WAASIGAN
TRANSMISSION LINE

FINAL ENVIRONMENTAL ASSESSMENT

Section 6.1 Physiography, Geology, Surficial Geology and Soils

November 2023

Acknowledgements

We wish to acknowledge that the Waasigan Transmission Line Project is located within lands that represent the traditional territories and homelands of the Robinson-Superior Treaty (1850) and Treaty #3 (1873) First Nations, and traverse the Red Sky Métis Independent Nation, Northwestern Ontario Métis Community and Northern Lake Superior Métis Community.

Hydro One also wishes to acknowledge Indigenous artist, Storm Angeconeb, for developing the covering page and wildlife designs throughout the Final Environmental Assessment. Storm is a highly recognized visual artist from Lac Seul First Nation in Treaty #3 and currently resides in Red Lake. Many of her works include animals and birds as representations of herself or those close to her. The artist's description of the covering page is presented below.

Hydro One Environmental Study Art:

What stands out in this art piece is the symbolic representation of solar rays as "Bringing Power"; we can see the environment represented through the wildlife and Ojibwe floral visuals. This artwork is an excellent representation of Hope, Life, and Opportunity, visually portrayed through the Black Bear and her two cubs. The colour theme of this artwork comes from the Waasigan Transmission Line Project brand identity.

Artist: Storm Angeconeb

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6.1 Physiography, Geology, Surficial Geology and Soils

Ezhinaagwak Aki, Aanjinaagwat Aki, Ogaji Aki Aanjinaagwat gaye Aki

This section describes and summarizes the physiography, geology, surficial geology, and soils baseline studies completed for the Project and presents an assessment of the effects of the Waasigan Transmission Line (the Project) on these aspects of the natural environment.

The assessment follows the general approach and concepts described in Section 5.0.

6.1.1 Input from Engagement

Comments pertaining to physiography, geology, surficial geology and soils that were raised by Indigenous communities, government officials and agencies, and interested persons and organizations during engagement and how they are addressed in the environmental assessment (EA) are listed in Table 6.1-1. Comments, responses and follow-up actions are provided in the Engagement Summary (Section 4.0). In addition, the Draft EA Report was provided to Indigenous communities, government officials and agencies, and interested persons and organizations for review and comment on May 17, 2023. A high-level summary of the key themes from the comments on the Draft EA Report are included in Table 6.1-1. The detailed responses to these comments are included in Appendix 4.0-A.

Table 6.1-1: Summary of Comment Themes Raised During Engagement Related to Physiography, Geology, Surficial Geology, and Soils

Comment Theme	How Addressed in the Environmental Assessment	Indigenous Community or Stakeholder
Rocks are the foundation of life and a valued component of the environment.	• New criterion and indicators were added for geology and soil distribution.	Migisi Sahgaigan
Concerns regarding potential erosion along Amp Lake from vegetation removal.	• Potential effects to soil productivity due to soil mixing, erosion and/or compaction are assessed, and appropriate mitigation measures are identified in this EA section.	Members of the public
Concerns regarding effects to soil, and changes to slope and topography.	• Potential effects to soil and geologic features are assessed and appropriate mitigation measures are identified in this EA section.	Members of the public

Comment Theme	How Addressed in the Environmental Assessment	Indigenous Community or Stakeholder
Concerns regarding soil contamination following construction.	• Potential effects to soil quality due to chemical or hazardous material spills and potential spread of contaminated soils are assessed and appropriate mitigation measures are identified in this EA section.	Members of the public
Concerns regarding loss of productive agricultural soils.	• Potential effects to soil productivity are assessed and appropriate mitigation measures are identified in this EA section.	Members of the public
Sewage generated at construction camps may require an Environmental Compliance Approval for discharge.	• Potential effects to soil productivity and quality are assessed and appropriate mitigation measures, including obtaining required regulatory approvals, are identified in this EA section.	Ministry of the Environment, Conservation and Parks
Concerns about changes to soil quality resulting from blasting and construction activities.	• Potential effects to soil productivity and quality are assessed and appropriate mitigation measures, including spill prevention and response, waste management, soil handling and reuse, and dust control are identified in this EA section.	Gwayakocchigewin Limited Partnership

6.1.2 Information Sources

Information for the characterization of physiography, geology, surficial geology, and soils baseline conditions was collected from a review of the following sources:

- Surficial Geology mapping of the Thunder Bay and Kenora-Rainy River areas (Zoltai 1965a, b), and Quaternary Geology of Ontario, west central sheet mapping (Barnett at al. 1991);
- Geology of Ontario, Part 1 (Ontario Geological Survey 1991);
- AgMaps website (OMAFRA 2022);
- The Ecosystems of Ontario, Part 1: Ecozones and Ecoregions (Crins et al. 2009); and
- The Ecosystems of Ontario, Part 2: Ecodistricts (Wester et al. 2018).

For the purposes of the EA, sufficient information was available from the references listed above to understand the existing conditions and assess the potential effects of the Project on physiography, geology, surficial geology, and soils.

6.1.3 Criteria and Indicators

Criteria are components of the environment that are considered to have economic, social, biological, conservation, aesthetic, or cultural value (Section 5.2). **Indicators** are an aspect or characteristic of a criterion that, if changed as a result of the Project, may demonstrate a physical, biological or socio-economic effect. Indicators may be characterized quantitatively or qualitatively.

During the EA process, feedback was received from Indigenous communities noting that rocks are the foundation of life and are a valued component of the environment. A new criterion and indicators were added for geology and soil distribution to consider the importance of rock (the basis of geology and soils). The criteria and indicators selected for the assessment of Project effects on physiography, geology, surficial geology, and soils, and the rationale for their selection, are provided in Table 6.1-1. The criteria identified for physiography, geology, surficial geology, and soils are described below:

- **Geology and Soil Distribution**: Indigenous Knowledge (IK) and community feedback have identified rock (the basis of geology and soils) as the foundation of life and a valued component of the environment. Changes to the distribution of geologic features and soils can impact water quality, vegetation, the visual environment, and access to natural resources.
- **Soil Productivity and Quality**: Soil productivity and quality interrelates with other ecosystem components such as vegetation. Feedback about the importance of this criterion was provided through IK and community engagement.

The identified indicators for the geology and soil distribution, and soil productivity and quality criteria are defined as follows:

- **Geology and Soil Distribution**
  - Change to the extent or properties of geologic features: refers to changes in the distribution and nature of geologic features such as bedrock or topography. This is measured qualitatively as changes to the extents or properties of geologic features in the study area.
  - Change to the areal extent of productive soil: refers to the amount or abundance and distribution of productive soils. This is measured quantitatively as the change to the area of productive soils in the study area.
- **Soil Productivity and Quality**
  - Change in soil productivity and soil quality: refers to changes to the physical, chemical, and biological characteristics of soil. These changes occur outside of the range of natural variation for soils or result from the introduction of contaminants. This is measured qualitatively in terms of expected changes to soil productivity or quality.

Table 6.1-2: Physiography, Geology, Surficial Geology, and Soils Criteria and Indicators

Criterion	Rationale for Selection	Indicators	Measurement of Potential Effects
Geology and Soil Distribution	• IK and community feedback regarding the importance of rock as the foundation of life. • Commitment to avoid or minimize loss of, and adverse effects to, productive soils given the importance to ecosystem diversity and interrelation with other components (e.g., groundwater, surface water, vegetation), as well as concern about impacts to existing agricultural operations.	• Change to the extent or properties of geologic features. • Change to areal extent of productive soil within the Project footprint.	• Potential effects are measured quantitatively as changes to the extents or properties of geologic features in the study area. • Potential effects are measured quantitatively as a change in area of productive or potentially contaminated soils in the study area.
Soil Productivity and Quality	• Commitment to avoid or minimize loss of, and adverse effects to, productive soils given the importance to ecosystem diversity and interrelation with other components (e.g., groundwater, surface water, vegetation), as well as concern about impacts to existing agricultural operations. • Commitment to avoid or minimize potential to introduce, encounter or disperse contaminated soils. • IK and community feedback regarding the importance of maintaining soil productivity and quality and avoiding contamination.	• Change in soil productivity and soil quality.	• Potential effects are measured qualitatively in terms of potential changes to soil productivity or quality in the study area.

6.1.4 Assessment Boundaries

6.1.4.1 Temporal Boundaries

The Project is planned to occur in three stages:

- **Construction stage**: the period from the start of construction to the start of operation (in-service date).

- **Operation and maintenance stage**: the period from the start of operation and maintenance activities through to the end of the Project life.
- **Retirement stage**: the period from the end of the Project life and start of retirement activities through to the end of final reclamation of the Project.

As described in Section 5.3.2, the Project will be operated for an indefinite period and the timing of retirement, or decommissioning, is not known at this time as it is anticipated that upgrades to reinforce or rebuild portions of the Project may occur over its lifetime to maintain its longevity. Further, potential effects and mitigation measures to be identified during the EA for the construction of the Project will likely equally apply to the potential removal of the Project at a future point in time, should it ever be required. Therefore, the construction scenario assessed as part of the EA is considered bounding and potential effects and mitigation measures for retirement are not identified separately in this EA.

The assessment of Project effects on physiography, geology, surficial geology, and soils considers changes that occur during the construction and the operation and maintenance stages. These boundaries are sufficient to capture the effects of the Project.

6.1.4.2 Spatial Boundaries

Spatial boundaries for the assessment are described in Table 6.1-3 and shown on Figure 6.1-1.

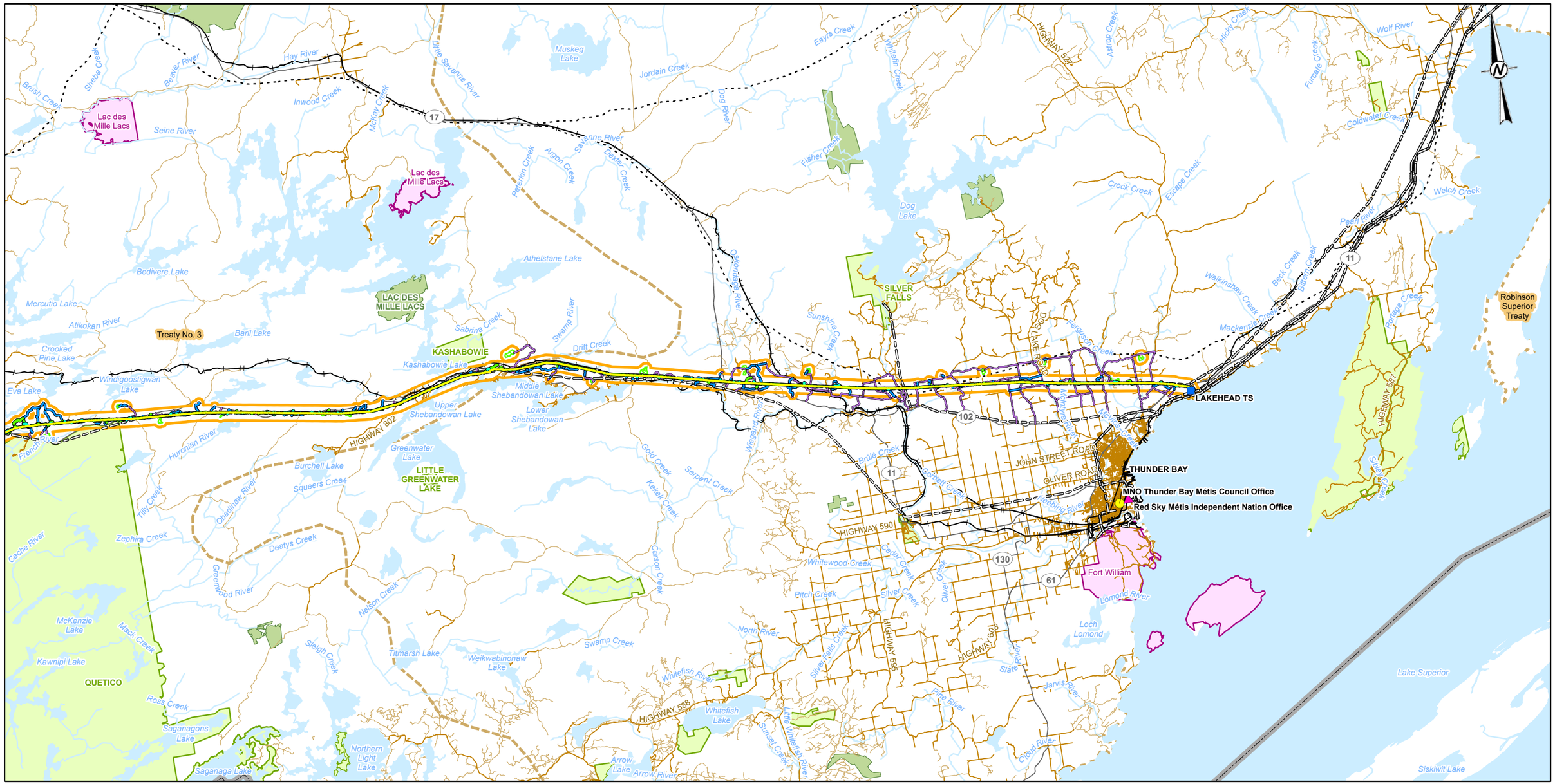
Table 6.1-3: Physiography, Geology, Surficial Geology, and Soils Spatial Boundaries

Spatial Boundaries	Area (ha)	Description	Rationale
Project footprint	4,073	The Project footprint includes: • Typical 46 m wide transmission line ROW; • Widened ROW for the separation of circuits F25A and D26A for 1 km; • Modification of the Lakehead TS, Mackenzie TS, and Dryden TS; • Access roads (improved existing roads and new); • Temporary supportive infrastructure associated with construction including fly yards, construction/stringing pads, laydown areas, construction camps, and helicopter pads; and • Aggregate pits.	• Designed to capture the potential direct effects of the physical footprint of the Project.

Spatial Boundaries	Area (ha)	Description	Rationale

LSA	89,098	Includes the Project footprint and:
		• A 1 km buffer on the transmission line ROW (including the ROW for circuits F25A and D26A)
		• A 500 m buffer on the ancillary components including:
		  ◦ TS expansion areas;
		  ◦ Access roads (improved existing roads and new);
		  ◦ Temporary supportive infrastructure; and
		  ◦ Aggregate pits.
			• Designed to capture the area within which most potential effects of the Project and immediate indirect effects are likely to be measurable.
			• Provides area for regional context and consideration of cumulative impacts.
			• A separate physiography, geology, surficial geology, and soils RSA was not assessed because the predicted zone of influence is anticipated to be confined to the LSA, and the spatial extent of the physiography, geology, surficial geology, and soils LSA is ecologically appropriate for assessing potential cumulative effects on soils from the various land use practices distributed across the LSA.

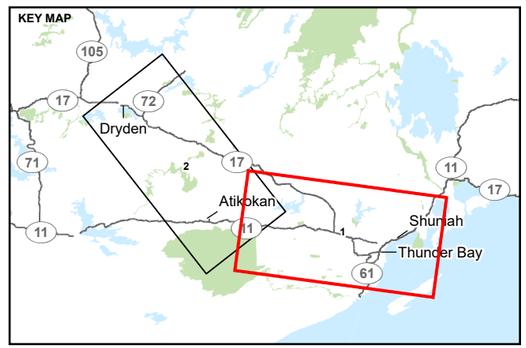
ROW = right-of-way; TS = Transformer Station; LSA = Local Study Area; RSA = Regional Study Area



LEGEND

- RED SKY MÉTIS INDEPENDENT NATION OFFICE
- MNO COUNCIL OFFICE
- 230 kV TRANSFORMER STATION (TS)
- RAILWAY
- LOCAL ROAD
- SECONDARY HIGHWAY
- RESOURCE / RECREATION
- WATERCOURSE
- NATURAL GAS PIPELINE
- INTERNATIONAL BORDER
- EXISTING TRANSMISSION LINE
- EXISTING ACCESS ROAD - NO IMPROVEMENTS REQUIRED
- EXISTING ACCESS ROAD - POTENTIAL IMPROVEMENTS
- NEW ACCESS ROAD - PREFERRED
- NEW ACCESS ROAD - ALTERNATE
- PREFERRED ROUTE TRANSMISSION LINE RIGHT-OF-WAY
- AGGREGATE SITE
- FLY YARD
- GROUNDWATER STUDY AREA
- FIRST NATIONS RESERVE
- TREATY BOUNDARY
- CONSERVATION RESERVE
- PROVINCIAL PARK
- WATERBODY

KEY MAP



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PROJECT
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CONSULTANT

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DESIGNED	MB
PREPARED	JR
REVIEWED	HK
APPROVED	CS

TITLE
PHYSIOGRAPHY AND GEOLOGY STUDY AREA

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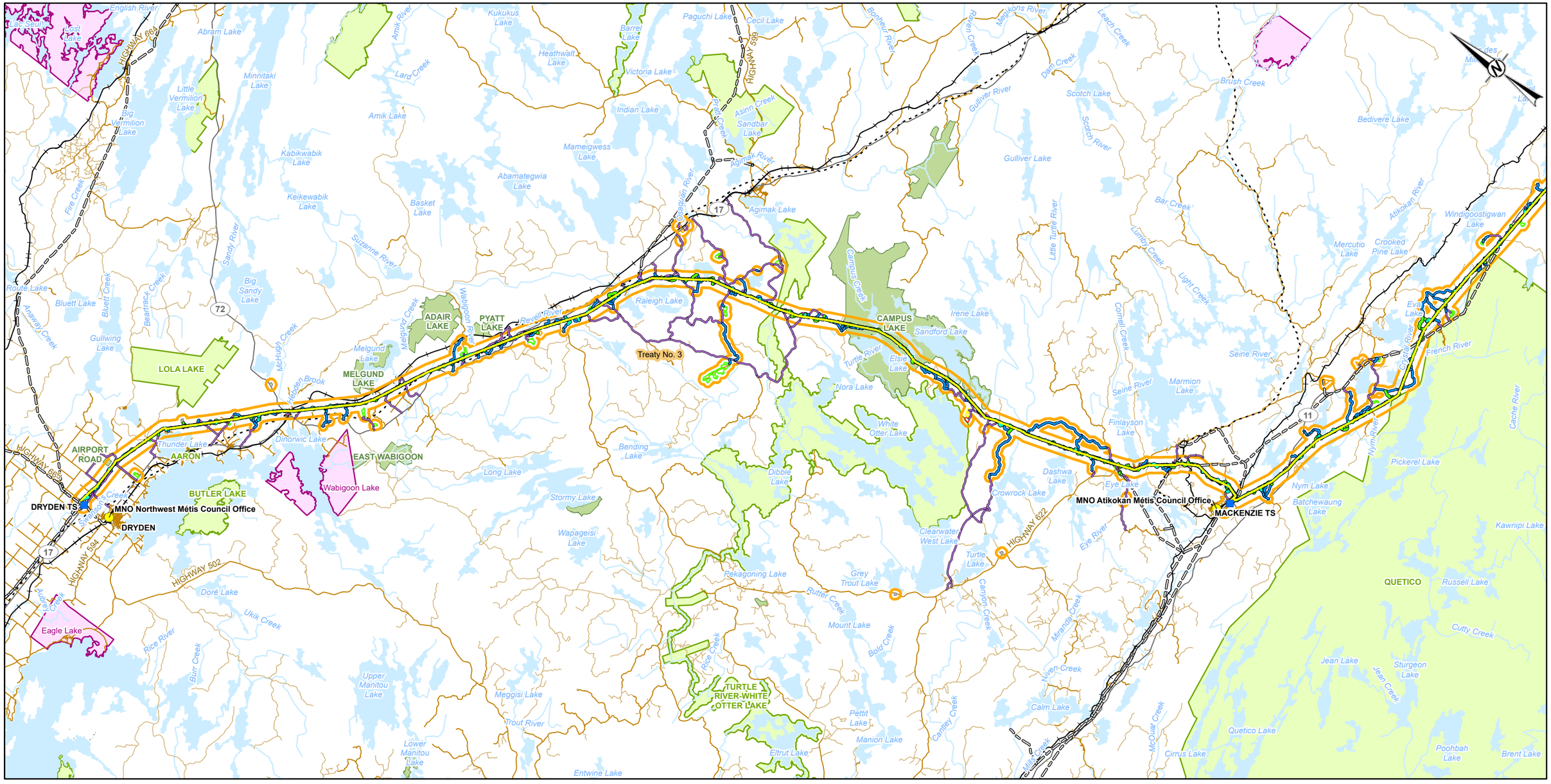

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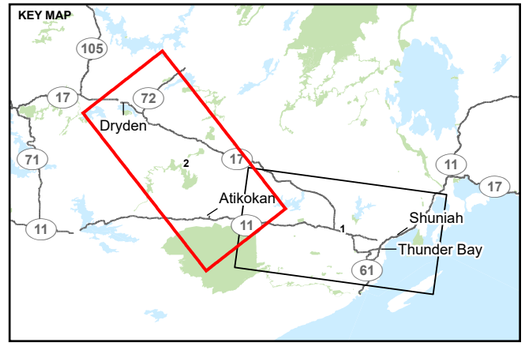
- 230 kV TRANSFORMER STATION (TS)
- RAILWAY
- LOCAL ROAD
- SECONDARY HIGHWAY
- RESOURCE / RECREATION
- WATERCOURSE
- NATURAL GAS PIPELINE
- EXISTING TRANSMISSION LINE
- EXISTING ACCESS ROAD - NO IMPROVEMENTS REQUIRED
- EXISTING ACCESS ROAD - POTENTIAL IMPROVEMENTS
- NEW ACCESS ROAD - PREFERRED
- NEW ACCESS ROAD - ALTERNATE
- PREFERRED ROUTE TRANSMISSION LINE RIGHT-OF-WAY
- D26A / F25A CIRCUIT SEPARATION
- AGGREGATE SITE
- FLY YARD
- CAMP / LAYDOWN
- FLY YARD / CAMP / LAYDOWN
- CONSTRUCTION CAMP (NO LONGER TO BE USED)
- GROUNDWATER STUDY AREA
- FIRST NATIONS RESERVE
- TREATY BOUNDARY
- CONSERVATION RESERVE
- PROVINCIAL PARK
- WATERBODY

KEY MAP



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CONSULTANT
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PREPARED	JR
REVIEWED	HK
APPROVED	CS

PROJECT
WAASIGAN TRANSMISSION LINE

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6.1.5 Description of the Existing Environment

This section provides a summary of the existing environment for physiography, geology, surficial geology, and soils based on review of desktop information.

6.1.5.1 Baseline Data Collection Methods

A desktop study was completed to identify the physiography, geology, surficial geology, and soils baseline conditions in the LSA. Available data sources were reviewed, and relevant information assembled to provide overview descriptions of landforms and topography (physiography), bedrock types and features (geology), overburden distribution and composition (surficial geology), and the classification and distribution of soil unit (soils) attributes in the LSA. Information was collected from existing published literature and provincial mapping data and incorporated into a geographic information system (GIS) platform. Baseline conditions are summarized below.

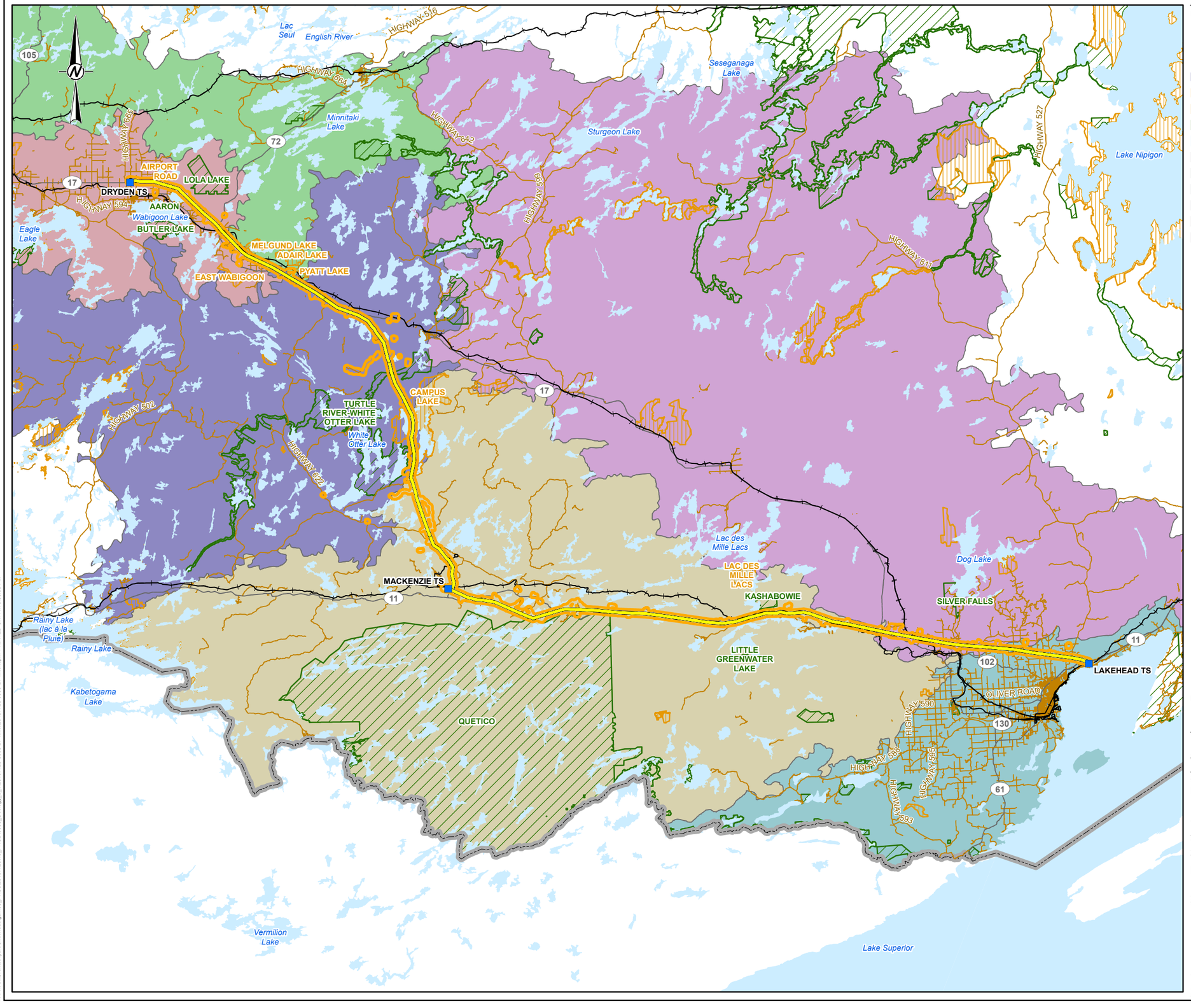
6.1.5.2 Baseline Conditions

The following section provides a summary of the baseline conditions of the physiography, geology, surficial geology, and soils in the LSA and wider region.

6.1.5.2.1 Physiography

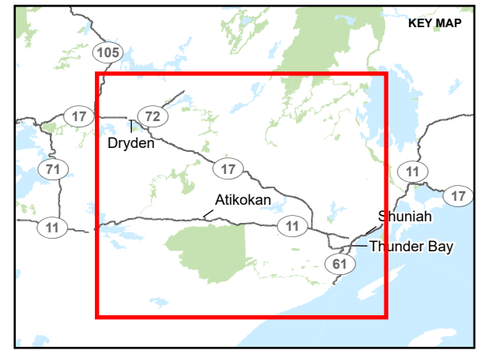
The physiography, geology, surficial geology, and soils LSA intersects the Lake Wabigoon (4S), Pigeon River (4W) and Lake Nipigon (3W) ecoregions of the Ontario Shield Ecozone (Crins et al. 2009). Ecodistricts are subdivisions of the ecoregions that are based on patterns of relief, geology, geomorphology, and substrate parent material, and were used to summarize the physiography, geology, surficial geology, and soils groups of the LSA. From east to west, the physiography, geology, surficial geology, and soils LSA crosses the following ecodistricts: Kakabeka (4W-2), Savanne (3W-2), Quetico (4W-1), Manitou (4S-5), English River (4S-3), and Dryden (4S-4) (Wester et al. 2018), as shown on Figure 6.1-2.

The broad scale topography across the physiography, geology, surficial geology, and soils LSA is rolling and defined by bedrock ridges and troughs as well as the deposition of glacial sediments (Wester et al. 2018). Local topographic relief is formed by bedrock ridges and faults and by moraine and esker deposits (Wester et al. 2018). Table 6.1-4 provides a summary of the topography and features within the ecodistricts crossed by the LSA (Wester et al. 2018).



LEGEND

- 230 KV TRANSFORMER STATION (TS)
- RAILWAY
- INTERNATIONAL BORDER
- PREFERRED ROUTE TRANSMISSION LINE RIGHT-OF-WAY
- LOCAL STUDY AREA
- CONSERVATION RESERVE
- PROVINCIAL PARK
- WATERBODY
- DRYDEN
- ENGLISH RIVER
- KAKABEKA
- MANITOU
- QUETICO
- SAVANNE



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APPROVED	CS

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Table 6.1-4: Topography Descriptions in Each Ecodistrict in the Local Study Area (after Wester et al. 2018)

Ecodistrict	Topography and Features
Kakabeka	Undulating to rolling, irregular topography
Savanne	Gently rolling, bedrock and glacial deposits control the topography, and local relief via faults, moraines, and eskers
Quetico	Bedrock defined rolling topography, NW-SE trending moraines in the Atikokan area
Manitou	Hilly, rolling landscape, defined by bedrock, faults and moraines add local relief
English River	Hilly, moraine and bedrock defined topography, moraines trend NW-SE, faults trend SW-NE
Dryden	Gently rolling to hilly, NW-SE trending moraines

NW = northwest; SE = southeast; SW = southwest; NE = northeast

6.1.5.2.2 Geology

The physiography, geology, surficial geology, and soils LSA is located within the Archean age Superior Province of bedrock in Ontario, which is part of the Canadian Shield. The LSA crosses the Wawa, Quetico, and Wabigoon subprovinces of the Superior Province, which generally consist of greenstone belts and granitoid plutons, metasediments and granite-greenstone complexes, respectively (Ontario Geologic Survey 1991). The very eastern portion of the LSA, south of the Lakehead TS, overlies bedrock of the Animikie Basin, part of the Proterozoic age Southern Province. The Animikie Group of formations within the Animikie Basin is composed of iron formations, chert and argillite overlying shales and greywacke (Ontario Geological Survey 1991). The bedrock geology of the LSA is shown on Figures 1 - 30 in Appendix 6.1-A.

A summary of the dominant bedrock types found in each of the ecoregions traversed by the physiography, geology, surficial geology, and soils LSA is provided in Table 6.1-5.

Table 6.1-5: Dominant Bedrock Types in Each Ecoregion in the Local Study Area

Ecoregion	Dominant Bedrock Types[a]
Lake Nipigon	Granitic with basalt, greenstone, siltstone, and shale
Pigeon River	Granitic with some bands of ultramafic and greenstone
Lake Wabigoon	Gneiss, granite, and metavolcanic

a) Intrusive bedrock is typically made up of dikes and sills within other bedrock types. Metavolcanic bedrock is typically basaltic and andesitic flows. Metasedimentary bedrock is typically wacke, siltstone, arkose, argillite, slate, and mudstone. Gneissic and granite bedrock is massive to foliated (Wester et al. 2018).

6.1.5.2.3 Surficial Geology

The surficial geology of the physiography, geology, surficial geology, and soils LSA is defined by the continental glaciations that overrode the area in the Pleistocene epoch. When the last of these glacial advances retreated from the area about 10,000 years ago, it left extensive deposits of till, moraines, eskers and other ice-contact deposits. These were often modified by and overlain by meltwater-lain deposits such as glaciolacustrine or outwash plains.

The LSA crosses a diverse range of surficial materials. Based on quaternary geology mapping, the dominant surficial cover across the LSA is characterized as bedrock (unit 1 on figures in Appendix 6.1-B) consisting of undifferentiated igneous and metamorphic bedrock, exposed at the surface or covered by a discontinuous, thin layer of drift (till) (Barnett et al. 1991). Older surficial geology mapping by Zoltai (1965a, b) of the same areas does not record bare bedrock along the LSA, but instead shows extensive areas of silty to sandy till ground moraine combined in some areas with clay and silt lacustrine, or loess (windblown) deposits. The till (ground moraine) forms the “discontinuous, thin layer of drift” that overlies the areas mapped as bedrock on the quaternary geology maps.

Other quaternary geology types encountered by the LSA, and their general distributions include (Barnett et al. 1991):

- **Sand to silty sand till deposits (unit 18 on figures in Appendix 6.1-B):** These are areas of thicker and more extensive tills similar to the ground moraine that covers much of the region. The LSA crosses limited areas of these deposits northwest of Thunder Bay and east of Atikokan, near Eva Lake.
- **Silt and clay glaciolacustrine deposits (unit 24 on figures in Appendix 6.1-B):** These fine-grained sediments were deposited from suspension in areas of quiet water deposits laid down in glacial lakes. The LSA crosses parts of these deposits laid down in glacial Lake Kaministikwia to the northwest of Thunder Bay between Highway 589 and Shabaqua Corners (Highways 11 and 17 intersection). Smaller areas of glaciolacustrine sediments are also encountered near Atikokan while larger, extensive areas are present from east of Dinorwic Lake to Dryden where they are the dominant surficial geology type. These deposits were laid down in the early and mid-stages of glacial Lake Agassiz.
- **Sand and Gravel glaciolacustrine deposits (unit 25 on figures in Appendix 6.1-B):** These are areas of beach and nearshore deposits laid down at the edges of glacial lakes. In general, the LSA encounters only small, isolated areas of these deposits for most of its length, but larger areas are crossed between Highway 622 and Melgund Lake and to the east and northwest of Thunder Lake.
- **Gravel and sand glaciofluvial ice-contact deposits or outwash deposits (units 22 and 23 on figures in Appendix 6.1-B):** These coarse-grained deposits are found throughout the Project area and are often found as elongated deposits that may stretch for many kilometres as they were formed by glacially derived rivers, deltas and end

moraines. The LSA encounters some of these deposits to the north and northwest of Thunder Bay (MacKenzie moraine). The LSA crosses parts of an extensive end moraine consisting of ice-contact deposits east and north of Atikokan (Eagle-Finlayson and Brule Creek moraines). Other smaller areas of glaciofluvial deposits occur in various areas throughout the remainder of the LSA.

- **Organic deposits (unit 32 on figures in Appendix 6.1-B):** These deposits occur where peat, muck or marl have accumulated and are typically found in low-lying areas with poor drainage. These are of limited extent within the LSA.
- **Fluvial Deposits (units 28 and 31 on figures in Appendix 6.1-B):** These are deposits of variable texture that have been deposited on modern river floodplains in the time since the area has been deglaciated. Fluvial sediments are of limited extent within the LSA.

The presence of mine tailing deposits near the former Steep Rock Mine has been noted by Lac des Mille Lacs First Nation (2023) and the MNRF. The former Steep Rock Mine is located just north of Atikokan and the tailings are reported to be acid leaching and an environmental concern.

6.1.5.2.4 Soils

Soil types across the physiography, geology, surficial geology, and soils LSA are broadly consistent with distributions that follow the surficial geology of the region. Common soil orders include (dystric) brunisols, (gray) luvisols, and (humo-ferric) podzols. The relative abundances of these soil orders, as well as that of bedrock, with no identified soil type, are summarized for each of the ecodistricts crossed by the LSA in Table 6.1-6. Detailed soil mapping for the Thunder Bay and Dryden areas is shown on Figures 1 - 8 in Appendix 6.1-C.

Table 6.1-6: Abundance of Bedrock and Soil Orders by Ecodistrict in the Local Study Area

Ecodistrict	Percent abundance within each ecodistrict (%) Bedrock	Percent abundance within each ecodistrict (%) Dystric Brunisol	Percent abundance within each ecodistrict (%) Gray Luvisol	Percent abundance within each ecodistrict (%) Humo-Ferric Podzol	Percent abundance within each ecodistrict (%) Other
Kakabeka	6	51	41	-	2
Savanne	39	20	-	38	3
Quetico	77	22	-	-	1
Manitou	91	8	-	-	1
English River	36	56	7	-	1
Dryden	18	23	58	-	1

Source: Wester et al. 2018.

Brunisol and podzol soils in the region tend to be found on areas of coarse-textured material, such as moraines or glaciofluvial deposits, while the luvisol soils of the region tend to be found on areas of fine-textured, well-drained and often calcareous material, such as glaciolacustrine deposits. Other soil order types are scattered throughout the region in local pockets of organic, poorly-drained (mesisol or gleysol) or poorly-developed soils (regosol).

Agriculture is practiced in the areas around Thunder Bay and Dryden, often in association with the fine-textured glaciolacustrine deposits in these areas. Soil productivity based on the Canada Land Inventory (CLI) capability ratings tend to be low (CLI rating of 4 or higher) in much of the LSA with limitations related to shallow bedrock and soils with low fertility and excessive droughtiness. Moderately extensive areas of CLI class 3 soils with capability limitations due to poor soil structure or drainage and topography are encountered by the LSA northwest of the Thunder Bay area. In the Dryden area, the LSA crosses limited areas of CLI class 2 and 3 soils. Capability limitations noted for these soils are related to poor soil structure or drainage, topography, and adverse climate (OMAFRA 2022).

6.1.5.2.5 Summary of Existing Conditions (Base Case)

The following section summarizes the key findings of the baseline assessment of physiography, geology, surficial geology, and soils.

The physiography, geology, surficial geology, and soils LSA is located in the Canadian Shield physiographic region of the province and is largely comprised of rolling and hilly topography with bedrock knobs and morainal and esker deposits forming the higher elevation areas and bedrock troughs and faults forming low elevation areas, which often contain lakes and wetlands. The LSA is underlain by granitic or gneissic bedrock, with greenstone bands of metavolcanic and metasedimentary rock (Ontario Geologic Survey 1991, Wester et al. 2018). The bedrock is exposed or covered by thin surficial sediments across much of the LSA, with the surficial geology dominated by glacial deposits (Barnett et al. 1991). These glacial deposits include sandy tills that form as ground moraine across much of the area and typically form brunisolic soils (Wester et al. 2018). Near Thunder Bay and Dryden, some areas of fine-grained glaciolacustrine deposits are found that generally consist of luvisolic soils and are supportive of agricultural activities. In other, more localized areas along the LSA, glacial deposits, such as coarse-grained end moraine, esker, outwash or ice-contact deposits, are found and more recent materials, such as organic soils and fluvial deposits, are found locally in depressions and valleys.

6.1.6 Potential Project-Environment Interactions

Potential Project-environment interactions were identified through a review of the Project Description and existing environmental conditions. The linkages between Project components and activities and potential effects to physiography, geology, surficial geology, and soils are identified in Table 6.1-7.

Table 6.1-7: Project-Environment Interactions for Physiography, Geology, Surficial Geology, and Soils

Criteria	Indicator	Project Phase Construction[(a)]	Project Phase Operation and Maintenance	Description of Potential Project-Environment Interaction
Geology and Soil Distribution	Change to the extent or properties of geologic features	✓	–	Changes to drainage patterns and surface water levels can cause changes to soil quality and distribution
Geology and Soil Distribution	Change to the extent or properties of geologic features	✓	–	Excavation and blasting for construction can alter geologic features
Geology and Soil Distribution	Change to areal extent of productive soil	✓	–	Project construction and supporting infrastructure can encroach on or disturb productive soil areas
Soil Productivity and Quality	Change in soil productivity and soil quality	✓	✓	Chemical or hazardous material spills on the Project footprint or along access roads can change soil quality
Soil Productivity and Quality	Change in soil productivity and soil quality	✓	✓	Soil mixing, erosion and/or compaction can change soil productivity and quality
Soil Productivity and Quality	Change in soil productivity and soil quality	✓	–	Construction activities introducing or encountering contaminated soils can mobilize or spread the contaminants

Criteria	Indicator	Project Phase Construction[a]	Project Phase Operation and Maintenance	Description of Potential Project-Environment Interaction
Geology and Soil Distribution	Change to areal extent of productive soil	–	✓	Access for Project maintenance during operations can disturb productive soils

✓ = A potential Project-environment interaction could result in an environmental or socio-economic effect;
_ = No plausible interaction was identified.

a) As described in Section 6.1.4.1, the construction scenario assessed as part of the EA is considered bounding and potential effects and mitigation measures for retirement are not identified separately in this EA.

6.1.7 Potential Effects, Mitigation Measures, and Net Effects

6.1.7.1 Drainage and Surface Water Level Changes Due to Soil Quality and Distribution

Potential Effects

Project construction activities may alter local topography such that drainage patterns and surface water levels change and affect soil productivity or quality.

Mitigation Measures

Hydro One and their contractors will include in the Access Plan and Environmental Protection Plan (EPP) requirements for access construction and reclamation. Mitigation measures include: using existing access and water crossings wherever possible; minimizing grading near waterbodies, slopes and sensitive receptors; installing drainage/equalization culverts; and maintaining drainage in the work area to minimize ponding or channelization of surface flow. Following construction, the restoration would recontour the land surface to restore drainage patterns and drainage and erosion control would be included in restoration inspections following construction.

Net Effects

No net effects are anticipated from changes to drainage patterns and surface water levels based on the mitigation measures listed above. Therefore, this interaction was not carried forward to the net effects characterization.

6.1.7.2 Alterations to Geologic Features due to Excavation and Blasting

Potential Effects

Excavations for Project construction, including for foundations, aggregate extraction, and blasting of bedrock, may remove and/or alter geologic features.

Mitigation Measures

Hydro One and their contractors will implement an Access Plan, EPP and Blasting and Communication Management Plan that will include mitigation measures to avoid or limit the changes made to the geologic features in the Project footprint. Mitigation measures include: using existing access routes wherever possible to avoid construction of new roads; minimizing road widths to limit potential construction impacts; sourcing aggregate from permitted pits and quarries where possible; using GPS-equipped machinery and/or flagging on the ROW to demarcate sensitive geologic features; limit soil stripping and grading, where feasible, conserve and replace soil and restore grading following construction; limit regrading of the workspaces; using rock ripping, hammering, or drilling where possible to avoid blasting; and, where blasting is used, designing blast patterns to minimize ground disturbance beyond the excavation area.

Net Effects

Implementing the mitigation measures described above will limit the removal and/or alteration of geologic features during Project construction. The construction of Project structure foundations and extraction of aggregate are expected to permanently remove and locally alter geologic features resulting in a net effect that was carried forward to the net effects characterization.

6.1.7.3 Disturbance of Productive Soil Areas During Construction

Potential Effects

Construction activities, including establishment of access roads, laydown areas, aggregate pits, and construction camps, may occur in areas with productive soils, which may result in a loss of soils for agricultural use.

Mitigation Measures

Hydro One and their contractors will implement an Access Plan, EPP, Erosion and Sediment Control Plan, Soil Management Plan, and Invasive Species and Biosecurity Management Plan that include procedures and mitigations to protect productive soils during Project construction. Mitigation measures include: utilizing existing access routes wherever possible and containing work to within the ROW as much as possible; locating structures where they minimize disturbance of agricultural operations; scheduling work during periods where soil disturbance is less likely (i.e., dry or frozen); working with landowners to schedule Project access and avoid blocking landowner access; utilizing erosion and sedimentation control measures; deploying temporary matting where required to prevent soil disturbance; monitoring soil conditions during construction and adapting work to avoid or minimize soil disturbance; following biosecurity best management practices to prevent spreading of weeds and soil pathogens; and remediating soil compaction where deemed necessary. These measures will be detailed in the contractor's Access Plan and EPP.

Net Effects

Implementing the mitigation measures described above will limit the loss of use of productive soils during construction access and prevent the loss of productive soils following the removal of temporary construction access. The construction of the transmission line itself may result in the long-term loss of use of productive soils that are within the tower footprints resulting in a net effect that was carried forward to the net effects characterization.

6.1.7.4 Changes to Soil Quality Due to Chemical or Hazardous Material Spills

Potential Effects

Spills of materials during Project construction, operation or maintenance may negatively impact soil quality.

Mitigation Measures

Hydro One and their contractors will implement a Spill and Emergency Preparedness and Response Plan. This plan will lay out the requirements for training and the storage, handling, and transportation of potential contaminants, as well as equipment operation and maintenance intended to prevent spills from occurring. Designated refuelling areas will be established, and spill kits will be deployed to at-risk areas and equipment. The plan will also communicate spill response procedures including emergency response, containment, clean up, disposal, and reporting. The spill prevention and response plan will follow industry standard mitigation measures and all applicable regulatory requirements.

Net Effects

No net effects are anticipated from spills of potential contaminants if the Spill and Emergency Preparedness and Response Plan and associated mitigation measures are implemented. These procedures would limit the potential impacts of any accidental spills and provide for containment and clean-up. Therefore, this interaction was not carried forward to the net effects characterization.

6.1.7.5 Changes to Soil Productivity Due to Soil Mixing, Erosion and/or Compaction

Potential Effects

Project construction and maintenance activities could cause soil mixing, erosion or compaction due to vehicle traffic, stripping and grading, material laydown, and aggregate extraction. Common reasons for this are improper soil handling that mixes different soil types or leaves soil vulnerable to erosion, vehicle traffic that compacts and mixes soft soils, and not preserving and protecting topsoil when constructing roads, construction facilities, and aggregate pits.

Mitigation Measures

Hydro One and their contractors will implement mitigation measures regarding soil management, construction, and grading, as appropriate, including the following: using equipment with low ground pressure when working alongside established roads or in soft soil areas; stripping and stockpiling topsoil from road and work areas where practicable; conducting

work under frozen or dry ground conditions when reasonably possible; protecting soil where roads or construction areas are constructed; covering or reseeding soil stockpiles and exposed slopes; implementing a Soil Management Plan; limiting grading and soil disturbance on slopes and near water features; implementing erosion controls for soil; implementing an Invasive Species and Biosecurity Management Plan which includes protocols for cleaning equipment; monitoring soil conditions during work and changing or adapting mitigation measures, as necessary; and reseeding exposed soil in erosion prone areas following construction work.

Net Effects

No net effects on soil productivity and quality are anticipated from soil mixing, erosion or compaction based on the mitigation measures listed above. Therefore, this interaction was not carried forward to the net effects characterization.

6.1.7.6 Introduction/Spread of Contaminants or Contaminated Soils during Construction

Potential Effects

Contaminated soils may be introduced or encountered during construction activities and moved by vehicle traffic or excavations and backfilling. This may spread the contamination to other areas by direct transport or exposure to water runoff or wind.

Mitigation Measures

Hydro One and their contractors will implement a Waste Management and Disposal Plan that will outline procedures for containment, management and disposal of hazardous and non-hazardous wastes generated during construction, and a Spill and Emergency Preparedness and Response Plan, which will provide procedures, response and reporting requirements to be used when contaminated or potentially contaminated materials are encountered. A Blasting and Communication Management Plan will establish proper usage and storage of explosives and in the unlikely event that construction blasting activities are determined to have impacted soil quality, the impacted soils will be managed following the procedures of the Spill and Emergency Preparedness and Response Plan and the Waste Management and Disposal Plan. In addition, a Soil Management Plan will be implemented to outline soil importing/exporting, handling and storage requirements that will prevent or limit potential contaminant introduction, soil loss, mixing, or soil movement due to water runoff or wind. The Soil Management Plan also details management of excess soils in accordance with regulations (O.Reg 406/19) and specifies criteria to be met in order to re-use soils on the Project site, including meeting Site Condition Standards (O. Reg 153/04) and not being taken from below the water table. A Dust Control/Air Quality Plan will be implemented during construction to outline mitigation measures to limit the generation and spread of fugitive dust due to construction activities. Hydro One and their contractors will also implement an Invasive Species and Biosecurity Management Plan that will outline mitigation measures for assessing equipment, work locations and potential receptors for risks from invasive species or pathogens, and establishing an inspection, cleaning, and tracking plan to mitigate the risks.

Net Effects

No net effects are anticipated from introducing or encountering contaminated soils based on the mitigation measures listed above. Therefore, this interaction was not carried forward to the net effects characterization.

6.1.7.7 Disturbance of Productive Soils During Project Maintenance or Operations

Potential Effects

Maintenance of the transmission line during operations, including establishing, using, and decommissioning of temporary access roads, may occur in areas of productive soil, which may result in temporary loss of access to these soils for agricultural use.

Mitigation Measures

Hydro One and their contractors will continue to employ mitigation measures when establishing, using and decommissioning temporary access during Project maintenance. Mitigation measures include: using existing access roads wherever possible; coordinating with landowners to maintain access to private lands; using temporary matting to protect soil in vulnerable areas; limiting the disturbance areas to the Project right-of-way as much as possible; and remediating soil compaction where deemed necessary.

Net Effects

No net effects are anticipated when using temporary access roads during Project maintenance when the standard mitigation measures are used. Therefore, this interaction was not carried forward to the net effects characterization.

6.1.7.8 Summary of Potential Effects, Mitigation Measures, and Net Effects

Table 6.1-8 provides a summary of the effects assessment, which is based on the previous assessment and the implementation of mitigation measures identified above, and further supplemented in the table below.

Table 6.1-8: Potential Effects, Mitigation Measures, and Predicted Net Effects to Physiography, Geology, Surficial Geology, and Soils

Project Component or Activity	Potential Effect	Mitigation Measures[(a)]	Net Effect
Project activities during the construction stage: • Construction of foundations, access roads, laydown areas, construction camps, and aggregate pits	Changes to drainage patterns and surface water levels can cause changes to soil quality and distribution	• Hydro One with their contractor(s) will prepare and implement an Access Plan and EPP. • Using existing access and watercourse crossings wherever possible. • Minimizing grading near waterbodies, slopes and sensitive receptors. • Installing equalization/drainage culverts to maintain water levels and drainage paths. • Maintaining drainage in the work area and limit ponding and channelization of surface flows. • Recontouring work areas following construction to restore drainage patterns and prevent erosion. • Post-construction monitoring and inspection to ensure that drainage and erosion control, and restoration efforts are effective.	No net effect

Project Component or Activity	Potential Effect	Mitigation Measures[(a)]	Net Effect
Project activities during the construction stage: • Construction of foundations, access roads, laydown areas, construction camps, and aggregate pits	Excavation and blasting for construction can alter geologic features	• Hydro One with their contractor(s) will prepare and implement an Access Plan, EPP and Blasting and Communication Management Plan. • Using existing access wherever possible. • Minimizing road widths to limit disturbance and material requirements. • Using permitted aggregate pits and quarries where possible. • Using GPS-equipped machinery and/or flagging on the ROW to demarcate sensitive features. • Limiting soil stripping and grading where feasible and replace soil and restore grading following construction. • Employing rock ripping, hammering, or drilling instead of blasting where possible. • Designing blast patterns to minimize ground disturbance.	Limited, local alteration of geologic features when constructing access roads, structure foundations and aggregate pits/quarries

Project Component or Activity	Potential Effect	Mitigation Measures[(a)]	Net Effect
Project activities during the construction stage: • Construction of foundations, access roads, laydown areas, construction camps, and aggregate pits	Project construction and supporting infrastructure can encroach on or disturb productive soil areas	• Hydro One with their contractor(s) will prepare and implement an Access Plan, EPP, Erosion and Sediment Control Plan, Soil Management Plan and Invasive Species and Biosecurity Management Plan. • Using existing access roads wherever possible. • Coordinating with landowners to maintain access to private lands and inform them of soil management options. • Locating Project structures and access roads out of agricultural areas where possible. • Scheduling work during periods when soil disturbance is less likely to occur, such as dry or frozen ground conditions, to the extent practicable. • Using temporary matting to protect soil in vulnerable areas. • Limiting disturbance areas to the ROW as much as possible. • Monitoring soil conditions during construction and adapting work plans to avoid soil damage. • Implementing biosecurity practices to prevent the spread of weeds and soil pathogens. • Remediating soil compaction where deemed necessary.	Net change to area of productive soil due to construction of long-term Project components

Project Component or Activity	Potential Effect	Mitigation Measures[(a)]	Net Effect
Project activities during the construction stage: • Construction of foundations, access roads, laydown areas, construction camps, and aggregate pits	Chemical or hazardous material spills on the Project footprint or along access roads can change soil quality	• Hydro One with their contractor(s) will prepare and implement a Spill and Emergency Preparedness and Response Plan. • Compliance with relevant regulations and laws. • Preventative maintenance and inspection of equipment. • Implementation of appropriate training. • Procedures for emergency response, containment, clean-up, disposal, and reporting. • Deployment of spill kits to at-risk areas and equipment. • Requirements for the safe storage, handling and transportation practices of hazardous materials. • Designated refuelling areas.	No net effect

Project Component or Activity	Potential Effect	Mitigation Measures[(a)]	Net Effect
Project activities during the construction stage: • Construction of foundations, access roads, laydown areas, construction camps, and aggregate pits	Soil mixing, erosion and/or compaction can change soil productivity and quality	• Hydro One with their contractor(s) will prepare and implement an Access Plan, Soil Management Plan, Invasive Species and Biosecurity Management Plan, and EPP. • Using existing access wherever possible. • Using equipment with low ground pressure if work is required in areas of unprotected or soft soils. • Scheduling work during dry or frozen ground conditions where reasonably possible. • Implementing erosion and sedimentation controls and procedures. • Covering or stripping topsoil in areas where it may be damaged by work. • Covering or reseeding soil stockpiles and exposed slopes. • Limiting grading and soil stripping on slopes and near waterbodies. • Cleaning and inspecting equipment. • Monitoring soil conditions in workspaces and changing soil management or protective approaches as necessary. • Carrying out restoration in areas of soil disturbance.	No net effect

Project Component or Activity	Potential Effect	Mitigation Measures[(a)]	Net Effect
Project activities during the construction stage: • Construction of foundations, access roads, laydown areas, construction camps, and aggregate pits	Construction activities introducing or encountering contaminated soils can mobilize or spread the contaminants	• Hydro One with their contractor(s) will prepare and implement a Waste Management and Disposal Plan, Spill and Emergency Preparedness and Response Plan, Blasting and Communication Management Plan, Soil Management Plan, Dust Control/Air Quality Plan, and Invasive Species and Biosecurity Management Plan. • Establishing procedures for containment, management and disposal of wastes generated during construction. • Protecting exposed soil from contamination, loss, mixing, or erosion. • Ensuring equipment is cleaned. • Ensuring imported, exported, and reused soils meet regulatory, use, and placement criteria, and tracking requirements. • Minimizing the spread of fugitive dust across the work site. • Handling contaminated soils according to the Spill and Emergency Preparedness and Response Plan for clean-up, storage, disposal, and reporting. • Assessing equipment, work areas and receptors for risks of spreading invasive species or pathogen. • Establishing inspection, cleaning and tracking to mitigate the risks of spreading invasive species or pathogens.	No net effect

Project Component or Activity	Potential Effect	Mitigation Measures[(a)]	Net Effect
Project activities during the operations stage: • Access for Project maintenance, inspections, and repairs on existing or temporary roads	Access for Project maintenance during operations can disturb productive soils	• Using existing access roads wherever possible. • Coordinating with landowners to maintain access to private lands. • Using temporary matting to protect soil in vulnerable areas. • Limiting disturbance areas to the Project ROW as much as possible. • Remediating soil compaction where deemed necessary.	No net effect
Project activities during the operations stage: • Access for Project maintenance, inspections, and repairs on existing or temporary roads	Chemical or hazardous material spills on the Project footprint or along access roads can change soil quality	• Compliance with relevant regulations and laws. • Preventative maintenance and inspection of equipment. • Implementation of a spill response and clean up plan and procedures with training. • Deployment of spill kits to at-risk areas and equipment. • Requirements for the safe storage, handling and transportation practices of hazardous materials. • Designated refuelling areas.	No net effect

Project Component or Activity	Potential Effect	Mitigation Measures[a]	Net Effect
Project activities during the operations stage: • Access for Project maintenance, inspections, and repairs on existing or temporary roads	Soil mixing, erosion and/or compaction can change soil productivity and quality	• Using existing access wherever possible. • Using equipment with low ground pressure if work is required in areas of unprotected or soft soils. • Scheduling work during dry or frozen ground conditions where reasonably possible. • Implementing erosion and sedimentation controls and procedures. • Cleaning and inspecting equipment in accordance with best management practices. • Monitoring soil conditions in workspaces and changing soil management or protective approaches as necessary. • Carrying out restoration in areas of soil disturbance.	No net effects

a) As described in Section 6.7.4.1, the construction scenario assessed as part of the EA is considered bounding for the retirement stage. Mitigation identified for the construction stage will be applied during the retirement stage as appropriate.

6.1.8 Net Effects Characterization

6.1.8.1 Net Effects Characterization Approach

The effects characterization approach followed the general process described in Section 5.6.4 (Characterize the Net Effects).

Potential effects with no predicted net effect after implementation of mitigation measures identified in Table 6.1-8 are not carried forward to the net effects assessment.

Net effects are described using the significance factors identified in Table 5.6-2. Effects levels are defined for the magnitude of effects characteristics for physiography, geology, surficial geology, and soils in Table 6.1-9.

Table 6.1-9: Magnitude Effect Levels for Physiography, Geology, Surficial Geology, and Soils

Criterion / Net Effect	Negligible	Low	Moderate	High
Geology and Soil Distribution	A small measurable change that is expected to be within the range of baseline values, or within the range of natural variability	A measurable change (discernable) that is expected to be at or slightly exceed the limits of baseline values	A discernable effect that is potentially detrimental but manageable – does not represent a management concern[(a)]	A discernable effect that is substantially detrimental – the effect can pose a serious risk and represents a management concern[(a)]
Soil Productivity and Quality	A small measurable change that is expected to be within the range of baseline or guideline values, or within the range of natural variability	A measurable change (discernable) that is expected to be at or slightly exceed the limits of baseline values	A discernable effect that is potentially detrimental but manageable – does not represent a management concern[(a)]	A discernable effect that is substantially detrimental – the effect can pose a serious risk and represents a management concern[(a)]

a) An effect that poses a management concern may require actions such as research, monitoring or recovery initiatives.

6.1.8.2 Net Effects Characterization

A summary of the characterization of net effects of the Project on physiography, geology, surficial geology, and soils is provided in Table 6.1-9. Net effects are described after the implementation of effective mitigation measures, and summarized according to direct/indirect, direction, magnitude, geographic extent, duration/reversibility, frequency, and likelihood of the effect occurring following the methods described in Section 5.6. Effective implementation of mitigation measures summarized in Table 6.1-8 is expected to reduce the magnitude and duration of net effects on physiography, geology, surficial geology, and soils.

6.1.8.3 Net Changes to Geology and Soil Distribution from Changes to the Extent or Properties of Geologic Features

Construction of the Project will involve excavations for road construction, structure foundations, construction camps, and aggregate extraction. This will result in the localized removal and redistribution of geologic features such as bedrock and aggregate deposits. Local grading of the ground surface may also be required in places to allow access road or structure construction, which would involve the removal and/or filling in over the natural geologic deposits. The EPP and associated Access Plan and Blasting and Communication Management Plan will contain mitigation measures to minimize the above activities where it is feasible to do so, but it is probable that limited disturbance of geologic features will be required.

This effect will be limited to the Project footprint and will be infrequent but permanent. Based on the extent of the Project and the environment, it is probable that the effects will occur.

The net changes to geology and soil distribution from excavation and blasting for construction are assessed to be of negligible magnitude as they may be locally measurable but will not represent significant changes and will be similar to other projects and/or activities that exist in the LSA.

6.1.8.4 Net Changes to Soil Productivity and Quality from Changes to Areal Extent of Productive Soil

Construction of Project infrastructure will result in the land that certain Project components (i.e., structure foundations) are built on being unavailable for agricultural use. In some areas this will result in reduced access to productive soils for cultivation. It is expected that permanent access roads will not have to be maintained in prime agricultural areas as the land will remain cultivated. Access to the Project components during operations will use existing access or temporary access where required and the use of soil management mitigation measures will prevent loss of productive soil resulting from the temporary access.

This effect will be limited to structure foundations and will be a continuous, long-term effect. The Project footprint will cross approximately 530 ha of potentially productive soils compared to a total Project footprint of 4,073 ha, and the area of structures will make up a limited portion of this area. Based on these areas, about 13% of the Project footprint will cross areas of potentially productive soils and it is estimated that less than 4% of the Project footprint area will be taken

up by structure foundations. Therefore, the total area of the Project footprint that would contain structures on potentially productive soils would be less than 1%. Despite the limited area of impact to potentially productive soils, the extent of the Project makes the effects probable to occur.

The net changes to soil productivity and quality from changes to areal extent of productive soil within the Project footprint are assessed to be of low magnitude as they will be measurable, but not a significant change in the regional availability of productive soils.

6.1.8.5 Characterization of Net Effects

A summary of the characterization of incremental adverse net effects of the Project on geology and soil distribution in the net effects assessment is provided in Table 6.1-10. Two potential net effects to geology and soil distribution were identified: disturbance to geological features in limited areas of the Project footprint due to excavations, grading, and blasting; and a reduction of less than 1% of the available area of productive soil in the Project footprint due to the construction of structure foundations.

No net effects of the Project on soil productivity and quality were identified. Net effects were described after the implementation of effective mitigation measures, and summarized according to direction, magnitude, geographic extent, duration/reversibility, frequency, and likelihood of the effect occurring following the methods described in Section 5.6. Effective implementation of mitigation measures summarized in Table 6.1-8 are expected to reduce the magnitude and duration of net effects on soil productivity and quality.

Table 6.1-10: Characterization of Predicted Net Effects for Physiography, Geology, Surficial Geology, and Soils

Criteria	Indicators	Net Effect	Direct/ Indirect	Direction	Magnitude	Geographic Extent	Duration/ Irreversibility	Frequency	Likelihood of Occurrence	Significance
Geology and Soil Distribution	Change to the extent or properties of geologic features	Limited disturbance to geologic features	Direct	Negative	Negligible	Project Footprint	Permanent	Infrequent	Probable	Not Significant
Geology and Soil Distribution	Change to areal extent of productive soil within the Project footprint	Project structures reduce available area of productive soils	Direct	Negative	Low	Project Footprint	Long-term	Infrequent	Probable	Not Significant

6.1.9 Assessment of Significance

The assessment of significance of net effects of the Project is informed by the interaction between the significance factors, with magnitude, duration and geographic extent being the most important factors. Consideration is also given to concerns of Indigenous communities, government officials and agencies, and interested persons and organizations raised during consultation and engagement and through review comments on the EA reports. Net effects to a criterion would be considered to be significant if they are assessed as high magnitude, long-term or permanent duration, at any geographic extent and represent a management concern.

Implementation of proven mitigation measures is expected to avoid or reduce the duration and magnitude of net effects on geology and soil distribution.

The magnitude of the predicted net effects on geology and soil distribution is negligible for change to the extent or properties of geologic features. Changes to the extent or properties of geologic features will be permanent in duration, but limited to the Project footprint, and expected to occur infrequently. As a result, changes to the extent or properties of geologic features are assessed to be not significant.

The magnitude of the predicted net effects on geology and soil distribution is low for changes to the areal extent of productive soils. Changes to the areal extent of productive soils will be limited to a portion of the Project footprint and long-term in duration and expected to occur infrequently. As a result, changes to the areal extent of productive soils are assessed to be not significant.

The predicted net effects on geology and soil distribution are not anticipated to result in a change to the criteria that will alter the sustainability of the criterion beyond a manageable level and the net effects do not result in changes that are not in accordance with provincial and federal guidelines. Therefore, the predicted net effects on geology and soil distribution are assessed as not significant.

6.1.10 Cumulative Effects Assessment

In addition to assessing the net environmental effects of the Project, which considered past and present developments, this assessment also evaluates and assesses the significance of net effects from the Project that overlap temporally and spatially with effects from other reasonably foreseeable future developments (RFD) and activities (i.e., cumulative effects).

For a criterion that has identified net effects, it is necessary to determine if the effects from the Project interact both temporally and spatially with the effects from one or more past, present, or RFD or activities, since the combined effects may differ in nature or extent from the effects of individual Project activities. Where information is available, the cumulative effects assessment estimates or predicts the contribution of effects from the Project and other developments on criteria, in the context of natural changes in the environment.

For this assessment, the net effects characterized in Table 6.1-10 are carried forward to a cumulative effects assessment if they have a likelihood of occurrence of ‘probable’ or ‘certain’

and a non-negligible magnitude. Net effects with this characterization are most likely to interact with other RFD.

Based on this assessment, the net effect to changes to the extent or properties of geologic features was not carried forward to the cumulative effects assessment because it was characterized to have a negligible effect. Whereas the net effect to geology and soil distribution that identified that Project structures will reduce available area of productive soils is carried forward to the cumulative effects assessment because it was characterized to have a low magnitude.

A list of the RFD that were considered for this EA are presented in Section 9.0, Table 9.0-1. Of these projects, those listed in Table 6.1-11 were identified as being probable to occur within the LSA and, therefore, have potential to have net effects within the LSA.

Table 6.1-11: Reasonably Foreseeable Developments that Overlap and Interact with the Local Study Area

ID	Project	Spatial Overlap of Net Effects	Temporal Overlap of Net Effects	Included in Cumulative Effects Analysis
17	Highway 11, 11B resurfacing, paved shoulders	• No	• Yes	• No
18	Highway 11 resurfacing, paved shoulders	• No	• Yes	• No
21	Seine River Bridge, rehabilitation	• No	• Yes	• No
23	Revell River No. 3 Bridge, rehabilitation	• No	• Yes	• No
24	Treasury Metals Inc. Goliath Gold Project	• Yes	• Yes	• Yes
25	Rehabilitation of Steep Rock Mine	• No	• Yes	• No

The RFD IDs 17, 18, 21, and 23 involve the rehabilitation and resurfacing of existing highway and bridge infrastructure and are unlikely to reduce the available area of productive soils as they would not add significant infrastructure footprint area, mostly occur outside of productive soil areas, and occur within existing ROWs. The RFD ID 25 involves the stabilization and remediation of the former Steep Rock Mine site including the raising of water levels in the flooded mine pit areas. The potentially flooded areas within the LSA do not involve areas identified as productive soils or potentially productive soils. Therefore, no cumulative effects on geology and soil distribution related to Project structures reducing available area of productive soils is identified for RFD IDs 17, 18, 21, 23, and 25 and these RFD are not further assessed.

The RFD ID 24 (Goliath Gold Project) involves the construction, operation and decommissioning of an open pit and underground gold mine. Expected activities and features related to this mining project that may impact the available area of productive soils include the construction and operation of pit excavations, waste rock storage, tailings storage, water management ponds, and mine infrastructure. These features could result in the covering and/or excavation of potentially productive soils which could result in cumulative effects to geology and soil distribution when combined with the potential net effect from the Project of reduced available area of productive soils.

A summary of the potential cumulative effects on physiography, geology, surficial geology, and soils are provided in Table 6.1-12**.**

Table 6.1-12: Summary of Cumulative Effects Interactions for Physiography, Geology, Surficial Geology, and Soils

Other Projects/Activities	Potential Incremental Effect	Rationale for Potential Cumulative Effect	Corresponding Number
Treasury Metals Inc. Goliath Gold Project	• Changes to geology and soil distribution due to Project structures reducing available area of productive soils	• Project-related structure foundations may reduce the area of potentially productive soils with potential to interact with this RFD.	24

The following section briefly describes the Goliath Gold Project RFD activities considered likely to have a cumulative interaction with the net effects of the Project on physiography, geology, surficial geology, and soils and the likely cumulative effects on geology and soil distribution.

Potential activities associated with the Goliath Gold Project RFD that could cause net effects on physiography, geology, surficial geology, and soils include: mine excavation; construction of mine facilities and infrastructure; construction of waste rock and tailings storage facilities; and construction of wastewater management ponds. Cumulative effects to geology and soil distribution may occur due to the construction of Project structures in combination with construction of the mine facilities.

The proposed Goliath Gold Project RFD would overlap the Project footprint and, therefore, the net effects of both projects could overlap. Cumulative effects to geology and soil distribution are expected due to the potential interactions of the Project and this RFD. However, due to the scale of the RFD relative to the Project, the cumulative effects are not expected to be significantly greater than the net effects of the RFD itself.

The Project transmission line ROW is adjacent to the proposed RFD operations area over a distance of approximately 1.5 km. Approximately five transmission towers would be constructed along this length with a combined foundation area of less than 1 ha. The RFD has a predicted footprint of approximately 188 ha (AMEC 2018).

Based on this example, the Project net effects are estimated to be on the order of 0.5% of the relative magnitude of the Goliath Gold Project net effects.

6.1.10.1 Cumulative Effects Characterization

Cumulative effects may occur where the Project and other RFD both cause similar net effects within Project boundaries. As discussed in the previous section, net effects to geology and soils distribution may occur due to Project and RFD activities that overlap spatially and temporally.

The cumulative effects are characterized based on the incremental effects that result from the combination of the standalone net effects of the Project and the RFD.

The summary of cumulative effects on geology and soils distribution in the LSA is presented in Table 6.1-13.

Table 6.1-13: Characterization of Cumulative Effects for Geology and Soil Distribution

Indicators	Cumulative Net Effect	Direction	Magnitude	Geographic Extent	Duration/ Irreversibility	Frequency	Likelihood of Occurrence	Significance
Areal extent of productive soil	Changes to geology and soil distribution due to structures and facilities reducing available area of productive soils	Negative	Low	Project Footprint	Long-term	Infrequent	Probable	Not Significant

6.1.10.2 Assessment of Significance

The contribution of the Project and other RFD to cumulative effects on geology and soil distribution in the physiography, geology, surficial geology, and soils LSA is not anticipated to have a cumulative effect on the overall functionality of physiography, geology, surficial geology, and soils resources as they currently exist based on the predicted characterization of the cumulative effects. Consequently, the cumulative effects on physiography, geology, surficial geology, and soils are predicted to be not significant (Table 6.1-13).

6.1.11 Monitoring

This section identifies any recommended effects monitoring to verify the prediction of the effects assessment and to verify the effectiveness of the mitigation measures and compliance monitoring to evaluate whether the Project has been constructed, implemented, and operated in accordance with the commitments made in the EA Report.

During construction, environmental monitors will conduct regular inspections of work areas to ensure that soil management and spill prevention mitigation measures are being implemented effectively. Proactive implementation of mitigation measures will be used based on expected work tasks and environmental conditions. Following completion of construction work, post-construction inspections will ensure that soil conditions along the Project footprint have been restored.

6.1.12 Prediction Confidence in the Assessment

The confidence in the effects assessment for physiography, geology, surficial geology, and soils is moderate to high.

For the purposes of the EA, sufficient information was available from the resources available for the desktop study to understand the existing conditions and assess the potential effects of the Project on physiography, geology, surficial geology, and soils.

The mitigation measures described in Section 6.1.6.1 are based on accepted and proven best management practices that are well understood and have been applied to transmission line projects throughout North America. There is a high degree of certainty that Project construction activities will result in minor and localized changes to the distribution of geologic features and soil. Construction of Project components has high certainty of occurring over areas of potentially productive soils.

Uncertainty in the assessment has been further reduced by making conservative assumptions regarding potential disturbances, areas, and magnitudes of effects. The implementation of monitoring programs will be used to provide feedback on the effectiveness of mitigation and success of reclamation activities. Using monitoring and adaptive management, mitigation may be modified and/or additional mitigation may be implemented to reduce predicted or unexpected effects.

6.1.13 Information Passed on to Other Components

Results of the physiography, geology, surficial geology, and soils assessment were reviewed and incorporated into the following components of the EA:

- Surface water (Section 6.2),
- Groundwater (Section 6.3),
- Vegetation and wetlands (Section 6.4); and
- Fish and fish habitat (Section 6.6).

6.1.14 Criteria Summary

Table 6.1-14 presents a summary of the assessment results for physiography, geology, surficial geology, and soils by criteria.

Table 6.1-14: Physiography, Geology, Surficial Geology, and Soils Assessment Summary

Criteria	Assessment Summary
Geology and Soil Distribution	• Net effects are assessed to be not significant. • Cumulative effects are assessed to be not significant.
Soil Productivity and Quality	• No net effects were identified.

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