Appendix 9-C

WHEELER RIVER PROJECT
Annex Report | Soil, Vegetation and Wildlife

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1 INTRODUCTION

EDI Environmental Dynamics Inc. (EDI) was contracted by Denison Mining Corp. (Denison) in September 2019 to assist with the environmental effects assessment related to the terrain and soils, vegetation, and wildlife components of the Environmental Impact Statement (EIS) for the Wheeler River Project (the Project). Prior to initiating the effects assessment, the discipline leads reviewed the baseline report that had been prepared by Omnia Ecological Services (Omnia). Upon review of the baseline report, areas that required additional information were identified to adequately complete the environmental assessment (EA) for the EIS that is clear, complete and concise, and to a standard that would be accepted and approved as part of to regulatory review. Identified data gaps in Omnia's 2020 Terrestrial Environment Wildlife and Vegetation Baseline Inventory are summarized in Table 1.

The following annex report uses the same terminology and structure provided in the 2020 Terrestrial Environment Wildlife and Vegetation Baseline Inventory. It provides the methods undertaken to acquire the additional baseline information, along with a summary of the information that was compiled for each of the terrain and soils, vegetation, and wildlife components.

Table 1. Identified data gaps for terrestrial baseline components.

Component	Identified Gaps	Requirements for EA
Terrain and Soil	No detailed assessments of terrain or soil were completed. Consideration for soil and terrain attributes not incorporated into the ecosite mapping component.	A desktop review of available literature and spatial inventories will better capture the predominant environmental setting of the soil component and provide a necessary point-of-reference to determine appropriate mitigation measures and evaluate Project effects to inform the EA and the reclamation and closure planning.
Vegetation	A description of the ecosite classifications for the Regional Study Area (RSA) was presented; however, the resulting categorization of regenerating forest stands as novel disturbed forest classification types does not follow provincial ecosite classification standards. These regenerating forests make up a large proportion of the RSA, and may have implications for the vegetation and wildlife EA.	A revision of the novel ecosite types to better reflect the provincial ecosite classification scheme will support both the vegetation and wildlife EA. This revision will take into consideration existing field data and the interpreted ecosite mapping product, desktop soils data, available predictive ecosystem mapping (PEM), and topographic information.
Wildlife	The baseline report characterizes the wildlife communities found in the RSA based on presence-absence field surveys or other existing data sources. Two wildlife components were inadequately surveyed and/or described: avian species of management concern (SOMC) and ungulates (woodland caribou and moose).	A description of available information on avian SOMC is required by the regulators as part of the EA, this includes information from field surveys and desktop reviews. Ungulates are important for Indigenous harvesters and other land users. In addition, woodland caribou are listed provincially and federally. Current population information (where available) will support the EA through the assessment of potential Project effects, cumulative effects, and the design of efficient mitigation measures.

2 STUDY AREAS

The spatial boundaries or study areas for the description of the environmental setting associated with the terrain and soils, vegetation, and wildlife components include: Project footprint, Local Study Area (LSA), and Regional Study Area (RSA). As defined in Table 2, these study areas were delineated to capture the spatial extent of potential direct and indirect effects of the Project on each Valued Component (VC) and to understand the context in which the effects can occur. The study areas used in this annex report are the same as those used in the 2020 baseline report (Omnia 2020).

Table 2. Description of spatial boundaries and study areas.

Study Area	Descriptors
Project Footprint	– The area in which all Project components will be located. It is expected that all physical disturbances resulting from construction, operation and reclamation activities will occur within this area.
Local Study Area (LSA)	– The area established to assess the potential, largely direct effects of the Project on the environment; delineated based on the area over which direct and indirect effects are most likely to occur on VCs. – Defined as the Project footprint plus a 1.7 km buffer (48 km^2). The buffer provided by the LSA was intended to address provincially and federally mandated activity setback distances required for protected species that may be found within the LSA.
Regional Study Area (RSA)	– The area established to assess the potential, largely indirect effects of the Project in the broader, regional context, and provides the regional context over which cumulative effects may occur. – Defined as a 7 km buffer around the LSA (400 km^2). This RSA was designed to capture regional effects on terrestrial resources including wildlife species with large home ranges (Omnia 2020).

3 TERRAIN AND SOIL

3.1 INFORMATION SOURCES

After review of the original Project-specific Wildlife and Vegetation baseline study (Omnia 2020), information pertaining to terrain and soil was only presented at broad scale and coarse resolution. Additional information was required to conduct the effects assessment. Therefore, desktop investigation of available studies, historic surveys and databases relevant to the Project was conducted to further describe existing conditions and environmental context. Where applicable/appropriate, the desktop review included sources relating to the predominant/regional environment to address information gaps. Table 3 summarizes the information sources consulted for development of the mapping products and data summaries for Terrain and Soil. The following sections describe (to the extent practical) the predominant terrain and soil resources within the study area.

Table 3. Existing information for terrain and soil for the Wheeler River Project.

Information Sources	Descriptors and Resolution
Project-Specific Topographic Survey (Denison Mines Corporation 2019)	– Database; 1 m Contours – Ortho/Aerial Imagery
Saskatchewan Mining and Petroleum GeoAtlas (Simpson 1997)	– Database; 1:1MM Scale – Description of surficial geology in Saskatchewan
Soil Landscapes of Canada (SLC) Version 3.2 Soils of Canada Viewer (Soil Landscapes of Canada Working Group 2010)	– Database; 1:1MM Scale – Compilation of Various Soil Surveys (1:20K to 1:250K Scale) – Coverage includes the entire land mass of Canada – Data includes major soil and landscape attributes
Field Guide to the Ecosites of Saskatchewan's Provincial Forests (McLaughlan et al. 2010)	– Reference Guide; 1:20K to 1:50K Scale – Coverage includes all Saskatchewan Ecosections and Ecosites.
The Ecoregions of Saskatchewan (Acton et al. 1998)	– Description of Saskatchewan's ecoregions and defining features
Terrestrial Ecozones of Canada (Wiken 1986)	– Description of Canada Ecological Framework
National Ecological Framework for Canada: Attribute Data (Marshall et al. 1999)	– Database; 1:7.5MM Scale – Hierarchical description of Canada Ecological Framework (Ecozone > Ecoprovince > Ecoregion > Ecodistrict) – Coverage includes the entire land mass of Canada – Data aligns with major soil and landscape attributes
Canada Land Inventory (CLI) (Agriculture and Agri-Food Canada 1998)	– Database; 1:250K Scale – Coverage includes most agricultural lands in Canada – Data includes capability for Agriculture, Forestry, Wildlife, Recreation, Ungulates (circa 1960's, 1970's and early 1980s)
Glacial landforms of northwest Saskatchewan (Norris et al. 2017)	– Description of predominant landforms and geomorphologic processes in northwestern Saskatchewan.

K = 1,000; MM = 1,000,000

3.2 SUMMARY OF BASELINE INFORMATION ACQUIRED

3.2.1 PROJECT LOCATION AND SETTING

The Project is located near the Wheeler River in north-central Saskatchewan within the uranium-rich Athabasca Basin region in the Canadian Shield (i.e., Laurentian Plateau). It is situated within the administrative boundaries of Division No.18, approximately 5 km west of Saskatchewan Highway 914. Current development includes the Key Lake Uranium Mine (closed) and Key Lake Airport located approximately 35 to 40 km south-southwest of the Project; the McArthur River Uranium Mine (currently under care and maintenance) and Cigar Lake Uranium Mine (operational) located approximately 35 to 40 km and 70 km, respectively, north-northeast of the Project. The landscape is characterized by ridges and drumlins, punctuated by glacial kettle lakes and low-lying wetlands that are interconnected by a network of rivers and creeks. The nearest large/major water body is Cree Lake, located approximately 45 to 50 km west of the Project; however, several named and unnamed waterbodies of various sizes are found in proximity to the Project.

The Project is located in the Athabasca Plain, within the Boreal Shield Ecozone (Ecodistrict 339), that is characterized by short cool summers (12ºC mean temperature) and long cold winters (−20.5ºC mean temperature). This ecoregion is classified as having a subhumid high boreal ecoclimate; the mean annual precipitation ranges from 350 to 450 mm. Predominant land use, vegetation composition and ecological assembly are described in further detail in Section 3 Vegetation. Generally, the landscape is composed of undeveloped coniferous forest and various types of wetlands (bogs, fens and swamps). In dry upland areas, vegetation is generally comprised of black spruce and jack pine-dominated species composition. In wet low-lying areas, vegetation is comprised of treed (black spruce, tamarack), shrubby (Labrador tea) or graminoid (sedges) dominated species composition. As shown in Figure 1, the region has undergone previous disturbance associated with various discrete land use activities, including road development and seismic and geologic/mineral exploration; mining is a common regional land use.

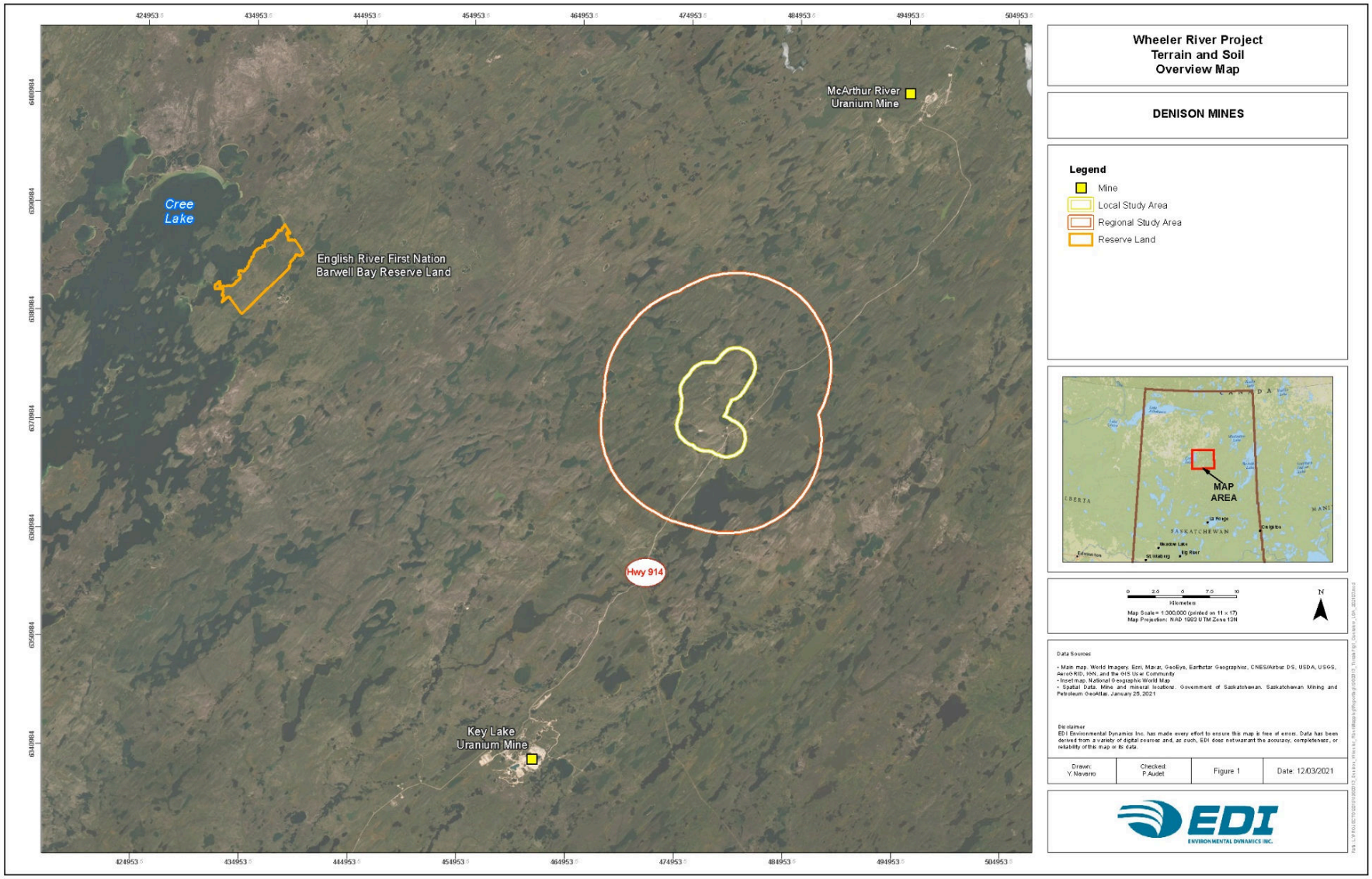

Figure 1. Regional land use map for the Wheeler River Project.

3.2.2 TERRAIN

Terrain morphology within the RSA has been shaped by the last period of glaciation (100,000 to 10,000 years ago) during which the region was covered by the Laurentide Ice Sheet. Geomorphologic processes include deglaciation (glacial retreat) and a combination of erosional and fluvial processes. As shown in Figure 2, landform elements within the RSA are then characterized by eskers (long winding ridges) and drumlins (elongated oval-shaped hills) with only small variations in elevation (ranging 480 to 590 m) resulting in a gently undulating terrain (GeoAtlas ID 7424).

The landscape is punctuated by glacial/proglacial kettle lakes and landscape depressions that are interconnected by a network of rivers and creeks. Based on available ecosite characteristics, the terrain is characterized by slopes ranging from Slope Class A (0 to 3%, little or no slope), Slope Class B (4 to 9% gradient, gentle slopes) and Slope Class C (10 to 15% gradient, moderate slopes). Surface drainage is predominantly rapid or very rapid. The reader should refer to the Project-specific hydrogeological study (Ecometrix 2021) for characterization of surface drainage patterns and processes.

Parent materials are associated with glacio-fluvial and morainal deposits (quartzite) originating from Proterozoic sandstone; surface textures are predominantly sand textured (sand, loam sand/sandy loam and silty sand). Insights on the landscape stability can be gained based on characteristics of terrain, landform elements and surface materials.

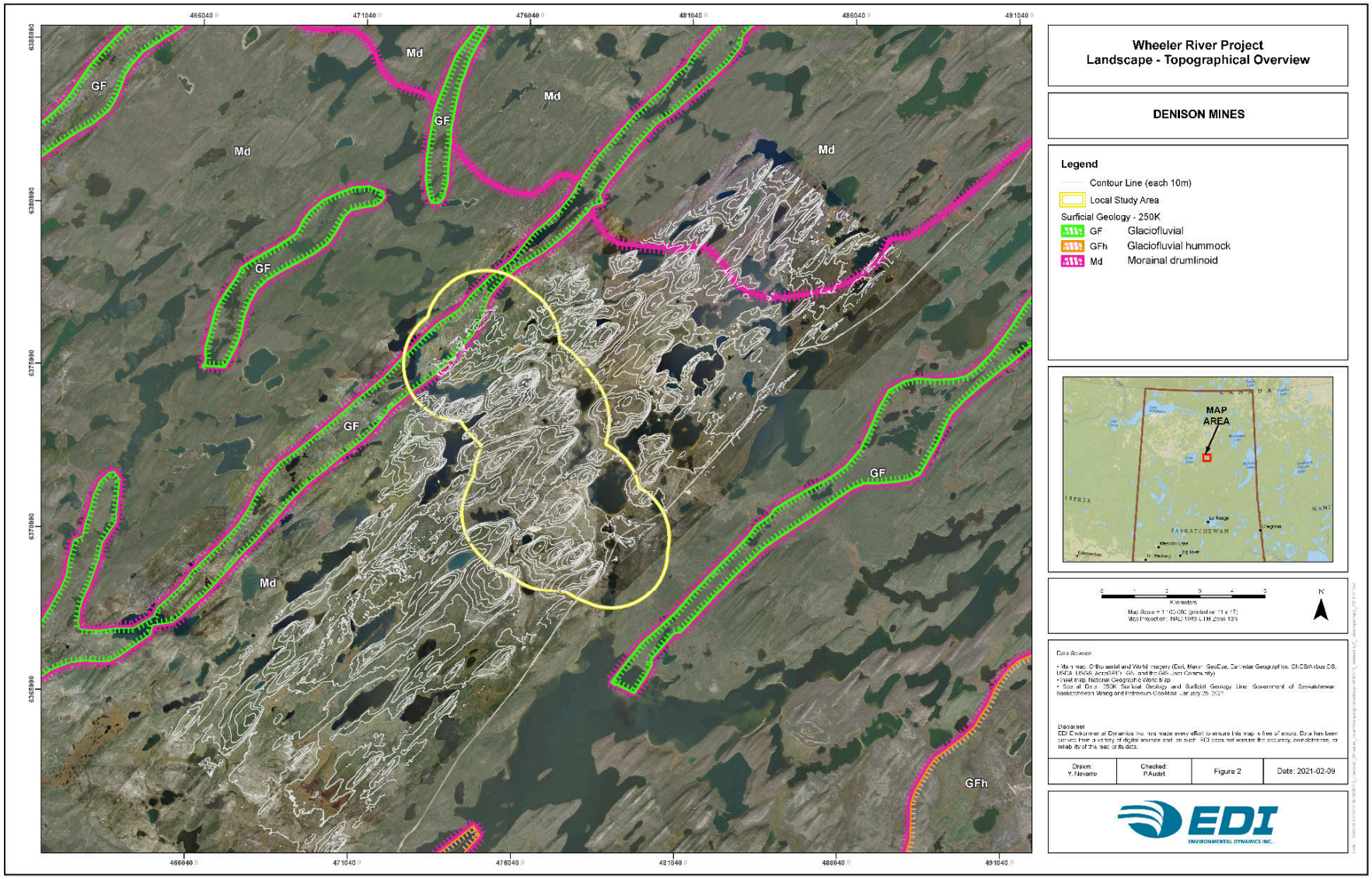

Figure 2. Terrain contours and geomorphology for the Wheeler River Project.

3.2.3 SOIL

As shown in Figure 3, Brunisols predominate the Athabasca Plain Ecozone and are considered the primary soil order within the RSA (Soil Landscapes of Canada, Soil ID 47054022). Regosols and Organic Fibrisols also occur, as well as discrete/sporadic Organic Cryosols.

Brunisols form under forest systems and are characterized by a defined Ae (eluviated) or Aeh (eluviated humic) horizon that is underlain by Bm (modified) and/or Bf (with clay and/or mineral inclusions) horizons that are physico-chemically similar to the parent material. Regosols are characterized by a thin Ah (humic) horizon but hold no recognizable (or only weakly defined) B horizon due to their relatively early/young pedogenic development. Organic Fibrisols are composed largely of organic fibric materials (Of) originated from readily identifiable botanical origin. Organic Cryosols are also composed of organic materials, but necessarily characterized by the presence of permafrost and/or cryoturbation. Based on available ecosite characteristics, mineral soils within the RSA refer to Sandy Dystric Brunisols that are typically acidic, hold low fertility and organic matter content, and lack a well-developed mineral-organic surface horizon. As such, the effective rooting depths (referring to the upper portion of the rooting zone where vegetation mostly access nutrients and water) can be relatively shallow (<30 cm). Topsoil profiles — representing the soil's uppermost and most bioactive portion — are composed of a thin surface organic layer (LFH, Litter-Ferment-Humus) followed by a thin, sand-textured Ae or Aeh. Subsoils are then composed of a characteristically sand-textured Bm and/or Bf horizon of variable depth followed by sand-textured BC or C horizons and/or R horizon (bedrock). Meanwhile, low-lying depressions within the RSA are commonly defined by the presence of wetlands (bogs, fens and swamps) and, therefore, the occurrence of organic soils. Organic soil profiles are likely characterized by a thin LFH followed by Of (fibric), Om (mesic) and/or Oh (humic) horizons of variable depths (depending on the wetland classification). Subsoils are characterized by sand-textured Cg (gleyed) horizon and/or R horizon. Generalized mineral and organic soil profile descriptors are shown in Figure 4.

Insights on soil salvage potential (i.e., the ability to strip and store the material) and soil erosion potential can be gained based on soil profile characteristics and composition, including horizon depths, texture, effective rooting depths, coarse fragment content and organic matter content. Interpretations on the specific soil salvage potential of landscape features within the RSA are speculative in the absence of field data.

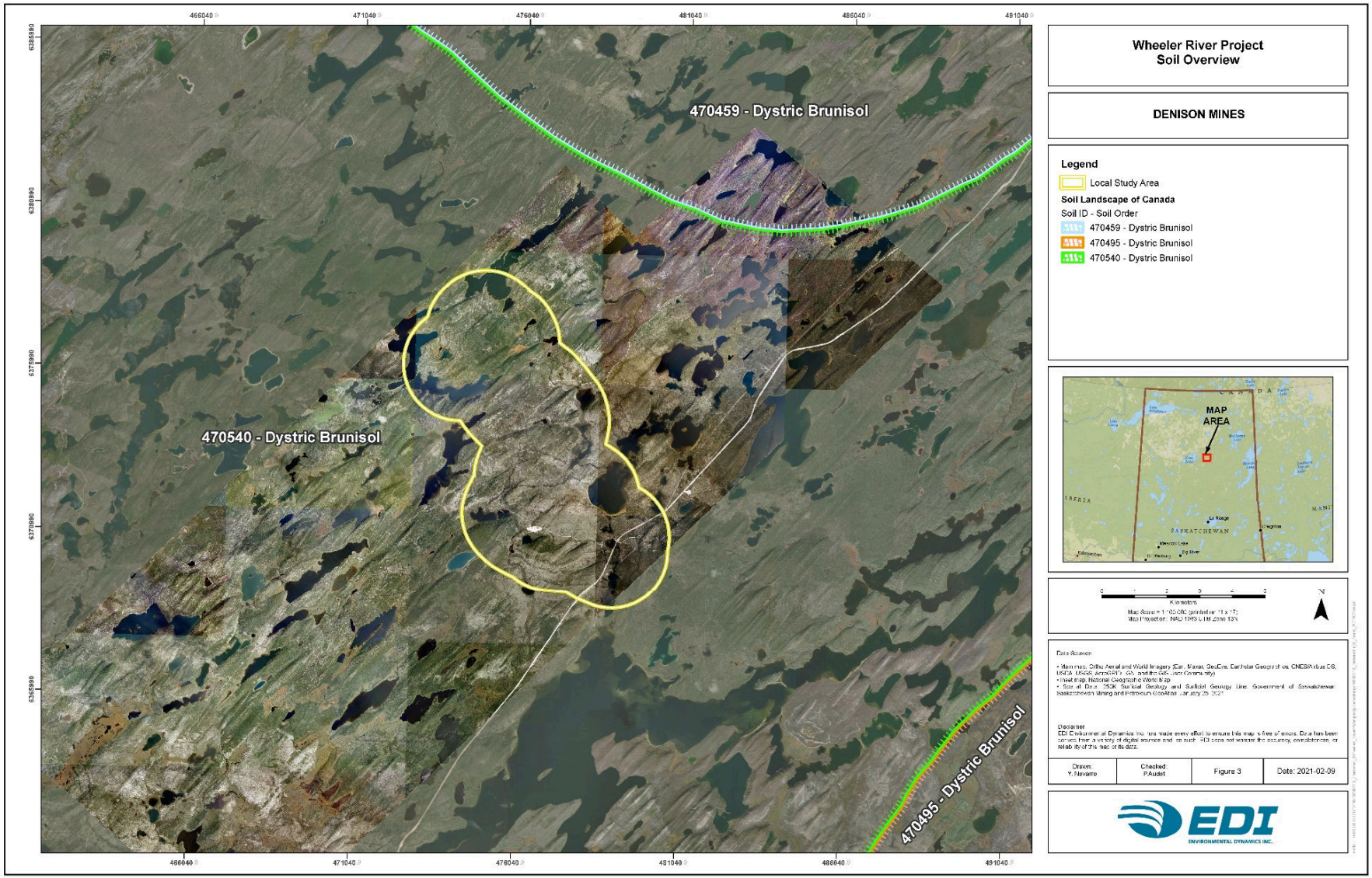

Figure 3. Predominant soil orders for the Wheeler River Project.

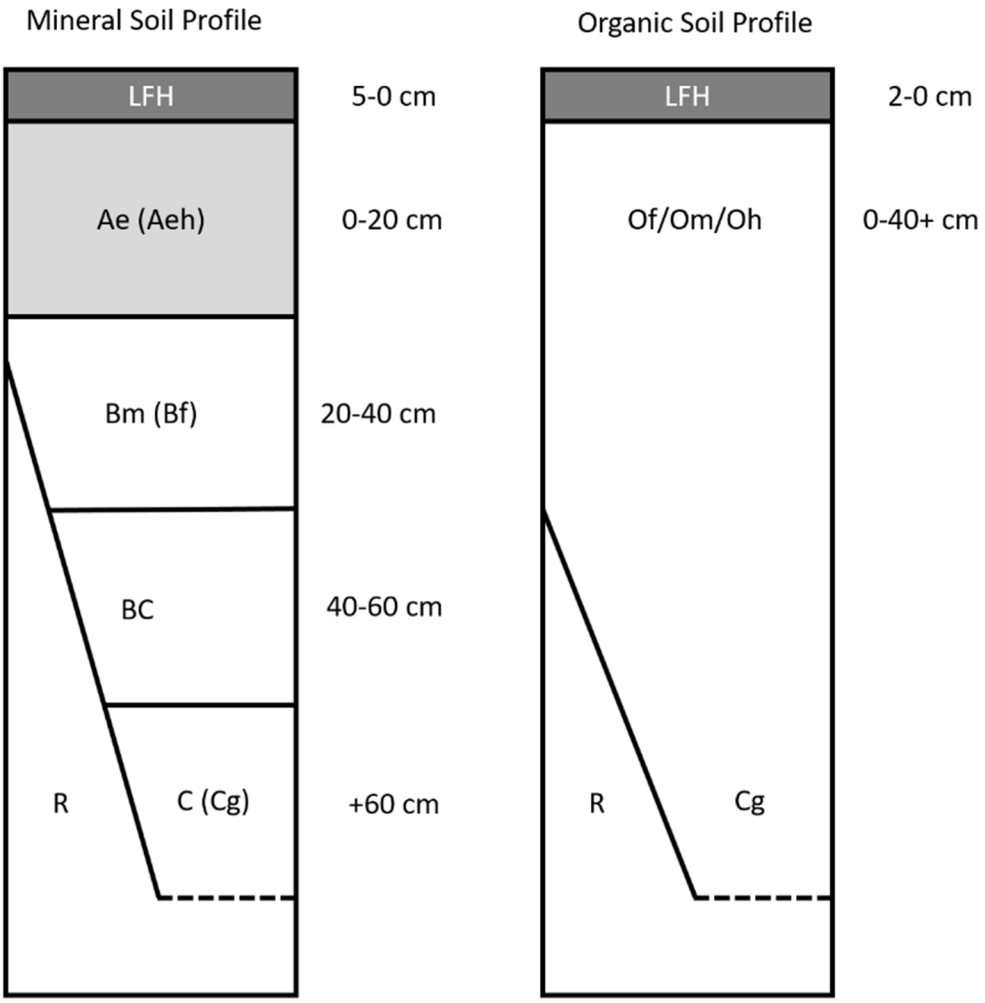

Figure 4. Mineral and organic soil profiles.

Note: Adapted from McLaughlan et al. (2010)

4 VEGETATION

The vegetation component of Project baseline studies presented a description of the ecosite classifications within the RSA. These ecosite classifications were summarized within a 1:20,000 interpreted ecosite mapping product compiled within the RSA with the use of the following inputs:

- 1:5,000 anthropogenic features mapping;
- historical fires data;
- provincial Predicted Ecosite Mapping (PEM);
- current and historical imagery; and,
- field sampling/ground truthing sites (Omnia 2020).

As the Boreal Shield Ecozone experiences a largely natural fire regime that results in the most area burned per unit area and the highest proportion of very large fires (>50,000 ha) in the province (Parisien et al. 2004), much of the vegetation within the RSA (70.6%) is comprised of post-fire regeneration (Omnia 2020). To account for the abundance of regenerating ecosystems within the RSA, the original interpreted ecosite mapping product categorized disturbed forest stands as novel regenerating forest types.

These novel regenerating forest types provide information about forest structure, differentiating among recently disturbed areas dominated by low shrub, tall shrub, and young forest; however, they do not describe dominant biotic (e.g., vegetation species and relative abundance) and abiotic (e.g., moisture and nutrient regimes) processes, or allow for broader ecological interpretation (McLaughlan et al. 2010).

Although these novel regenerating forest types were developed under the assumption that the classification within the *Field Guide to the Ecosites of Saskatchewan's Provincial Forests* does not describe forest types under 40 years of age (Omnia 2020), the guide offers the following advice when working within areas of recent disturbance:

> *"Young (e.g., <40 years old) or modified sites may still be classified according to the guide, but elements or specific features of these sites may vary from the mature natural condition. For both young and modified sites, the reader should anticipate differences in vegetation and are encouraged to supplement their ecosite evaluation with features such as moisture regime and other soil attributes".*

As such, while the provincial ecosite descriptions have been developed to represent the "average natural and mature site condition", they are still valid within disturbed landscapes. Accordingly, to bring this interpreted ecosite mapping product in line with provincial ecosite descriptions, a desktop revision was completed for polygons described with novel regenerating forest types to better reflect the provincial ecosite classification.

4.1 METHODS

Accepted provincial ecosite classification allows for broader ecological interpretation, providing information about soil moisture and nutrient regimes and vegetation community composition and successional trajectories. Thus, novel regenerating forest types within the interpreted ecosite mapping product (Omnia 2020) were reclassified in accordance with accepted provincial ecosites based on available desktop data sources, including:

- Interpreted Ecosite Mapping (Omnia 2020);
- 1 m topographic contours (Denison Mines Corporation 2019);
- soils information (Soil Classification Working Group 1998; Section 3);
- Field Guide to the Ecosites of Saskatchewan's Provincial Forests (McLaughlan et al. 2010); and,
- ecosite descriptions within the Baseline Report (Omnia 2020).

Lower intensity fires are common in the Boreal Shield Ecozone, creating the opportunity for multiple forest age cohorts and diverse structural complexity, which can be important for wildlife habitat (Andison 2013). This diversity of burned and unburned areas was accounted for within the original baseline mapping: in addition to delineating polygon boundaries around burned and unburned areas, Omnia mappers differentiated novel regenerating forest types into low shrub (<1 m tall, 5-20 years old), tall shrub (1–5 m tall, 20–40 years old), and young forest (>5 m tall, 30–50 years old) categories (Omnia 2020).

To retain this level of detail and describe vegetation structure within the RSA, a structure attribute was added to the interpreted ecosite mapping product to match local site conditions and successional trajectories (Table 4). This vegetation structure attribute provides further information about the habitat heterogeneity present within the RSA. It was assumed that all ecosites attributed in accordance with the provincial ecosite guide were present in their "average mature stage", and that any young or modified sites were fully encompassed by polygons described by the novel regenerating forest types (e.g., RF1, RF2, RF3), or anthropogenic features.

Novel regenerating forest types were then reclassified as per provincial ecosite definitions within the Field Guide to the Ecosites of Saskatchewan's Provincial Forests (McLaughlan et al. 2010) based on available spatial datasets and baseline information from Omnia (2020).

Table 4. Vegetation structure definitions used to modify interpreted ecosite mapping for the Wheeler River Project.

Vegetation Structure	Definition
0	Unvegetated – areas that do not support terrestrial vegetation (e.g., paved surfaces, open water).
1	Sparse / bryophyte / lichen – either the initial stages of primary succession, a very early stage of community establishment following a stand-destroying disturbance, or a bryophyte / lichen community maintained by environmental conditions (e.g., bedrock). Bryophytes or lichens can be dominant; time since disturbance is <5 years for normal forest succession; sparse tree, shrub and herb cover: either sparsely vegetated overall, or dominated by bryophytes / lichens.
2	Herb / graminoid – early successional stage or herb community maintained by environmental conditions or disturbance; generally dominated by herbs (forbs, graminoids), although herb cover can be low if sparsely vegetated overall as long as herbs characterize the vegetation; trees and shrubs are usually absent or sparse; time since disturbance is <5 years for normal forest succession; many non-forested communities are perpetually maintained in this stage.
3a	Low shrub – dominated or characterized by shrubby vegetation <1 m tall; time since disturbance 5-20 years for normal forest succession.
3b	Tall shrub – dominated or characterized by shrubby vegetation that is 1-5 m tall; time since disturbance 20-40 years for normal forest succession.
5	Young forest – dominated by trees >5 m tall; forest canopy may have begun to differentiate into distinct layers; time since disturbance estimated between 30-50 years.
6	Mature forest – trees established after the last stand-replacing disturbance have matured; shrub and herb understories well developed; time since disturbance is 50+ years.

Notes:

Modified from the *Field Manual for Describing Terrestrial Ecosystems* (B.C. Ministry of Environment, Lands, and Parks, and B.C. Ministry of Forests 1998).

4.2 RESULTS

Project-specific vegetation structure attributes were assigned in accordance with the definitions in Table 4, based on the "average mature stage" of each ecosite (McLaughlan et al. 2010).

Novel regenerating forest types characterized within the original interpreted ecosite mapping product included three upland types and two wetland types (Table 5). The three novel upland regenerating forest types (RF1-C, RF2-C, RF3-C) were described as structural categories along a natural successional trajectory from a low shrub stage characteristic of recent fire disturbance (RF3-C) toward a young forest stage (RF1-C; Omnia 2020). Vegetation plots within all three novel upland regenerating forest types indicate a dominance of jack pine within the tallest vegetation layer (sometimes co-dominant with black spruce), with blueberry and reindeer lichen dominating the low shrub layer and ground cover, respectively (Omnia 2020; Table 5). Although no soils information was collected during ecosite field verification, vegetation community observations are consistent with the provincial ecosite classification of BS3 (jack pine / blueberry / lichen: moderately fresh sand) and/or BS7 (black spruce / blueberry / lichen: moderately dry sand) (McLaughlan et al. 2010).

Table 5. Novel regenerating forest types, revised ecosites and vegetation structure.

Novel Regenerating Forest Type[1]	Original Ecosite Description[1]	Dominant Tree Species[1]	Revised Ecosite[2]	Vegetation Structure[3]
RF3-C – Regenerating coniferous forest – low shrub <1 m tall (5–20 years)	A pioneer stage following forest fires. Blueberry and jack pine are the most common low shrub species, although cranberry is found in some plots. Scattered tall shrubs include black spruce and jack pine. Commonly encountered in the study area; associated with the hills of eskers and drumlins as well as level plains. Poor in plant and lichen species diversity. The RF3 ecosite is a pioneer stage following forest fires and will succeed towards RF2 in the absence of fire.	Jack pine	BS3 – jack pine / blueberry / lichen or BS7 – black spruce / blueberry / lichen	3a
RF2-C – Regenerating coniferous forest – tall shrub 1–5 m tall (20–40 years)	Usually dominated by a thick cover of tall jack pine stands. Some areas have residual patches of trees. The low shrub layer is dominated by blueberry, with a dominant ground cover of reindeer lichen. RF2 ecosites are relatively poor in vascular species diversity, but lichen diversity is relatively high. Closely resemble the RF1 ecosite but generally younger. Commonly encountered ecosite on the Boreal Shield, associated with the hills of eskers and drumlins as well as level plains. The RF2 ecosite succeeds the RF3 ecosite and will continue to succeed towards RF1 in the absence of fire.	Jack pine	BS3 – jack pine / blueberry / lichen or BS7 – black spruce / blueberry / lichen	3b
RF1-C – Regenerating coniferous forest – treed >5 m tall (30–50 years)	RF1 regeneration stage is usually jack pine dominated. Blueberry and bog cranberry shrubs can be found beneath the tree canopy, along with jack pine and the occasional black spruce and Labrador tea. Bryophytes are sporadically distributed, and the dominant ground cover is reindeer lichen. This phase is on average 40 years old in the study area. RF1 ecosites have a moderate structural diversity and high species richness. They closely resemble the RF2 ecosite but RF1 sites have a greater structural diversity and canopy closure. RF1 can be considered to be a more advanced successional stage than RF2 and will succeed towards a BS3 or BS7 over time.	Jack pine (with components of jack pine, alder and black spruce in shrub layer)	BS3 – jack pine / blueberry / lichen or BS7 – black spruce / blueberry / lichen	5
RF2-B – Regenerating bog – tall shrub 1–5 m tall (20–40 years)	Not described	Not described	BS18 – Labrador tea shrubby bog	3b
RF3-B – Regenerating bog – low shrub <1 m tall (5–20 years)	Not described	Not described	BS18 – Labrador tea shrubby bog	3a

Notes

1 Derived from Omnia 2020.

2 Ecosites as described in McLaughlan et al. 2010.

3 3a — Low Shrub — dominated or characterized by shrubby vegetation <1 m tall; time since disturbance 5 to 20 years for normal forest succession.

3b — Tall shrub — dominated or characterized by shrubby vegetation that is 1-5 m tall; time since disturbance 20 to 40 years for normal forest succession.

5 — Young forest — dominated by trees >5 m tall; forest canopy may have begun to differentiate into distinct layers; time since disturbance estimated between 30 and 50 years.

The jack pine dominated BS3 ecosite is the most common ecosite on the Boreal Shield, occurring in almost every topographic position and slope. It is closely tied with the BS7 ecosite, which can be either dominated by black spruce or a mixture of black spruce and jack pine, and as a result tends to have a greater canopy closure and stem density than the BS3 ecosite. The successional relationship between BS3 and BS7 are interdependent: with sufficient abundance of pine, the BS7 may follow a successional pathway toward BS3, and in the absence of disturbance, BS3 ecosites may transition toward BS7 (McLaughlan et al. 2010).

The two 'novel wetland regenerating forest' types (RF2-B and RF3-B) were similarly described as structural categories within fire-disturbed wetland ecosystems. These 'novel wetland regenerating forest' types are sparsely distributed, absent from the LSA and representing <0.1% (2.0 ha) and 0.1% (20.2 ha) of the RSA, respectively. Accordingly, little information about these regenerating forest types was provided in the baseline report (Omnia 2020).

The provincial ecosite guide describes four bog ecosites within the Boreal Shield that can represent a successional pathway following disturbance: BS20 (open bog); BS19 (graminoid bog); BS18 (Labrador tea shrubby bog); and BS17 (black spruce treed bog) (McLaughlan et al. 2010). As both 'novel wetland regenerating forest' types are defined as different age classes of shrubby bog, both were deemed to fall within the BS18 ecosite. Structural differences associated with the RF2-B (tall shrub) and RF3-B (low shrub) were maintained by assigning structure codes of 3b and 3a, respectively (Table 5).

A summary of the revised ecosite mapping and vegetation structures within the LSA and RSA as is presented in Figure 5 and Figure 6, respectively, as well as summarized in Table 6.

4.3 CONCLUSIONS

These revisions have aligned the Omnia (2020) ecosite mapping product with accepted provincial ecosites (i.e., McLaughlan et al. 2010), while maintaining details about the structural complexity resulting from historic fire disturbance within the RSA. The dominant ecosites within the RSA are upland forested ecosite BS3 (jack pine / blueberry / lichen) and BS7 (black spruce / blueberry / lichen), comprising an estimated 70.1% (Table 6), and the overall composition of ecosites within the RSA appears to be consistent with ecosystems within the Boreal Shield ecozone (McLaughlan et al. 2010).

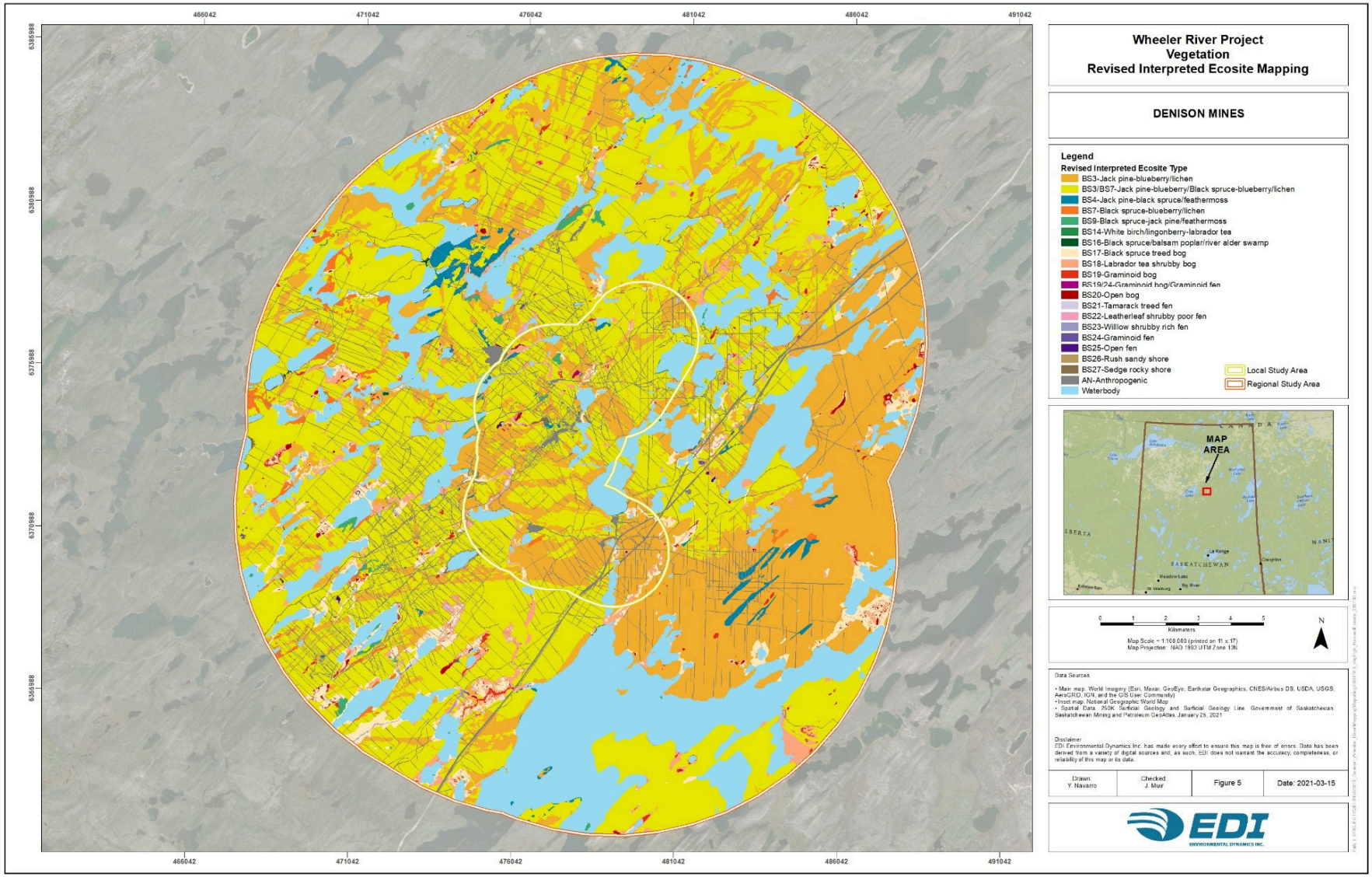

Figure 5. Wheeler River Project - vegetation - revised interpreted ecosite mapping.

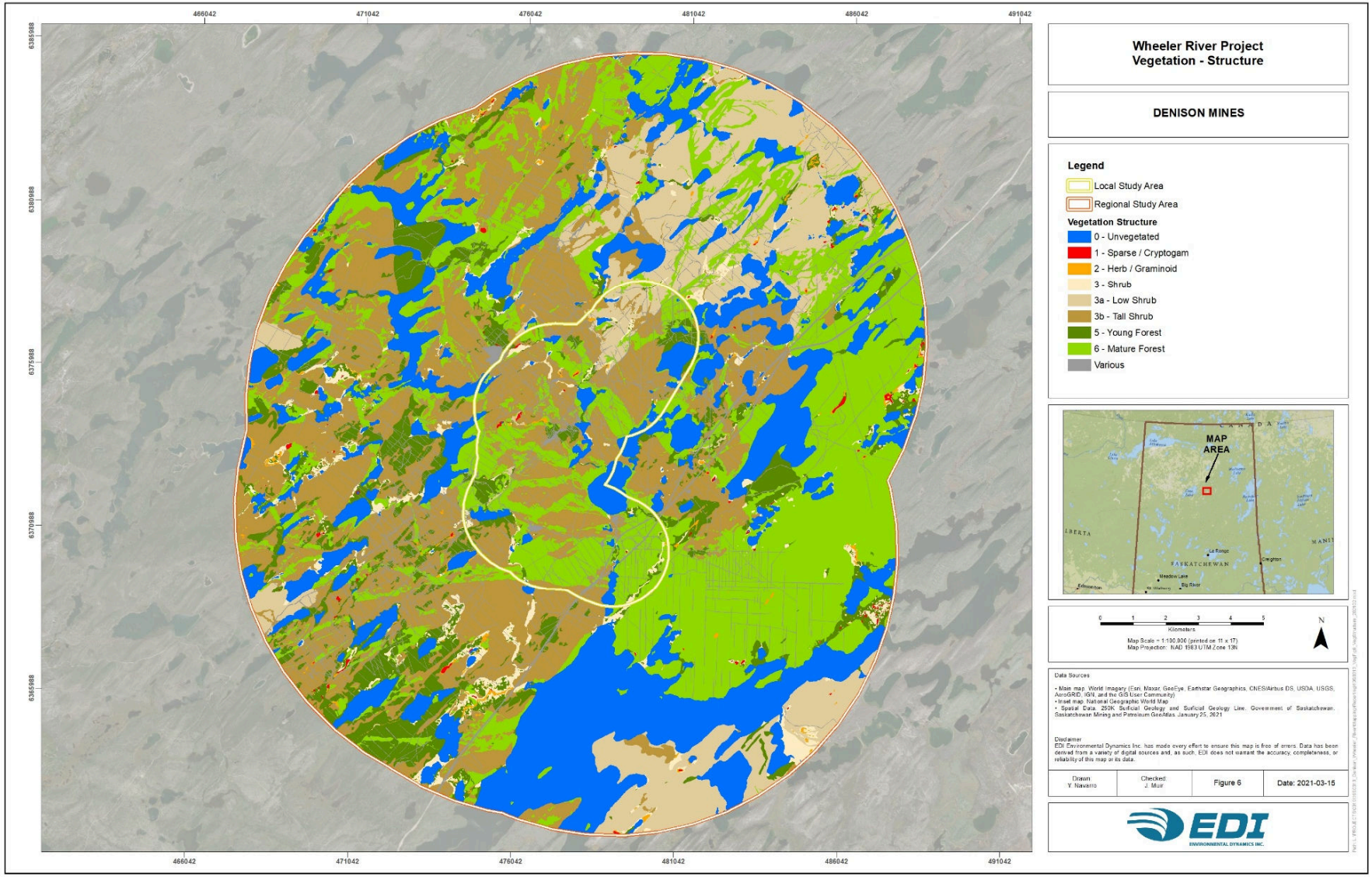

Figure 6. Wheeler River Project vegetation structure.

Table 6. Summary of ecosites and vegetation structure for the Wheeler River Project.

Ecosite Code[1]	Ecosite Description[1]	Structure Code[2]	RSA (ha)	RSA (%)	LSA (ha)	LSA (%)
AN	Anthropogenic	Various[3]	599.0	1.5	166.6	3.5
BS3	Jack pine / blueberry / lichen	6	10,374.8	25.8	1,612.7	33.8
BS3/BS7	Jack pine / blueberry / lichen **or** black spruce / blueberry / lichen	3a	4,556.4	11.3	238.1	5.0
		3b	10,525.5	26.2	1,830.3	38.4
		5	2,412.1	6.0	200.2	4.2
BS4	Jack pine – black spruce / feathermoss	6	332.8	0.8	22.9	0.5
BS7	Black spruce / blueberry / lichen	6	281.0	0.7	9.7	0.2
BS9	Black spruce – jack pine / feathermoss	6	148.5	0.4	15.1	0.3
BS14	White birch / lingonberry – Labrador tea	5	1.8	<0.1	0.3	<0.1
BS16	Black spruce / balsam poplar / river alder swamp	6	8.8	<0.1	--	--
BS17	Black spruce treed bog	5	1,157.1	2.9	82.5	1.7
BS18	Labrador tea shrubby bog	3	967.6	2.4	101.4	2.1
		3a	20.3	0.1	--	--
		3b	2.0	<0.1	--	--
BS19	Graminoid bog	2	160.5	0.4	8.7	0.2
BS19/24	Graminoid bog **or** graminoid fen	2	2.4	<0.1	2.4	0.1
BS20	Open bog	1	65.5	0.2	4.8	0.1
BS21	Tamarack treed fen	5	66.5	0.2	14.8	0.3
BS22	Leatherleaf shrubby poor fen	3a	28.5	0.1	13.2	0.3
BS23	Willow shrubby rich fen	3b	20.9	0.1	3.2	0.1
BS24	Graminoid fen	2	9.0	<0.1	--	--
BS25	Open fen	1	5.7	<0.1	2.1	<0.1
BS26	Rush sandy shore	2	15.1	<0.1	0.9	<0.1
BS27	Sedge sandy shore	2	29.3	0.1	4.2	0.1
Waterbody	--	0	8,381.6	20.9	436.1	9.1
		Total	**40,172.5**	**100.0**	**4,770.2**	**100.0**

Notes:

1 Ecosystems are described in detail in the *Guide to the Ecosites of Saskatchewan's Provincial Forests* (McLaughlan et al. 2010).

2 Modified from the *Field Manual for Describing Terrestrial Ecosystems* (B.C. Ministry of Environment, Lands, and Parks, and B.C. Ministry of Forests 1998). Project-specific structure codes are further described in Table 4.

3 Areas of anthropogenic disturbance have various vegetation structures depending on the intensity and duration of the original disturbance, as well as the time elapsed since disturbance.

5 WILDLIFE

The information presented in the Terrestrial Environment Wildlife and Vegetation Baseline Inventory (Omnia 2020) characterizes the wildlife communities found in the RSA based on several 2017 to 2019 presence-absence field surveys or other existing data sources. However, there were two wildlife components that were subsequently identified as requiring additional information to fully describe the wildlife assemblage in the RSA: avian species of management concern (SOMC) and ungulates (i.e., woodland caribou [*Caribou tarandus caribou*] and moose [*Alces alces*]).

This section describes EDI's approach to acquire the information as part of a desktop exercise and consultations with provincial species specialists for avian SOMC and ungulates, and describes the information obtained through this process that will be used to inform the environmental assessment for the Project.

Avian Species of Management Concern

To detect avian species (including SOMC) in the RSA, Omnia (2020) conducted breeding songbird point count surveys and one aerial waterfowl and raptor stick nest survey. These surveys were designed to capture presence of avian species in the RSA (note that Omnia's report uses the term "Phoenix project area" and the figures depicting the resulting observation locations use the LSA and RSA). The Saskatchewan Ministry of Environment (SK MOE) published Species Detection Survey Protocols (SDSP; available through the Government of Saskatchewan Publication Centre 2021) for a variety of avian species (including avian SOMC), however, these protocols were not implemented for Omnia's surveys. The following list includes avian SOMC mentioned as "known to occur or potentially occurring in the project area" (Appendix 1 of the Terrestrial Environment Wildlife and Vegetation Baseline Inventory [Omnia 2020]):

- Common nighthawk (*Chordeiles minor*): the Omnia (2020) document mentions that there were incidental sightings of common nighthawk, and that the observations of individuals and nest locations were mapped (see Figures 3.1 and 3.2). While the observations were incidental and the SK MOE SDSP for common nighthawk was not used, it is assumed that the available data will satisfy the Environmental Impact Statement (EIS) requirements.
- Short-eared owl (*Asio flammeus*): the Omnia (2020) document does not mention any species-specific surveys or incidental observations of this SOMC.
- Yellow rail (*Coturnicops noveboracensis*): the Omnia (2020) document does not mention any species-specific surveys or incidental observations of this SOMC.
- Rusty blackbird (*Euphagus carolinus*): the Omnia (2020) document does not mention any species-specific surveys or incidental observations of this SOMC.

Ungulates

Two ungulate species were included in the baseline field studies and will be considered in the EIS: boreal woodland caribou and moose.

Omnia (2020) conducted several field surveys to identify seasonal presence and habitat use of woodland caribou and moose (and other terrestrial wildlife species), including the following: winter track count surveys, spring pellet group/browse availability transects, and remote camera surveys. No aerial ungulate surveys were completed as part of the baseline investigation because the SK MOE would not provide permits for these surveys. However, the Terrestrial Environment Wildlife and Vegetation Baseline Inventory (Omnia 2020) summarizes several aerial ungulate surveys that were completed between 2008 and 2014 in the Boreal Shield of Saskatchewan (i.e., in the SK1 Woodland Caribou Management Unit, where the Project is located).

5.1 INFORMATION SOURCES

Additional information regarding the three avian SOMC that were not included in Omnia's (2020) report was gathered from the Hunting, Angling, and Biodiversity Information of Saskatchewan (HABISask) database managed by the Saskatchewan Conservation Data Centre (SKCDC).

In an attempt to gather additional information from more recent aerial surveys conducted by the SK MOE and other entities, EDI reached out to regional SK MOE personnel and University of Saskatchewan researchers took place to acquire the data, where publicly available. Details are provided in Section 5.2.2.

5.2 SUMMARY OF BASELINE INFORMATION ACQUIRED

5.2.1 AVIAN SPECIES OF MANAGEMENT CONCERN

A query was initiated and the HABISask database was searched for the above mentioned four avian SOMC within a 10 km radius around the Project (SK MOE 2021). Table 7 provides the results of the search. Note that common nighthawk is also included in the table, in addition to the incidental sightings of this species recorded and mapped in the baseline report (Omnia 2020).

Table 7. Additional information on avian Species of Management Concern for the Wheeler River Project.

Common Name	Scientific Name	Provincial Rank	COSEWIC[1]	SARA Status[2]	Known Occurrences	Descriptions[3]
Common nighthawk	*Chordeiles minor*	S4B, S4M	Special concern	Threatened	Yes	One observation of one individual.
Short-eared owl	*Asio flammeus*	S3B, S2N, S3M	Special concern	Special concern	No	N/A
Yellow rail	*Coturnicops noveboracensis*	S3B, S3M	Special concern	Special concern	No	N/A
Rusty blackbird	*Euphagus carolinus*	S3B, SUN, S3M	Special concern	Special concern	Yes	Several observations in 2019; between one and three adults per observation.

1 Species listed by the Committee on the Status of Endangered Wildlife in Canada.
2 Species listed under the *Species at Risk Act*.
3 Observations in this database did not provide sighting locations.

In addition to the noted occurrences of common nighthawk, there is evidence that rusty blackbird is using habitat within the RSA. Similar sensitive timing windows (e.g., May 1 to August 31) and setback distances from high disturbance activities (e.g., 200 m) to those outlined for common nighthawk, based on the Saskatchewan Activity Restriction Guidelines (SK MOE 2017), should be considered for rusty blackbird (refer to Table 3.1 of the Terrestrial Environment Wildlife and Vegetation Baseline Inventory [Omnia 2020]).

5.2.2 UNGULATES

To update the Omnia (2020) report with more recent aerial ungulate survey data, EDI contacted SK MOE staff and University of Saskatchewan researchers, once approval from Denison was received. After being informed that the University of Saskatchewan conducted recent aerial surveys, attempts were made to establish a data sharing agreement between Denison and the university or the funding partners but have been unsuccessful to-date. Table 8 summarizes the communications undertaken to obtain additional aerial survey data, and the information received.

Table 8. Communications to obtain additional ungulate data.

Agency	Contact	Data Type / Information	Availability
SK MOE	Gigi Pittoello Habitat Ecologist	No additional aerial ungulate surveys were completed by the government. The 2019 amendment to the federal caribou recovery strategy (Environment and Climate Change Canada [ECCC) 2019) identified that the caribou population in the SK1 Boreal Shield range as the only population assessed as being self-sustaining at a threshold of 40% undisturbed habitat (in a range with predominantly fire disturbance) and that total anthropogenic disturbance should not exceed 5% (while maintaining a minimum of 40% undisturbed habitat in the range).	N/A
University of Saskatchewan	Phil Mcloughlin Department of Biology	Collected GPS telemetry data on caribou, wolves, and black bears in SK1 caribou range. Ninety-four GPS collared caribou were followed from 2014 through 2018; 36 wolves were monitored from 2014 through 2016. In February 2017, a wolf-moose-caribou aerial survey was completed in an area encompassing over 4,500 km². In 2015, a helicopter survey was conducted in the Courtney Lake area. In addition, throughout the collaring study area in March of each year (2015, 2016, 2017, and 2018) cow:calf ratios where surveyed when locating collared caribou[1].	Collected data will not be publicly available as they are funded by third parties. It may be possible to access data through data sharing agreements[2].

1 This information was summarized in McLoughlin et al. 2019 and a high-level summary is included in this report.

2 A data sharing agreement between Denison and either with the university or participating (funding) third parties could not be established at the time of this report.

Based on these communications, no additional aerial ungulate survey data were available at this time for inclusion into this baseline annex report and the subsequent EIS.

SK MOE has developed a range plan for woodland caribou in Saskatchewan to facilitate effective landscape management in support of a self-sustaining woodland caribou population (SK MOE 2019). This first range plan was developed for the SK2 Central Caribou Administration Unit (for an area over 200 km south of the Project). To establish a range plan for the SK1 Boreal Shield caribou range (in which the Project is located), initial range planning activities and meetings were scheduled to begin late in 2020. All currently available geospatial woodland caribou information is provided on the Saskatchewan GeoHub (2021). No range information is currently available for the SK1 Boreal Shield range and critical habitat has not yet been identified.

Omnia (2020) cited the document by McLoughlin et al. (2016) entitled "Population Dynamics and Critical Habitat of Woodland Caribou in the Saskatchewan Boreal Shield - Interim Project Report" for a summary of the 2008 to 2014 aerial ungulate surveys. While the 2019 Final Project Report by McLoughlin et al. (which was not included in the Omnia 2020 document) does not provide additional aerial survey results, it does provide some details about the boreal caribou population and other terrestrial wildlife species in the SK 1 Boreal Shield range in which the Wheeler River Project is located. The observations provided in the report are based on the authors' detailed 2014 to 2018 study and are summarized in the following paragraphs.

The Denison Wheeler Project is located in the SK1 Boreal Shield Woodland Caribou Management Unit which has low levels of anthropogenic disturbance (i.e., approximately 3% of habitat occurs within 500 m of any industrial footprint and linear features) and exposed to large fire disturbances in the past 40 years (ECCC 2019). The SK1 management unit contains high-quality conifer-dominated caribou habitat with >40-year-old stands of jack pine and black spruce forests suitable for lichen colonization, black spruce swamps and open muskegs. Surveyed areas support relatively high densities of caribou, at 36.9 caribou/1000 km^2 or approximately 3,380 caribou in McLoughlin et al.'s (2019) study area, translating to approximately 4,000 caribou across the SK1 Boreal Shield Woodland Caribou Management Unit.

Predator surveys were also conducted as part of the study and revealed relatively low population densities (McLoughlin et al. 2019). Wolf (*Canis lupus*) densities in the region were observed to be low, with 3.1 wolves/1000 km^2. Large territories were occupied by established packs (i.e., 2,865 ± 595 km^2 per territory) and pack size averaged at 4.00 ± 0.51 wolves/pack (McLoughlin et al. 2019). Black bear (*Ursus americanus*) densities were also estimated to be low based on large home range sizes (adult males: 316.5 ± 62.1 km^2; adult females: 79.8 ± 13.2 km^2); however, no estimates for bear densities were provided.

In addition to relatively low predator densities, McLoughlin et al. (2019) found that there was some spatial separation between caribou and wolves. Caribou did not seem to avoid existing linear features (such as roads, trails, and transmission lines) in the area, while wolves established their territories away from linear features. Black bears were found to select for linear and anthropogenic features more strongly than did caribou or wolves. Unlike caribou, who preferred mature conifer stands, wolves selected for wetlands and patches of deciduous-mixed forest, avoiding stands of mature conifers (McLoughlin et al. 2019). Black bears used mixed-wood forests similarly to wolves, but, particularly during fall, bears selected for younger stands of jack pine,

with high occurrence of berry-producing shrubs. Other prey species, such as moose, also occurred at relatively low densities in the McLoughlin et al. (2019) study area (i.e., 45.7 moose/1000 km^2).

Mortality of adult caribou in this study was observed mostly during the snow-free season, with 76% of observed mortalities occurring between April and October and only 1 of 94 caribou was harvested by a hunter during the four years of the study. McLoughlin et al. (2019) observed that, from 2014 to 2018, the caribou population exhibited a high average adult female survival rate and moderate recruitment (0.192 calves per cow in March), ranging from a low of 0.134 calves/cow in March 2016 to 0.244 calves/cow in March 2018. These demographic parameters lead the authors to assess the SK1 caribou population as being stable over time (McLoughlin et al. 2019).

6 CONCLUSION

Sections 2 through 4 of this annex report describe the additional baseline information compiled for the terrain and soils, vegetation, and wildlife components, respectively. Table 9 summarizes key findings for each component.

Table 9. Summary of additional baseline information for the Wheeler River Project.

Baseline Component	Additional Information Identified to Complete the EA	Information Sources	Summary of Additional Information
Terrain and Soils	Desktop review of available literature and spatial inventories was conducted to situate the Project in the context of Terrain and Soil.	• Interpretation of Project-Specific Topographic Survey Information, (Denison Mines Corporation 2019) and Geology (Simpson 1997), and Soil (Soil Landscapes of Canada Working Group 2010) • Interpretation of Ecosites (McLaughlan et al. 2010), Ecoregions (Acton et al. 1998), and Ecozones (Wiken 1986; Marshall et al. 1999)	General summary of predominant landscape attributes, topography and soil based on available Ecozone, Ecoregion and Ecosite information.
Vegetation	Reclassification of the novel regenerating forest types provided within interpreted ecosite mapping product to the provincial ecosite classification.	• Interpreted Ecosite Mapping (Omnia 2020); • 1 m topographic contours (Denison Mines Corporation 2019); • Soils Information (Soil Classification Working Group 1998). • Field Guide to the Ecosites of Saskatchewan's Provincial Forests (McLaughlan et al. 2010). • Ecosite descriptions within the Baseline Report (Omnia 2020).	Revisions to the interpreted ecosite mapping product aligned regenerating forest areas with accepted provincial ecosite classifications (i.e., McLaughlan et al. 2010), while retaining detail about the structural complexity resulting from historic fire disturbance within the RSA.
Wildlife - Avian Species of Management Concern	Identification of species-specific surveys or literature for avian species of management concern.	Biodiversity Information of Saskatchewan (HABISask) database (SK MOE 2020).	There is evidence that, in addition to common nighthawk, rusty blackbird use the RSA. Mitigation measures (such as setback distances and work outside of sensitive timing windows) need to be included in the EIS.

Baseline Component	Additional Information Identified to Complete the EA	Information Sources	Summary of Additional Information
Wildlife - Ungulates	Survey data and associated information for boreal caribou and moose.	Personal communications with SK MOE staff and University of Saskatchewan researchers; review of recent publication on boreal caribou ecology in northern Saskatchewan (McLoughlin et al. 2019).	No additional aerial ungulate survey data are available for inclusion into the Annex Report. Recent population and habitat studies for boreal caribou in the SK1 Boreal Shield management unit characterize the caribou population in the region as stable, predator densities as low and the habitat currently experiencing low levels of anthropogenic disturbances.

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