur in Manitoba

Species	Common Name	SARA	COSEWIC	MESA
Endangered				
Agalinis aspera	Rough agalinis	X	X	X
Agalinis gattingeri	Gattinger's agalinis	X	X	X
Chenopodium subglabrum	Smooth goosefoot			X
Cypripedium candidum	Small white lady's-slipper	X		X
Pellaea gastonyi	Gastony's cliffbrake			X
Platanthera praeclara	Western prairie fringed-orchid	X	X	X
Spiranthes magnicamporum	Great Plains lady's tresses			X
Vernonian fasciculata	Fascicled ironweed	X	X	X
Threatened				
Bouteloua dactyloides	Buffalograss			X
Celtis occidentalis	Common hackberry			X
Chenopodium subglabrum	Smooth goosefoot	X	X	
Cypripedium candidum	Small white lady's-slipper		X	
Dalea villosa	Prairie clover	X		X
Solidago riddellii	Riddell's goldenrod			X
Symphyotrichum sericeum	Western silvery aster	X	X	X
Tradescantia occidentalis	Western spiderwort	X	X	X
Veronicastrum virginicum	Culver's-root			X
Leptogium rivulare[1]	Flooded jellyskin			

Notes:
1 *Leptogium rivulare* was rated as threatened at the time of the EIS (KHLP 2012b), but has since been adjusted to ."special concern".

Table 6-2: List of species and broader taxa identified on Long-Term Effects on Habitat transects, including their common name, MBCDC S-rank and the number of transect occurrences during the 1st survey (2022 and 2023)

Scientific Name	Common Name	S-Rank	1st survey
Achillea millefolium	Common Yarrow	SNA	2
Alnus alnobetula	Green Alder	S5	11
Arctostaphylos uva-ursi	Common Bearberry	S5	1
Arctous alpina	Alpine Bearberry	S3S4	7
Aster spp.		NA	5
Betula papyrifera	Paper Birch	S5	7
Calamagrostis canadensis	Bluejoint Reedgrass	S5	1
Carex concinna	Northern Elegant Sedge	S4S5	3
Carex deflexa	Bent Northern Sedge	S4S5	1
Carex gynocrates	Northern Bog Sedge	S5	1
Carex scirpoidea	Single-spike Sedge	S4S5	1
Carex spp.		NA	2
Carex vaginata	Sheathed Sedge	S5	7
Chamaenerion angustifolium	Fireweed	S5	10
Cladonia arbuscula ssp. mitis	Green Reindeer Lichen	S4	8
Cladonia rangiferina	Gray Reindeer Lichen	S5	10
Cladonia spp.		NA	6
Cladonia stellaris	Star-tipped Reindeer Lichen	S5	8
Cornus canadensis	Bunchberry	S5	11
Cornus sericea	Red-osier Dogwood	S5	1
Elymus canadensis	Cada Wildrye	S4S5	1
Elymus lanceolatus ssp. lanceolatus	Thick-spike Wildrye	S3	1
Empetrum nigrum	Black Crowberry	S5	2
Endotropis alnifolia	Alder-leaved Buckthorn	S5	1
Equisetum arvense	Field Horsetail	S5	2
Equisetum scirpoides	Dwarf Scouring-rush	S4S5	8
Equisetum sylvaticum	Woodland Horsetail	S5	5
Festuca saximontana	Rocky Mountain Fescue	S4S5	1
Fragaria virginiana	Smooth Wild Strawberry	S5	1
Geocaulon lividum	Northern Comandra	S5	9
Goodyera repens	Dwarf Rattleske-plantain	S4S5	1
Grass spp.		NA	4
Hordeum jubatum	Foxtail Barley	S5	1
Hylocomium splendens	Stairstep Moss	S4S5	14
Juniperus communis	Common Juniper	S5	2
Larix laricina	Tamarack	S5	3

Scientific Name	Common Name	S-Rank	1st survey
Linnaea borealis	Twinflower	S5	6
Lonicera dioica	Limber or Twining Honeysuckle	S5	1
Lycopodium spp.		NA	1
Medicago sativa	Alfalfa	SNA	1
Mertensia paniculata	Tall Lungwort	S5	2
Mitella nuda	Mitrewort	S5	5
Moss spp.		NA	14
Orthilia secunda	One-sided Wintergreen	S5	3
Packera paupercula	Balsam Groundsel	S5	1
Peltigera spp.		NA	12
Petasites frigidus var. palmatus	Palmate-leaved Colt's-foot	S5	7
Picea mariana	Black Spruce	S5	14
Pinus banksiana	Jack Pine	S5	4
Pleurozium schreberi	Red-stemmed Feather Moss	S4S5	14
Poa alpina	Alpine Bluegrass	S4S5	1
Poa palustris	Fowl Bluegrass	S5	1
Polytrichum juniperinum	Juniper Haircap Moss	S4S5	1
Populus balsamifera	Balsam Poplar	S5	3
Prunus pensylvanica	Pin Cherry	S5	2
Ptilium crista-castrensis	Knight's Plume Moss	S4S5	6
Pyrola spp.		NA	1
Rhododendron groenlandicum	Labrador-tea	S5	13
Ribes glandulosum	Skunk Currant	S5	3
Ribes oxyacanthoides	Cada Wild Gooseberry	S5	2
Ribes triste	Wild Red Currant	S5	3
Rosa acicularis	Prickly Rose	S5	13
Rubus arcticus	Stemless Raspberry	S5	2
Rubus chamaemorus	Cloudberry	S5	1
Rubus idaeus	Red Raspberry	S5	8
Rubus pubescens	Dewberry	S5	2
Salix arbusculoides	Shrubby Willow	S2S3	2
Salix bebbiana	Bebb's or Beaked Willow	S5	11
Salix glauca	Smooth Willow	S4	1
Salix myrtillifolia	Myrtle-leaved Willow	S5	6
Salix planifolia	Plane-leaved Willow	S5	1
Shepherdia canadensis	Soapberry	S5	1
Solidago hispida	Hairy Goldenrod	S5	1
Solidago spp.		NA	2
Spinulum annotinum	Stiff ClubMoss	S5	2

Scientific Name	Common Name	S-Rank	1st survey
Symphyotrichum puniceum	Purple-stemmed Aster	S5	1
Taraxacum officinale	Common Dandelion	SNA	1
Vaccinium myrtilloides	Velvet-leaf Blueberry	S5	4
Vaccinium oxycoccos	Small Cranberry	S5	1
Vaccinium uliginosum	Bog Whortleberry	S5	7
Vaccinium vitis-idaea	Bog Cranberry	S5	14
Viburnum edule	Mooseberry	S5	6
Viburnum rafinesqueanum	Downy Arrow-wood	S4S5	1
Viola spp.		NA	3