Appendix B.1

Soils and Terrain Baseline Report

Crawford Nickel Project: Soils and Terrain Baseline Report

September 30, 2024

Prepared for:

Canada Nickel Company

Prepared by:

Stantec Consulting Ltd.

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Prepared by: Piraux, Olivier Digitally signed by Piraux, Olivier Date: 2024.09.23 13:49:33 -04'00'
Signature

Olivier Piraux M.Sc
Printed Name

Prepared by: Mel Zwierink Digitally signed by Mel Zwierink Date: 2024.09.23 13:29:57 -06'00'
Signature

Melvin Zwierink P.Ag.
Printed Name

Reviewed by: Tsang, Sid 2024.09.23 12:00:03 -07'00'
Signature

Sid Tsang P.Geo
Printed Name

Approved by: Digitally signed by Freymond, Roger Date: 2024.09.24 14:13:48 -04'00'
Signature

Roger Freymond B.A.Sc., P.Eng
Printed Name

Project Personnel

Report Authors:	Olivier Piraux M.Sc., Senior Terrain Scientist – Geohazard and Geomorphology (Lead Author) Melvin Zwierink P.Ag., CPESC, RPF, Reclamation and Environmental Specialist
Quality Review:	Sidney Tsang P.Geo., Principal, Geohazards and Geomorphology
Independent Review:	Roger Freymond B.A.Sc., P.Eng., Principal, Senior Hydrogeologist

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Acronyms and Abbreviations

Al	aluminium
ARD	Acid rock drainage
asl	Above sea level
BC	Base cation
BS	Base saturation
Ca	calcium
CaCO3	calcium carbonate
CanSIS	Canadian Soil Information System
CEC	Cation exchange capacity centimetre
IAA	*Impact Assessment Act*, 2019
IK	Indigenous knowledge
LSA	Local Study Area
m^3	Cubic metres
Mg	magnesium
meq	milliequivalent
NGO	Non-governmental Organization
OM	Organic Matter
PA	Project Area
RSA	Regional Study Area
RUSLEFAC	Revised Universal Soil Loss Equation for Application in Canada
SCWG	Soil Classification Working Group

SIL	Survey Intensity Level
‘the Minister’	Minister of Environment and Climate Change
TIS Guidelines	Tailored Impact Statement Guidelines
TDR	Technical data report
TKN	Total Kjeldahl nitrogen
TOC	Total organic carbon
tpd	tonnes per day
VC	Valued Component

Glossary

Coarse fragments	Any primary soil particle with a nominal diameter greater than 2 millimetres including gravels, cobbles and boulders.
Coarse textured	Textures of soils that are made up of at least 70% of sand by weight and include loamy sand to sand.
Fluvial	Well sorted sediments that have been transported and deposited by streams and rivers.
Glaciofluvial	Fluvial sediments that were deposited in contact with glacial ice.
Glaciolacustrine	Lacustrine sediments that were deposited in contact with glacial ice.
Gleyed	Characterized by gray colours and/or prominent mottling indicative of intermittent or continuous saturation with water.
Gleysol	Soil order classified under the Canadian Soils Classification System (Agriculture and Agri-Food Canada 1998) defined as having properties that indicate prolonged periods of intermittent or continuous saturation with water and reducing conditions.
Lacustrotill	Sediments transported from glacial ice through the waters of a glacier-dammed lake.
Luvisol	Soil order classified under the Canadian Soils Classification System (Agriculture and Agri-Food Canada 1998) defined as having a diagnostic textural contrast between the A and the B horizon where the A horizon has less clay than the B horizon; dominantly found under forested landscapes.
Mottles	Spots or blotches of different colour interspersed with the dominant soil colour.

Organic soil	Soil order classified under the Canadian Soils Classification System (Agriculture and Agri-Food Canada 1998) that is comprised of material of botanical origin varying in different degrees of decomposition within the pedon.
Overburden	Depositional material that is found below topsoil or organic soil and above mine rock that can sometimes be used in reclamation.
Parent materials	Sediments from which soils form that are classified based on their mode of formation.
Peat	Organic (i.e., humic, mesic, or fibric material) horizons of Organic soils.
Project Area	Encompasses the anticipated area of physical disturbance associated with the construction and operations of the Project.
Soil Admixing	Mixing of topsoil with subsurface soils or unsuitable material that results in a reduction of topsoil quality, which can be topsoil degradation structurally and/or chemically.
Soil Compaction	The action of compressing soil structure by external forces causing a reduction in soil porosity and thus, soil quality.
Soil Contamination	The condition of soil that is caused by the release of a substance that can cause detrimental effects to the environment and human health.
Soil Erosion	The detachment, movement and later deposition of soil particles caused by water or wind. Accelerated erosion can be caused by human activity and can have adverse effects.
Soil profile	Vertical section of soil from the ground surface to where the soil meets the underlying bedrock or unaltered surficial material.
Soil Porosity	The volume percentage of voids in a soil mass not occupied by soil particles.

Soil Quality	The measure of the capacity of a soil to function within a natural or managed ecosystem to sustain plant or animal productivity, maintain or enhance water and air quality and support human health and habitation.
Soil Reclamation Suitability	The physical chemical and biological properties and characteristics that soil affect its use as a plant growth medium.
Soil texture	Defined by classes that are based on the size and distribution of primary particles (clay, silt, sand).
Stripping Depth	Estimated excavation depth of topsoil and/or organic soil from foundational areas of Project disturbances.
Subsoil	Weathered material underlaying the surface soil.
Surficial Material	Surficial materials are non-lithified, unconsolidated sediments. They are produced by weathering, sediment deposition, biological accumulation, human and volcanic activity.
Topsoil	Leaf litter or organic layer and A and/or AB horizon of mineral soils.
Till	Sediments consisting of well compacted heterogeneous material that has been transported on or in the vicinity of a glacier.

1 Introduction

Canada Nickel Company (Canada Nickel) proposes to develop, operate, and progressively reclaim the Crawford Nickel Project ('the Project'), a new open pit nickel mine and processing facility located approximately 42 kilometres (km) north of Timmins, Ontario along Highway 655. The Project is being assessed in accordance with the *Impact Assessment Act*, 2019 (Impact Assessment Agency of Canada [IAAC] 2019).

Stantec Consulting Ltd. (Stantec) was retained by Canada Nickel to conduct a baseline assessment of soils and terrain for the Project. This soil and terrain baseline report was completed to inform the Impact Statement. It has been prepared pursuant to the *Impact Assessment Act,* 2019 and in consideration of the Tailored Impact Statement (TIS) Guidelines developed for the Crawford Nickel Project (IAAC 2023).

The information presented in this report is intended to summarize and document the existing conditions of soils and terrain to support the preparation of the Impact Statement.

1.1 Project Location and Setting

The Crawford Nickel Project site is located approximately 42 km north of the City of Timmins, Ontario, in the geographic townships of Crawford, Carnegie, Kidd, Lucas, Beck, Nesbitt, Wark, and Prosser. A small portion of the Project extent within the geographic townships of Kidd and Wark also lies within the municipal boundary of the City of Timmins.

1.2 Project Overview

Canada Nickel proposes to develop, construct, operate, and progressively reclaim a new open pit nickel mine and processing facility, collectively known as the Crawford Nickel Project. The Project includes the development of an Open Pit, Stockpiles, two ore Processing Plants, and other mine related infrastructure, as well as a new rail spur line and the relocation of Highway 655 and an existing 500 kilovolt (kV) transmission line. Ore will be extracted from a single Open Pit that will be divided into an East Zone and Main Zone. The Project has a mineral reserve estimate of 1,715 million tonnes (Mt) and an expected Project life of 41 years.

Based on the current Project design, the maximum rate of ore extraction will be up to 240,000 tonnes per day (tpd) during year 5 of operations and an average rate of 160,000 tpd over the life of mine. The two ore Processing Plants and associated service facilities will process run of mine ore delivered to Primary Crushers to produce nickel concentrate, iron concentrate, and tailings at a rate of approximately 60,000 tpd at the start of mine life, ramping up to a maximum of 120,000 tpd. In addition to nickel and iron, other metals such as cobalt, chromium, palladium and platinum are expected to be recovered from concentrate streams.

Concentrate from the processing plants will be loaded onto rail cars and shipped via the rail spur line for refinement offsite.

1.3 Study Objectives

This baseline report summarizes soils and terrain baseline conditions to inform the Impact Statement for the Project. The scope of the soils and terrain assessment was developed in accordance with the TIS Guidelines, more specifically, with regards to specific guidance associated to the Geology and Geological Hazards (Chapter 10 of the Impact Statement), and Soil (Chapter 11 of the Impact Statement) Valued Components (VCs) of the Impact Statement (see Section 8.2 and 8.4 of the TIS Guidelines, respectively).

Key topics included in the assessment of soils and terrain conditions include the following:

- Physiography and bedrock geology (Section 4.1.1)
- Glacial and post-glacial history (Section 4.1.2)
- Topography (Section 4.1.3)
- Surficial materials (Section 4.1.4)
- Soils (Section 4.1.5)
- Geohazards (Section 4.1.6)

2 Study Area

The Crawford Nickel Project is located in Northeastern Ontario, about 42 km north of Timmins along the 655 Highway. It occupies the subwatersheds of both the Mattagami River (Jocko Creek) to the southwest and Abitibi River (North Driftwood River and West Buskegau River) to the north and east.

The boundaries for geology and geological hazards and soils study area boundaries were selected based on past project experience, guidance from regulators, input from potentially affected Indigenous nations, public interest, and professional judgment.

These boundaries represent the areas where data was compiled to characterize baseline conditions in support of the Project-specific effects assessment and the cumulative effects assessment.

2.1 Project Area

The **Project Area (PA)** encompasses the Project footprint and is the anticipated area of physical disturbance associated with the construction, operations, decommissioning and closure of the Project.

The PA is shown on Figure A.1 (Appendix A of this report).

2.2 Local Study Area

The **Local Study Area (LSA)** encompasses the area in which Project-related effects (direct or indirect) were predicted or measured with a level of confidence appropriate for the assessment and in which there is a reasonable expectation that the potential effects in the LSA are of public interest.

The LSA covers an area of 16,453 ha and consists of the PA plus an additional 500 metres (m) buffer area. This footprint as it was considered large enough to provide a confident assessment of the effects on geology and geologic hazards and soils from the Project and potential cumulative effects from the Project and previous, existing and reasonably foreseeable developments.

The LSA is shown on Figure A.1 (Appendix A of this report).

2.3 Regional Study Area

Given the localized nature of potential Project-related effects to geology and geological hazards and to soil (i.e., potential effects are expected to be limited to either the PA and/or the LSA), the **Regional Study Area (RSA)** for the geology and soils assessments are equal to the LSA.

3 Methods

The approach developed to gather information and present baseline conditions within the PA and LSA/RSA consisted of the following key tasks (in order of execution):

1. Compilation and review background data
2. Preliminary mapping and classification
3. Field survey program
4. Final soils and terrain mapping

The methodology associated to each of these tasks is presented in the following sections.

3.1 Compilation and Review of Background Data

While developing a baseline characterization of soils and terrain conditions within the PA/LSA/RSA, a detailed background review was completed of open-access database and existing mapping data, academic literature, and site-specific information.

Among the first documents reviewed as part of the current assessment were Canada Nickel's site-specific reports and datasets produced in support of the Project. This included factual data reports related to geotechnical field investigation programs conducted by Golder (WSP 2022) and SRK Consulting (Appendix B.12.1; Appendix B.12.2 of the Impact Statement).

Additional data sources reviewed as part of the assessment included (but are not limited to):

- Google Earth and ArcGIS satellite imagery
- Topographic base data and other digital datasets available from the Government of Ontario Data Catalogue
- Light Detection and Ranging (LiDAR) from Canada Nickel
- Surficial geology mapping by the Ontario Geological Survey (OGS) (Paulen and McClenaghan, 1998)
- Bedrock geology mapping by the OGS (2011)
- Soils of Timmins-Noranda-Rouyn (Agriculture and Agri-Food Canada, 2024)
- Ontario Water Well Records (MECP 2023)
- Publicly available reports and scientific literature (see in-text references).

A complete list of data sources and references used as part of the assessment is presented in Section 6.

3.2 Preliminary Terrain Mapping and Classification

Preliminary terrain mapping was completed for the LSA/RSA, which includes the PA. The mapping was conducted in the ArcGIS Pro platform, using open-source ortho-imagery and LiDAR data. LiDAR data covering the entire LSA/RSA was provided by Canada Nickel in LAS format. This 3D point cloud data was processed to create bare-earth hillshade images, contour lines, and a slope raster.

Because Ontario does not currently have specific provincial standards for terrain mapping, widely accepted standards and guidelines developed by and for the province of British Columbia were applied. These consist of:

- Guidelines and Standards to Terrain Mapping in British Columbia (Resource Inventory Committee 1996)
- Terrain Classification System for British Columbia, Second Edition Ministry of Environment Manual 10 (Howes and Kenk 1997).

As part of the mapping, relatively homogeneous terrain units (or polygons) were delineated based on surficial materials (e.g., till, glaciolacustrine), surface expression (e.g., hummocky, fan), or stratigraphic composition (i.e., identifying the expected subsurface material) and geomorphological processes (e.g., gullying). Because of the detailed nature of the mapping, some terrain map units (polygons) were classified using a composite label accounting for two main material types (e.g., fluvial and organics). For those terrain polygons, the two material types are separated by a delimiter. These symbols (“/“ = 60/40, “//” = 80/20) indicate the relative percentage of each surficial material type.

In general, the delineation of individual polygons was conducted at scales ranging from 1:2,500 to 1:7,500, with final data presentation at a scale of 1:10,000 (see terrain figures presented in Appendix A of this report**,** Figure A.3). The map legend presented on the terrain figures describes the labels and map symbols used as part of the mapping. As a rule, surficial materials occupying less than 20% of the total area of a polygon were not indicated in the terrain unit label. Attempts were made to adhere to a minimum polygon size of 4 ha; however, in some areas, smaller polygon sizes were delineated when it was important from a terrain or ecosystem perspective (e.g., small wetlands, water bodies or geomorphic processes occurring on, or immediately adjacent to a Project infrastructure).

Upon completion, a senior geomorphologist reviewed the mapping to ensure that both the linework and terrain classification adhered to the standards listed above.

3.3 Geohazard Assessment

Geological hazards (hereafter geohazards) are geological conditions that may lead to localized or widespread damage to property and threaten personal safety. The geohazards evaluated as part of the baseline program focused primarily on identifying areas subject to, or susceptible to occurrence of landslides and other hydrotechnical hazards (e.g., bank erosion and instability, channel evulsion, gully erosion).

The use of bare-earth LIDAR images to support the terrain mapping provided the advantage of displaying the ground surface without the vegetation cover; therefore, allowing for visualization of topographic features otherwise generally hidden by the canopy layer. Due to the very planar character of the landscape throughout most of the LSA/RSA, documenting landslides and hydrotechnical hazards consisted primarily in reviewing terrain conditions along waterbody and watercourse areas.

Three main types of geohazard features were looked for while conducting the terrain mapping, and wherever present, were identified from distinctive geomorphic characteristics:

- **Landslides** - areas affected by slope failure and associated with displaced deposits of surficial material; often marked by a prominent head scarp at the upslope boundary of the affected area.
- **Watercourses** - areas where streams, creeks, or rivers, either permanent or flowing intermittently, with defined bed and banks were visible on the landscape.
- **Gullies** - steep V-shaped landform created by running water, eroding sharply into soil, typically on a hillside.

The assessment for potential dynamic and rapid release of stored water due to failure of a dam, dike, levee, or other water retaining or diversion structure was not conducted as part of the baseline program as there are currently no such structures within the LSA/RSA. Similarly, the characterization of instabilities caused by historical mining activities (e.g., landslides along existing pits or ground subsidence in previously mined areas) were not conducted as no previous mining occurred within the LSA/RSA (except from gravel extraction).

3.4 Field Survey Program

3.4.1 Planning and Execution

The soils and terrain field planning activities were initiated following completion of the preliminary terrain mapping. This allowed for the field crew to have a good overall understanding of terrain conditions within the limits of the LSA/RSA.

From a terrain and geohazard perspective, the main goals of the field survey program were to ground truth the preliminary desktop findings and to collect detailed field data required to complete the terrain mapping and data reporting phases of the baseline data acquisition program. This included conducting field observations in all key terrain unit types, including visiting areas where geohazards were most likely to be present (e.g., along the Jocko Creek River valley). For soils, the main goals of the program were to complete field plots at the locations of planned Project infrastructure (e.g., Open Pit and Stockpile areas), and that key ecosystems, materials and/or landscape types were adequately sampled.

The field survey program was conducted from October 11 to 20, 2023. A total of 106 soil pits were dug and described in the 16,453 ha LSA/RSA. Additionally, 107 boreholes, test pits and monitoring wells were also described within the LSA/RSA and these were used in delineating and describing the mapped Soil Map Unit's (SMU's). The 213-soil data points (1 soil point per 78 ha) meet Coen's (1987) guidelines of a reconnaissance level survey (Soil Intensity Level (SIL) 3).

Mineral soils were dug and/or hand augered and described to 80- to 110-centimetres (cm) depth at each inspection site and organic soils were hand augered and described to the bottom of the organic layer or 2.2 metres (m) for the 106-soil pits. Borehole, test pit and monitoring wells were sampled from 4 to 48 m depth; however, generally only information from the top 3 to 4 m was used to describe terrain and soils.

Landform information collected at each soil inspection site included:

- Slope class and gradient
- Surficial material
- Surface expression
- Depth to bedrock (where possible)
- Soil drainage
- Depth to seepage, where observed
- Depth to water table, where observed
- Current land use.

Soil profiles at each soil inspection site were described according to soil attributes in the Manual for Describing Soils in the Field (Agriculture Canada Expert Committee on Soil Survey 1983) and were classified to the subgroup level according to the Canadian System of Soil Classification (Agriculture and Agri-Food Canada 1998).

Soil profile information collected for each soil horizon included:

- Depth
- Texture
- Structure
- Consistence
- Colour
- Coarse fragment content
- Level of organic decomposition for organic horizons
- Mottling and gleying, where observed
- Carbonates or salts, where observed.

Soil samples were collected to confirm field soil inspections supporting subgroup classification and soil series correlation, as well as baseline physical (e.g., texture) and chemical (e.g., pH, exchangeable bases, cation exchange capacity and calcium carbonate equivalent) information for topsoil and subsoil reclamation suitability classification.

Modal soil profile descriptions are presented in Appendix B of this report. Selected site photographs are presented in Appendix C of this report.

3.4.2 Laboratory Analysis

Soil samples were collected from representative soil profiles and submitted for laboratory analysis. Laboratory analyses were performed by Testmark Laboratories Ltd, an accredited third-party laboratory. Laboratory analyses were conducted to determine whether there were chemical limitations of the soil reclamation suitability, provide confirmation of soil subgroup and field texture classification. Parameters analyzed included particle size (percent (%) sand, silt and clay), pH ($CaCl_2$ solution), cation exchange capacity (CEC), exchangeable base cations (calcium, magnesium, potassium, and sodium) and Calcium Carbonate Equivalent. Additionally, Total Kjeldahl Nitrogen (TKN), and total organic carbon (TOC) analysis was conducted in the topsoil (A horizon, i.e., the top layer of the mineral soil horizon). The certificate of analysis is provided in Appendix D of this report.

3.5 Final Soils and Terrain Mapping

The purpose of the final mapping was to modify any of the preliminary line work and classification by incorporating the site-specific data collected as part of the field program. The terrain mapping (including both linework and classification) was reviewed by a senior geomorphologist during both the preliminary and final mapping stages. Discrepancies in linework and classification, including comparisons with the existing terrain and surficial geology mapping datasets from the OGS, were discussed and revised as necessary.

While preliminary terrain mapping occurred following Project initiation, the soil mapping occurred as field data was available and as the terrain mapping was completed. This approach allowed for increased efficiency as terrain mapping and field data are key inputs to the soil mapping.

The soil mapping was completed within the same mapping platform as for the terrain mapping and consisted in delineating and classifying the distribution of soils within the LSA. Soils were mapped as per the federal and provincial standards (Agriculture Canada 1981; Coen 1987), at a general scale of 1:5,000. Soil types and landscape features are represented by soil map units (SMUs). SMUs are individual polygons encompassing areas of similar dominant surficial material, dominant slope gradients, drainage and soil and topographic assemblages found within the delineation. SMU polygons have discrete boundaries in the mapping but are representations of soil patterns on the landscape that are often complex and have gradational boundaries.

The SMU polygons in the LSA/RSA were delineated as follows:

- SMUs were created by attributing terrain mapping polygons based on inferred relationships between soil types and surficial material, vegetation types, slope gradients, slope morphology, drainage patterns and soil landscape types.
- SMU names were derived from the Soils of Timmins-Noranda-Rouyn (Agriculture and Agri-Food Canada 2024) map legend.

- Soil data collected from field surveys was used to assign dominant and co-dominant soil types, soil texture, coarse fragment content and drainage for each SMU polygon. Polygons without inspection points had data extrapolated from adjacent polygons containing inspection points.

3.5.1 Water Erosion Risk

Water erosion ratings for the topsoil and subsoil for each described SMU soil association were rated based on soil and site characteristics from the field data and slope raster. Water erosion risk for topsoil and subsoil was rated according to the Revised Universal Soil Loss Equation for Application in Canada (RUSLEFAC) by Wall et al. (2002). The rating system includes the ratings of very low, low, moderate, high to severe based on the factors described in the RUSELFAC. The RUSLEFAC predicts average soil loss by water erosion, taking into account rainfall, soil and landscape characteristics, and management practices. The rainfall factors for the Project region were taken from the RUSLEFAC manual (Wall et al. 2002). Soil and landscape characteristics such as soil texture, slope gradient and slope length were taken from the field data.

A = R x K x L x S x C x P

Where:

A = the potential long-term average soil loss (tonnes ha-1 year-1)

R = rainfall factor (MJ mm ha-1 h-1) (assumed to be the same for the entire Project)

K = soil erodibility factor (t h MJ-1 mm-1) (based primarily on soil texture)

L = slope length factor (dimensionless) (estimated slope length based on landform)

S = slope steepness factor (dimensionless) (maximum slope gradient for each slope classes)

C = cropping management factor (dimensionless) (assumed to be bare, recently replaced soil with no management)

P = support practice factor (dimensionless) (assumed to be bare, recently replaced soil with no management)

Water erosion risk classes are determined using Ontario Ministry of Agriculture Food and Rural Affairs (2023) shown in Table 1.

Table 1 Soil Loss Tolerance Rates

Soil Erosion Class	Potential Soil Loss
Very Low	< 6.7 tonnes/ha/yr
Low	6.7 - 11. 2 tonnes/ha/yr
Moderate	11.2 - 22.4 tonnes/ha/yr
High	22.4 - 33.6 tonnes/ha/yr
Severe	> 33.6 tonnes/ha/yr

3.5.2 Soil Compaction Risk

Soil compaction risk was rated using the Hazard Assessment Keys for Evaluating Site Sensitivity to Soil Degrading Processes Guidebook (BC MOF 1999) based on inferred soil moisture content from drainage rating, soil texture and coarse fragment content. The soil compaction risk rating system is summarized in Table 2.

Table 2 Generalized Risk Rating System for Compaction

Drainage Regime	Soil Textural Class					
	Very Coarse (S, LS, LFS)	Moderately Coarse (SL, FSL)	Medium (VFSL, L, SiL)	Moderately Fine (SCL, CL, SiCL, Si)	Fine/ Very Fine (SC, SiC, C, HC)	Organic
Rapid	Low Risk	Low Risk	-	-	-	N/A
Well	Low Risk	Low Risk	Low Risk	Moderate Risk	Moderate Risk	
Imperfect	Low Risk	Low Risk	Moderate Risk	High Risk	High Risk	
Poor	Moderate Risk	Moderate Risk	High Risk	High Risk	High Risk	
Very Poor	N/A					High Risk

Notes:

N/A = Not applicable	FSL = fine sandy loam	SiC = silty clay
LS = loamy sand	VFSL = very fine sandy loam	SiCL = silty clay loam
S = sand	SCL = sandy clay loam	Si = silt
LFS = loamy fine sand	SC = sandy clay	C = clay
SL = sandy loamy	L = loam	CL = clay loam
	SiL = silt loam	HC = heavy clay

3.5.3 Soil Reclamation Suitability

The soil physical and chemical properties from field and laboratory analytical data were used to calculate soil reclamation suitability, which classification is based on criteria for evaluating the suitability of surface material (upper lift) and subsurface lift (Lower lift) for revegetation in the Northern Forest Region (AAFRD 1987; see table 8 and 9).

Surface and subsurface lift reclamation suitability was determined for each SMU and was determined for modal soils based on field information (e.g., texture) and laboratory analysis (e.g., pH, and $CaCO_3$ equivalent). These results will be used to inform closure planning.

4 Results

4.1 Baseline Site Conditions

The following sections summarize the findings of the baseline program for soils and terrain.

4.1.1 Physiography and Geology

The Project is located within the Lake Abitibi Ecoregion of Ontario (Ecoregion 3E), a part of the Ontario Shield. This ecoregion is described as the Humid Mid-Boreal Ecoclimatic Region, characterized by long, cold, and snowy winters, with short and mild summers (Ecoregions Working Group 1989). This region sits on top of the Precambrian Shield, that is overlain by diverse surficial geology which is composed of both glacial and post-glacial processes. The PA and LSA/RSA are covered by a mix of wetland, mixed deciduous and boreal forest complexes with many streams and rivers and few small lakes. Vegetation communities that occur directly within and adjacent to the proposed PA are generally early successional mixed deciduous communities that have been shaped by timber harvest and infrastructure development; however, a few fragmented mature coniferous forest areas remain intact. As with most of northern Ontario, the site is crossed by several minor waterbodies and tributaries to larger rivers.

The Project site is located primarily between the North Driftwood River and the West Buskegau River both of which drain north into the Abitibi River. Jocko Creek crosses the southern portion of the PA and drains into Kidd Creek and subsequently the Mattagami River.

The bedrock in the PA and LSA/RSA consist in a succession of supracrustal rocks with discrete intrusive contact rocks, all formed in the Neo to Mesoarchean (3.2 to 2.5 Ga). The main geological units from south to north are metasedimentary rocks (wacke, siltstone, argillite), followed by mafic to intermediate metavolcanic flows (basalt, andesite, tuff and breccias), and by felsic to intermediate metavolcanic formations (dacitic and andesitic flows, tuffs and breccias). These are interrupted by areas of intrusive contact rocks, mafic to ultramafic rock as well as granitoid intrusions (Diorite-monzondiorite-granodiorite suites, foliated tonalites and massive granodiorites to granites). Iron formations abound in a northwest-southeast orientation, especially in the metavolcanic formations (OGS, 2011). The region is well covered by a deep succession of till and glaciolacustrine deposits, but cresting hills of plutonic rock that are only covered by veneers of till should have bedrock close to the surface. These are not found directly in the LSA except at the southern end of the Project boundary, east of Highway 655.

A map presenting the regional bedrock geology (including orientation of major faults) is presented in Figure A.2 (Appendix A of this report). Three sub-parallel fault lines cross the Project footprint, converging from the northwest-toward a southeast location east of the LSA/RSA. They cross every major structure of the Project, including the Process Plant area, the Tailings Management Facility, the Open Pit and Stockpiles. Similarly oriented faults cross the region further to the northeastern and southern end of the LSA/RSA. The major regional faults are the Mattagami River Fault converging north to south, and Buskegau River Fault converging from southeast to northwest. Another set of discontinuous faults oriented perpendicularly to the first two sets described surrounds the LSA/RSA on the northern and

southern end. The Ontario Geological Survey does not list faults as inactive or active, and their activity level remains unknown, and no earthquake of magnitude > 3 has occurred within the LSA/RSA in the past 40 years. The area is still in a phase of active isostatic rebound due to the last glaciation, with a rise of 6.4 ± 2.6 mm per year registered at Timmins, Ontario (Peltier et al. 2015).

Major Geological units underlying planned Project infrastructure are presented in Table 3.

The mineralization in the LSA/RSA is described as Komatiite-hosted Ni-Cu-Co-(PGE) deposit type (Caracle Creek, 2022). Komatiitic rocks are ultramafic rock with a high magnesium content. A regional study by Kretschmar and Kretschmar (1986) in the Timmins-Kirkland area found that asbestos deposits are derived from magmas of komatiitic composition, and that serpentinization and chrysotile-asbestos occurrences are mainly associated with dunitic to peridotite formations in the region. Borehole data indicates the presence of chrysotile in the bedrock and is mainly associated with ultramafic bodies. Visually inspection of core samples indicated that approximately 70% of all chrysotile mineralization occurs in dunite, ~20% in peridotite, <5% in pyroxenite and <2% in gabbro, talcose ultramafics and lamprophyre. Intervals containing chrysotile are on average 23 m long but can reach up to 294 m (range is 0.1 m to 294 m). When quantified in % presence over the total length of core samples, chrysotile in the Crawford Deposit was found to be <2% (Appendix B.13 of the Impact Statement [Asbestiform Mineral Quantification Procedure]).

Table 3 Bedrock Geology within the LSA/RSA

Geologic Unit	Epoch	Major Lithologies	Planned Project infrastructure
Felsic to intermediate Metavolcanic rocks	Neo-to Mesoarchean (2.5-3.2 Ga)	Dacitic and andesitic flows, tuffs and breccias	Open Pit, West Stockpile, East Stockpile, Impoundment Facility, Reclaim Stockpile, TMF, Collection Ponds 1-3, Process Plant Area
Mafic to intermediate metavolcanic rocks	Neo-to Mesoarchean (2.5-3.2 Ga)	Basaltic and andesitic flows, tuffs and breccias, chert, iron formation, minor metasedimentary and intrusive rocks, related migmatites	Reclaim Stockpile, West Stockpile, Reclaim Rock Dump, Open Pit, TMF, TMF NE Collection Pond
Mafic and ultramafic rocks	Neo-to Mesoarchean (2.5-3.2 Ga)	Ultramafic rocks	Open Pit, Collection Pond 2, West Stockpile, Reclaim Rock Dump, Impoundment Facility, Reclaim Stockpile, TMF NE Collection Pond, TMF
Metasedimentary rocks	Neo-to Mesoarchean (2.5-3.2 Ga)	Marble, chert, iron formation, minor metavolcanic rocks	Impoundment Facility, Reclaim Stockpile, Collection Pond 1, Open Pit, Collection Pond 3, TMF NE Collection Pond, East Stockpile, TMF, West Stockpile, TMF NW Collection Pond
Source: OGS 2011			

4.1.2 Glacial and Post-Glacial History

The topography, soils and sediment conditions in the LSA/RSA are essentially a result of glacial and post-glacial history, and an overview of deglaciation conditions and depositional settings is essential to understanding these conditions. The following section describe the glacial history and the character and distribution of surficial materials within the LSA/RSA, and then describes the soils as they evolved on top of these features/deposits.

Glacial flows were mainly oriented toward the south in the region, with ice flow shifting from southwestern to southeastern as the Laurentide Ice Sheet thinned out. This first set of glacial retreat deposited the Matheson Till (Paulen and McClenaghan, 1997). The area was initially deglaciated around 10,000 years before present (BP) (Dyke and Prest, 1987), and ice margins were occupied by glacial lake Ojibway. This period concords with the formation of eskers and fluvio-glacial sediment complexes, along with the Barlow-Ojibway glaciolacustrine deposits (Barlow-Ojibway Formation). General advance of the ice sheet around 8,400 BP overrode the lacustrine clay and silts, depositing Cochrane Till and ice-margin glaciolacustrine deposits (North Driftwood Formation) over the area just north of Timmins (Marich, 2021). There are uncertainties on how long lake Ojibway-Barlow remained (renamed following the merger of lakes Ojibway and Barlow) until the retreat and catastrophic drainage, but evidence suggests the event to have occurred around 8,200 BP (Evans, 2012, Roy et al., 2011). For reference, a map presenting existing regional surficial geology mapping compilation by the OGS (1997) is included in Figure A.3 (Appendix A of this report).

4.1.3 Topography

Topographically, the site ranges from 258.4 to 306.2 m asl, with an average local relief of 15 m. Site slopes average 2% (1.2°), with little evidence of underlying bedrock expression due to deep surficial materials. The ground surface is generally flat, with local topographic lows typically associated with surface water features (wetlands, lakes and streams), and topographic highs associated with an esker.

The glacial retreat left behind a low-lying landscape, where the overall average slope is generally lower than 2 % (1.2 degrees). It is assumed that topographic lows in the underlying bedrock surface were infilled with glacial and post glacial sediments. As such, there is little evidence of surface expressions indicative of the underlying bedrock structure. This excludes a few instances of bedrock-controlled relief found predominantly to the south and north of the LSA/RSA (Figure 2 below).

A few hills of low relief (i.e., less than 5 m above surrounding terrain) oriented in the direction of glacial flows were identified as part of the terrain mapping, but otherwise the most notable glacial landform present within LSA/RSA consist of an esker complex. The feature crosses the west-central portion of the LSA/RSA from north to south (west from the current highway position) and includes ice-contact landforms such as a series of small kettle lakes. A topographic cross section across that esker (Figure 2 below) shows that it reaches a maximum of approximately 15 m above the surrounding terrain. Aside from the esker complex, the high stream banks along Jocko Creek are the next most notable expressions of surface topography in the LSA/RSA. The floodplain is cut into the glaciolacustrine plain, in some areas up

to 8 m below the surrounding terrain (Figure 1 below). Some active erosion and gullying are taking place along Jocko Creek (see Section 4.1.6.2 Hydrotechnical Hazards).

In addition, deepening marks from iceberg keels marks (or plough marks, i.e., when icebergs enter in contact with the bottom of the former glacial lake) created furrows throughout the area, and these are often integrated into the drainage system as linear drainage features over a few hundred metres to a few kilometres. The keel marks will favour slow-moving waters and deposition of organics in these localised depressions.

Figure 1 Bare-earth LiDAR hillshade view and cross section of the esker crossing the LSA

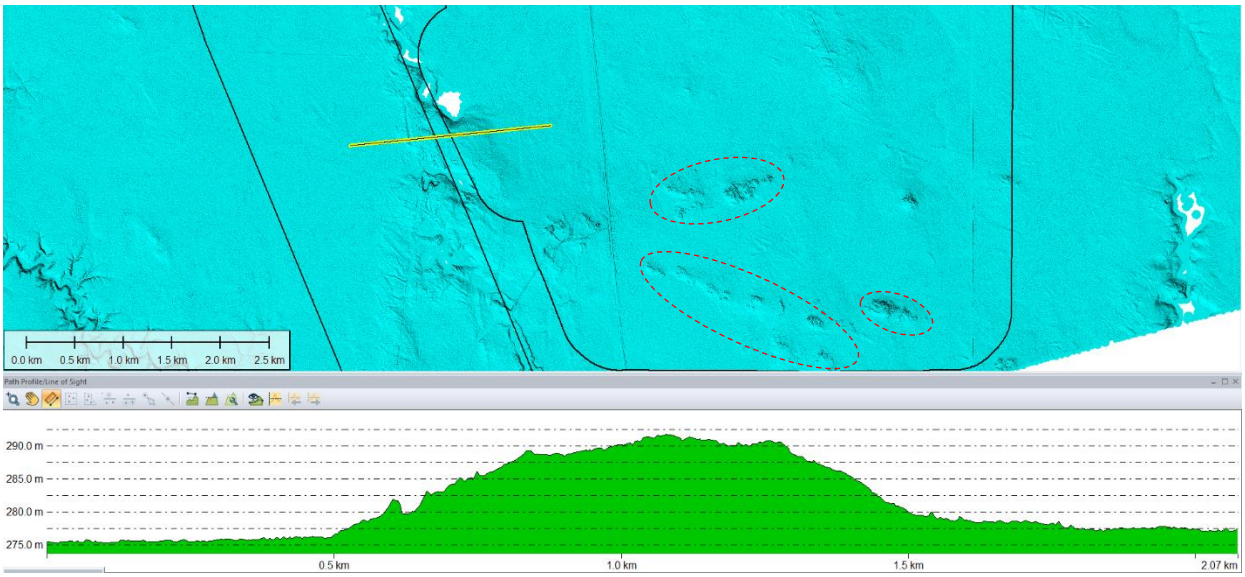
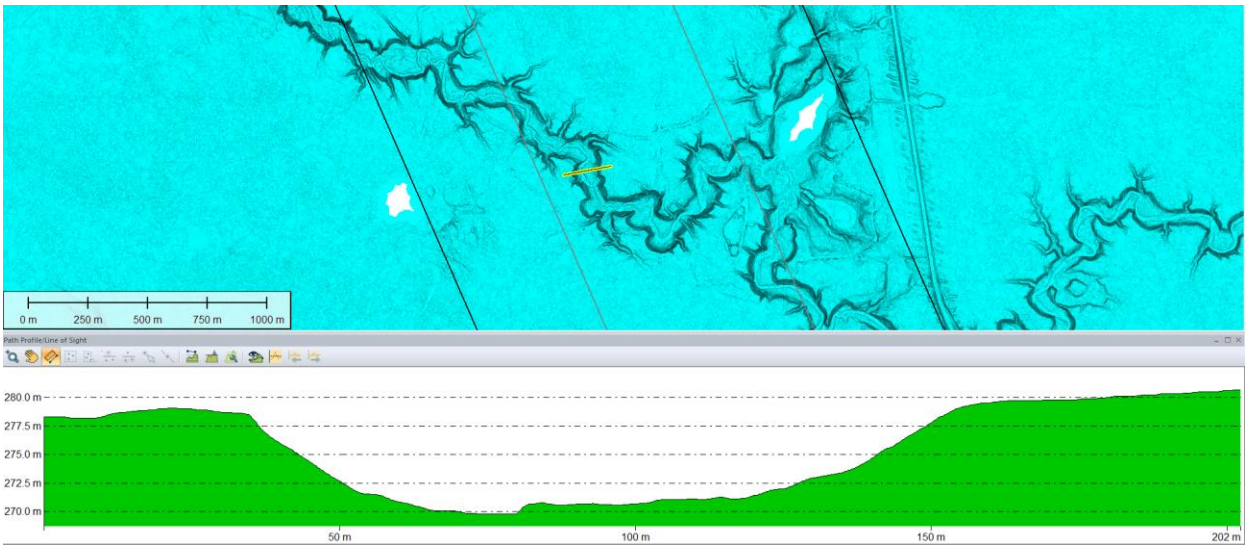


Figure 2 Bare-earth LiDAR hillshade view and cross section of Jocko Creek.



On the figures above, the LSA/RSA footprint is displayed in black, the cross sections in yellow, and areas of shallow or exposed bedrock (Figure 1 only) are highlighted in red.

4.1.4 Surficial Materials

4.1.4.1 Surficial Materials Descriptions

Materials listed below represent the most comment Quaternary materials found in the LSA/RSA. They are presented from most ancient to most recent. Since the deglaciation included a re-advance of the ice-sheet, this sequence can repeat itself where stratigraphic sequences are complete.

Till deposited directly by glacial ice occurs throughout the region. Material from the original glacial retreat will typically be buried under thick glaciolacustrine deposits, till from the readvance, and glaciofluvial deposits.

The origin of the till overlying the bedrock at the bottom of the stratigraphic sequence is commonly referred as the Matheson Till, a sandy till with up to 15% clasts by volume. There is no evidence of this material at the surface in the LSA/RSA, as thick clay deposit from the Barlow-Ojibway formations has buried these deposits following the initial retreat of the ice sheet.

The Cochrane Till formation was deposited during the re-advance of the ice sheet, and can be found near or at the surface in topographic highs. The material composing this till is mainly silt (~50%), with sand, clay and clasts in decreasing abundance (Marich 2021). Three facies of these deposits are found, and the most common is a deformation till from the incorporation and reworking of the glaciolacustrine deposits. It is massive, with blocky and jointed features and is difficult to distinguish from the glaciolacustrine deposits identified in the borehole logs. The second facies is a massive, compact lodgement till facies, which is quite fissile once exposed. The third facies is a pebbly facies with local incorporation of glaciofluvial or other coarse substrate deposits.

Observations made as part of the field survey program have shown that the till is often calcareous; therefore, insinuating that glacial erosion of carbonate bedrock did occur upstream from glacial deposition.

Glaciofluvial materials are deposited by glacial meltwater streams often in close proximity to glacial ice, are typically well- to moderately-well drained, and rapidly permeable. These materials are composed of gravel and sand in varying amounts, with occasional coarse silt. The main glaciofluvial deposit within the LSA/RSA consist of a north-south trending esker and fan complex located west of the planned Tailings Management Facility. Field investigations conducted along the esker (Golder, part of WSP, 2022) showed that sand and/or gravel are present at or near the surface along the axis of the esker. Boreholes drilled within the esker showed that the granular material extended to a depth of 42 m below ground surface (bgs), and that the deposit was found to directly overly bedrock. This suggests that the glacial meltwater eroded away any previously deposited materials prior to depositing the esker.

Glaciolacustrine materials are sediments deposited in and along the margins of glacial lakes and can include materials released by the melting of floating ice. Within the LSA/RSA, glaciolacustrine material composition varies depending on the depositional environments, but are dominantly composed of silt and clay, with more sand and less clay in shallower depositional settings or higher in the stratigraphic sequence. These deposits are at times varved, and occasional dropstones from floating ice can be found.

Within the LSA/RSA, glaciolacustrine deposits occur primarily as plains and blankets and are the most widespread surface deposits. They are often 10-20 m thick, can reach upwards of 40 m and are at times intersected with glaciofluvial or Cochrane Till deposits. They are also present on top of hummocky terrain covering glaciofluvial or ice-contact features.

Littoral / Aeolian materials are rarely found topping the glaciolacustrine deposits, but can occur locally. They are inherited from shoreline environments before vegetation colonization. They are composed of silty sand and gravel, but less than 2 m thick and only at discrete locations over a few hundred metres in extent. Since they are the expression of wave/wind action on glaciolacustrine sediments they are mapped as glaciolacustrine deposits.

Alluvial (fluvial) materials are those that have been transported by streams and rivers and typically occupy valley floors. Alluvial materials are mostly imperfectly drained and moderately to rapidly permeable. Textures will likely range from clayey silty sand to very gravelly sand. Alluvial soils often experience periodic flooding and sediment deposition; therefore, have either weak or no (pedogenic) soil development. These deposits typically occur as terraces in the stream channels, or as plains (floodplains) and abandoned meanders. The fine-grained nature of surface deposits limits in-channel deposition, and meander/side bars are uncommon in the river system. Subsequent re-working of these colluvial deposits by stream action does occur.

Organic deposits resulting from the accumulation of vegetative matter are a common surface material, found typically in poorly to very poorly drained areas and forming peatlands. These are usually under 2.5 m thick, but some level of organic accumulation on top of mineral deposit is widespread through the LSA/RSA.

Anthropogenic disturbances to soils and terrain occur within the LSA/RSA.

They include, but are not limited to:

- Transportation infrastructure such as existing highway and roads, winter road, trails, bridges
- Railroads
- Transmission lines
- Cut lines
- Seasonally-used trails
- Existing mining areas, including borrow sources and quarries.

4.1.4.2 Surficial Materials Distribution

The following section summarizes the spatial distribution of the surficial materials by dominance in the PA and LSA/RSA (Table 4 and Table 5, respectively).

Glaciolacustrine deposits are the dominant mineral material origin in the LSA/RSA, followed by till, and glaciofluvial material. Organic deposits (fens, bogs) are very widespread throughout the landscape, and are inherited from the imperfect to very poor drainage associated to the extensive presence of glaciolacustrine clay. Bedrock exposures are mapped as very minor components of the landscape, and wherever presented, are often overlaid by a discontinuous veneer of till.

Refer to the Terrain Mapbook located in Figure A.4.0 to Figure A.4.12 (Appendix A of this report) for maps presenting the distribution of surficial materials within the LSA/RSA.

Table 4 Dominant Surficial Materials Within the PA

Dominant Surficial Material	Area within the PA	
	Area (ha)	Percent (%)
Anthropogenic	193	1.6
Bedrock	1	< 0.1
Fluvial	29	0.2
Glaciofluvial	160	1.4
Glaciolacustrine	5,428	46.1
Organic	4,346	36.9
Till	1,580	13.4
Waterbody	48	0.4
Total	**11,785**	**100**

Table 5 Dominant Surficial Materials Within the LSA/RSA

Dominant Surficial Material	Area within the LSA/RSA	
	Area (ha)	Percent (%)
Anthropogenic	319	1.9
Bedrock	1	< 0.1
Colluvial	3	< 0.1
Fluvial	80	0.5
Glaciofluvial	520	3.1
Glaciolacustrine	7,510	44.4
Organic	5,844	34.6
Till	2,459	14.6
Waterbody	160	0.9
Total	**16,896**	**100**

4.1.5 Soils

4.1.5.1 Soils Descriptions

The primary influences on soil development in the Project area are climate, parent material, and drainage. Generally, cold climate and poor drainage favours the accumulation of organic material over existing surface material, and a continuous high-water table. Soils in the Project area was classified according to the Canadian System of Soil Classification (Agriculture and Agri-Food Canada 1998). The broadest element of soil classification is the soil order, which is determined from the nature of the soil environment and the effects of dominant, soil-forming processes.

4.1.5.2 Soil Mapping

A SMU is a defined and named repetitive group of soil bodies occurring together in an individual and characteristic pattern over the soil landscape (Gregorich et al. 2001). A total of 670 SMUs polygons were delineated in the 16,453 ha LSA/RSA. Nineteen (19) SMU labels were assigned to each polygon based on dominant and associated soil subgroup, dominant slope classes, parent material, drainage, topsoil/surface layer thickness and subsoil textures. This information and areas occupied by each SMU is presented in Table 6. Figure A.5.1 to Figure A.5.12 (Appendix A of this report) shows the delineated SMUs and soil inspection, borehole and test pit points for the LSA/RSA.

Very poor to poor drainage and low relief leads to the formation Organic and Gleysolic soil over most of the LSA/RSA. Very poorly drained Organic soils, with a surface organic layer that is deeper than 40 cm are generally found in Harley, Kushog, Kenogami, Larder and Uno Park SMUs, are the dominant order in the LSA/RSA accounting for approximately 7,882 ha (47.9 %) of the LSA/RSA. Poorly drained Gleysol soils defined as saturated soils with reducing conditions within 50 cm of the surface are also presents in large areas accounting for approximately 5,657 ha (34.4 %) of the LSA/RSA.

Moderately well to imperfectly drained Luvisols, which have a clay-enriched Bt horizon created from clay translocation account for approximately 2,031 ha (12.3 %) of the LSA/RSA. Coarse-textured, well drained Brunisols with juvenile pedogenic development account for approximately 374 ha (2.3 %) of the LSA/RSA.

A description of the 19 delineated SMUs is outlined below.

- The Abitibi 1 SMU was mapped on glaciofluvial deposits in the central portion of the soils/terrain LSA/RSA near Highway 655 and occupies approximately 453 ha (2.7 %) of the LSA/RSA. This SMU consists of mostly Eluviated and Orthic Dystric Brunisols developed on well-drained loamy sand textured parent materials or loamy sand textured veneers/blankets over clay loam textured till materials.
- The Abitibi 2 SMU was mapped on glaciofluvial deposits near Highway #655 and occupies approximately 9 ha (0.1 %) of the eastern soils LSA/RSA) of the soils/terrain LSA/RSA. This SMU consists of mostly Eluviated and Orthic Dystric Brunisols developed on well to rapidly drained sand to loamy sand textured parent materials.

- The Devitt 1 SMU was mapped on Lacustro-till/Glaciolacustrine deposits and occupies approximately 148 ha (0.9 %) of the soils/terrain LSA/RSA. This SMU consists of mostly Gleyed Gray Luvisols/Gleyed Dark Gray Luvisols developed on imperfectly to moderately well drained clay to clay loam textured parent materials.
- The Devitt 2 SMU was mapped on Lacustro-till/Glaciolacustrine deposits and occupies approximately 1,051 ha (6.2 %) of the soils/terrain LSA/RSA. This SMU consists of mostly Gleyed Gray Luvisols/Gleyed Dark Gray Luvisols developed on imperfectly to moderately well drained clay to clay loam textured parent materials. There are areas of poorly drained Humic Luvic Gleysols in this SMU.
- The Ford 1 SMU was mapped on Glaciolacustrine deposits mostly located in the northern and western positions of the soils/terrain LSA/RSA and occupies approximately 678 ha (4.0%) of the LSA/RSA. This SMU consists of mostly poorly drained Orthic/Orthic Luvic/Humic Luvic Gleysols developed on silty clay loam/silt loam and silty clay parent materials.
- The Ford 2 SMU was mapped on Glaciolacustrine deposits mostly located in the northern and western positions of the soils/terrain LSA/RSA and occupies approximately 854 ha (5.1%) of the LSA/RSA. This SMU consists of mostly poorly drained Orthic Gleysols and peaty Orthic Gleysols developed on silty clay loam/silt loam and silty clay parent materials. There are areas of very poorly drained Terric Humisols.
- The Ford 3 SMU was mapped on Glaciolacustrine deposits mostly located in the northern and western positions of the soils/terrain LSA/RSA and occupies approximately 1,868 ha (11.1%) of the LSA/RSA. This SMU consists of mostly poorly drained peaty Orthic Gleysols; however, there are areas of imperfectly drained Gleyed Gray Luvisols developed on silty clay loam/silt loam and silty clay textured parent materials.
- The Harley SMU was mapped as organic deposits with peat layers deeper than 1.6 m the soils/terrain LSA/RSA and occupies approximately 1,879 ha (11.1 %) of the LSA/RSA. The underlying mineral horizon is silt loan, silty clay loam or silty clay texture. This SMU consists of very poorly drained Typic Fibrisols, Fibric Mesisols and Typic Mesisols
- The Kenogami 1 SMU was mapped on organic veneers over Glaciolacustrine/Lacustro-Till deposits in the soils/terrain LSA/RSA and occupies approximately 426 ha (0.6%) of the LSA/RSA. This SMU consists of very poorly drained Terric Humisols.
- The Kenogami 2 SMU was mapped on organic veneers over Glaciolacustrine/Lacustro-Till deposits in the soils/terrain LSA/RSA and occupies approximately 1,327 ha (1.9%) of the LSA/RSA. This SMU consists of very poorly drained Terric Humisols and some areas of Fibric Mesisols.
- The Kenogami 3 SMU was mapped on organic veneers over Glaciolacustrine/Lacustro-Till deposits in the soils/terrain LSA/RSA and occupies approximately 2,239 ha (13.2%) of the LSA/RSA. This SMU consists of very poorly drained Terric Humic/Terric Fibric Humisols and some areas of peaty Gleysols and Typic Mesisols.

- The Kushog SMU was mapped on very poorly drained fibric organic veneers over Glaciolacustrine deposits usually found in adjacent and along watercourses. This SMU occupies approximately 146 ha (0.9 %) of the soils/terrain LSA/RSA and consists mostly of a Terric Fibrisols.
- The Larder SMU was mapped on very poorly drained mesic organic deposits found throughout the soils/terrain LSA/RSA. This SMU occupies approximately 298 ha (1.8 %) of the soils/terrain LSA/RSA and consists of mostly Typic Humisols, Typic Mesisols and Mesic Humisols.
- Lowther 1 SMU was mapped on moderately well drained Lacustro-Till and occupies approximately 175 ha (1.0 %) of the soils/terrain LSA/RSA. This SMU consists of mostly Orthic Gray Luvisols developed on silt loam. silty clay loam, clay loam to clay textured parent materials.
- Lowther 2 SMU was mapped on moderately well to imperfectly drained Lacustro-Till and occupies approximately 614 ha (3.6 %) of the soils/terrain LSA/RSA. This SMU consists of mostly Orthic Gray Luvisols however there are some areas of Dark Gray Luvisols and Orthic Gleysols in this SMU.
- The Lowther 3 SMU was mapped along the short erosion escarpments along Jocko Creek in the southern portion of the soils/terrain LSA/RSA, occupies approximately 121 ha (0.7 %) and is a mix of Orthic Gray Luvisols and Orthic Regosols developed on silt loam. silty clay loam, clay loam to clay textured parent materials.
- The Shetland 1 SMU was mapped on poorly drained Lacustro-till/Glaciolacustrine deposits in the eastern and southern portion in soils/terrain LSA/RSA, occupies approximately 712 ha (4.2 %) of the LSA/RSA). This SMU consists of a mix of Orthic Gleysols, Rego Gleysols, peaty Orthic Gleysols developed poorly drained clay loam/clay/silty clay parent materials.
- The Shetland 2 SMU was mapped on poorly drained Lacustro-till/Glaciolacustrine deposits in the eastern and southern portion in soils/terrain LSA/RSA, occupies approximately 708 ha (4.2 %) of the LSA/RSA). This SMU consists of a mostly of peaty Orthic Gleysols developed poorly drained clay loam/clay/silty clay parent materials.
- The Shetland 3 SMU was mapped on poorly drained Lacustro-till/Glaciolacustrine deposits in the eastern and southern portion in soils/terrain LSA/RSA, occupies approximately 1,023 ha (6.1 %) of the LSA/RSA. This SMU consists of mostly Orfhic Gleysols; however, there are areas of very poorly drained Terric Humisols and imperfectly drained Gleyed Gray Luvisols developed poorly drained clay loam/clay/silty clay parent materials.
- The Uno Park SMU was mapped on very poorly drained fibric organic veneers over Lacustro-Till/Glaciolacustrine deposits throughout the soils/terrain LSA/RSA and occupies approximately 1,598 ha (9.5 %) of the LSA/RSA. This SMU consists of a mix of very poorly drained Terric Mesisols and Terric Fibric Mesisols.
- Waterbodies were delineated and occupy approximately 147 ha (0.9 %) of the soils/terrain LSA/RSA.

Table 6 Soil Map Units (SMUs) in the Local Study Area (LSA/RSA)

Soil Map Unit	Dominant Soil Subgroup	Associated Soil Subgroups	Parent Material	Drainage	Dominate Slope Classes	Dominate Topsoil Depths (cm)	Subsoil Texture	Area (ha)	Area (%)
Abitibi 1	Eluviated Dystric Brunisols	Orthic Dystric Brunisols	Glaciofluvial; Glaciofluvial/Lacustro-Till	Well to Moderately Well	0 to 5%	Topsoil + LFH Horizon – 15 to 25 cm	Loamy Sand. Sandy Loam Sand (Glaciofluvial) Clay loam (if Tell preent at depth	453	2.7
Abitibi 2	Orthic Dystric Brunisols	Eluviated Dystric Brunisols	Glaciofluvial	Well to Rapid	0 to 5%	Topsoil + LFH Horizon – 15 to 25 cm	Loamy Sand. Sand	9	0.1
Devitt 1	Gleyed Gray Luvisols	Dark Gray Luvisols Gleyed Dark Gray Luvisols	Lacustro-Till Glaciolacustrine	Imperfect to Moderately Well	0 to 2%	Topsoil + LFH Horizon – 15 to 35 cm	Clay, Clay loam	148	0.9
Devitt 2	Gleyed Gray Luvisols	Dark Gray Luvisols Humic Luvic Gleysols	Lacustrol-Till Glaciolacustrine	Imperfect to Poor	0 to 2%	Topsoil + LFH Horizon – 15 to 35 cm	Clay, Clay loam	1,051	6.2
Ford 1	Orthic Gleysols	Orthic Luvic Gleysols Humic Luvic Gleysol	Glaciolacustrine	Poor	0 to 1%	20 cm of Organic + Topsoil	Silty Clay Loam. Silt Loam Silty Clay	678	4.0
Ford 2	Orthic Gleysols (peaty)	Orthic Humic Gleysols Terric Humisols	Glaciolacustrine	Poor to Very Poor	0 to 1%	20 to 40 cm of Organic + Topsoil	Silty Clay Loam. Silt Loam Silty Clay	854	5.1
Ford 3	Orthic Gleysols (peaty)	Gleyed Gray Luvisols Orthic Gleysol	Glaciolacustrine	Poor	0 to 1%	20 to 40 cm of Organic + Topsoil	Sitly Clay Loam/ Silt Loam/ Silty Clay	1,868	11.1
Harley	Typic Fibrisols Fibric Mesisols	Typic Mesisols	Organic	Very Poor	0 to 1%	Greater than 140 cm Organic Layer	Silty Clay Loam/ Silt Loam/ Silty Clay	1,879	11.1
Kenogami 1	Terric Humisols		Organic Veneer over Glaciolacustrine/Lacustro-Till	Very Poor	0 to 2%	40 to 120 cm of Organic layer	Silty Clay Loam/Silty Clay/Clay	426	0.6
Kenogami 2	Terric Humisols	Fibric Mesisol	Organic Veneer over Glaciolacustrine/Lacustro-Till	Very Poor	0 to 2%	40 to 120 cm of Organic layer	Silty Clay Loam/Silty Clay/Clay	1,327	1.9
Kenogami 3	Terric Humisols Terric Fibric Humisols	Typic Mesisol Peaty Gleysols	Organic Veneer over Glaciolacustrine/Till	Very Poor to Poor	0 to 2%	40 to 120 cm of Organic layer	Silty Clay Loam/Silty Clay/Clay	2,239	13.2
Kushog	Terric Fibrisols		Organic Veneer over Glaciolacustrine	Very Poor	0 to 1%	60 to 100 cm of Organic layer	Silt Loam/Silty Clay Loam	146	0.9
Larder	Typic Humisols	Mesic Humisols	Organic	Very Poor	0 to 1%	Greater than 140 cm Organic layer	Clay Loam/Silty Clay	298	1.8
Lowther 1	Orthic Gray Luvisols		Lacustro-Till	Moderately Well	0 to 2%	Topsoil + LFH Horizon – 20 to 25 cm	Silt loam. silty clay loam, Clay Loam/Clay	175	1.0
Lowther 2	Orthic Gray Luvisols	Dark Gray Luvisols Orthic Gleysols	Lacustro-Till	Moderately Well to Imperfect	0 to 2%	Topsoil + LFH Horizon – 20 to 25 cm	Silt loam. Silty clay loam, Clay Loam/Clay	614	3.6

Soil Map Unit	Dominant Soil Subgroup	Associated Soil Subgroups	Parent Material	Drainage	Dominate Slope Classes	Dominate Topsoil Depths (cm)	Subsoil Texture	Area (ha)	Area (%)
Lowther 3	Orthic Gray Luvisols	Orthic Regosols	Lacustro-Till	Moderately Well	2 – 20%	Topsoil + LFH Horizon – 20 to 25 cm	Silt loam. Silty clay loam, Clay Loam/Clay	121	0.6
Shetland 1	Orthic Gleysols Rego Gleysols	Orthic Gleysols (peaty)	Glaciolacustrine/Lacustro-Till	Poor	0 to 2%	5 to 40 cm of Organic layer + Topsoil	Clay Loam/Clay/Silty Clay	712	4.2
Shetland 2	Orthic Gleysols (peaty)		Glaciolacustrine/Lacustro-Till	Poor	0 to 2%	5 to 40 cm of Organic layer+ Topsoil	Clay Loam/Clay/Silty Clay	708	4.2
Shetland 3	Orthic Gleysols	Terric Humisols Orthic Gleysols (peaty) Gleyed Gray Luvisol	Glaciolacustrine/Lacustro-Till	Very Poor - Imperfect	0 to 2%	5 to 40 cm of Organic layer + Topsoil	Clay Loam/Clay/Silty Clay	1.023	6.1
Uno Park	Terric Mesisols	Terric Fibric Mesisol	Organic Veneer over Glaciolacustrine/Lacustro-Till	Very Poor	0 to 2%	40 to 140 cm of Organic layer	Clay/Silty Clay/Silty Clay Loam	1,598	9.5
Rock	-	-	-	-	-	-	-		
Disturbed	-	-	-	-	-	-	-		
Water	-	-	-	-	-	-	-		
Total	-	-	-	-	-	-	-	**16,896**	**100**
Note: Numbers may not add up due to rounding error									

4.1.5.3 Water Erosion Risk

Water risk ratings for the LSA/RSA are summarised in Table 7 and presented on Figure A.6 (Appendix A of this report). Surface layer water risk is Very Low to Low for approximately 5003 ha (29.6 %) and Moderate for approximately 3,862 ha (22.9 %) of the LSA/RSA. Approximately 7,912 ha (46.9 %) of the surface layers are organic. Subsurface layers water erosion is Low and Low to Moderate for approximately 12,453 ha (73.7 %) of the LSA/RSA. The low soil erosion risk is mostly due to the near-level to very gentle slope gradients over most of the LSA/RSA. Soil water erosion risk is high to severe for short (e.g., 10-to-15-metres slope length) escarpments along Jocko Creek. The potential for soil erosion will greatly increase when soils are disturbed and recontoured as part of mining operations.

Water erosion risk ratings for each representative soils are presented in Appendix B of this report.

Table 7 Water Erosion Risks for Soils in the Local Study Area (LSA/RSA)

	Water Erosion Risk			
Rating	**Surface Layer Lift Area (ha)**	**Surface Layer Lift Area (%)**	**Subsurface Layer Lift Area (ha)**	**Subsurface Layer Lift Area (%)**
Organic	7,912	46.9	-	-
Very Low	1,199	7.1	-	-
Low	3,408	22.5	6,030	35.7
Low to Moderate	-	-	6,423	38.0
Moderate	3,401	20.1	3862	22.9
High to Severe	121	0.7	121	0.7
Rock	1	<0.1	1	<0.1
Disturbed	297	1.6	297	1.6
Water	160	0.9	160	0.9
Total	**16,453**	**100**	**16,453**	**100**
Note: Numbers may not add up due to Rounding Error				

4.1.5.4 Compaction Risk

The compaction risk for the LSA/RSA is summarized in Table 8 and shown in Figure A.7 (Appendix A of this report). Compaction risk is high for most soils in the LSA/RSA due to combination of clay loam, clay, silt loam. silty clay loam, silty clay and clay textures and imperfect to very poor soil drainage. Compaction risk is High or Moderate to High for approximately 5,844 ha (34.6 %) and 15,867 ha (93.1 %) of surface and subsurface layers, respectively. Compaction risk was not determined for the surface layer of Organic soils because compaction is mostly an issue in a change in soil porosity in mineral soils.

Compaction risk ratings for each representative soils are presented in Appendix B of this report.

Table 8 Compaction Risks for Soils in the Local Study Area (LSA/RSA)

Rating	Compaction Risk			
	Surface Layer Lift Area (ha)	Surface Layer Lift Area (%)	Subsurface Layer Lift Area (ha)	Subsurface Layer Lift Area (%)
Organic	7,912	46.9	-	-
Low	462	2.3	462	2.3
Moderate	2,219	13.1	109	0.6
Moderate to High	-	-	911	5.4
High	5,644	34.6	14,956	88.5
Rock	1	<0.1	1	<0.1
Disturbed	297	1.6	297	1.6
Water	160	0.9	160	0.9
Total	**16,453**	**100**	**16453**	**100**
Note: Numbers may not add up due to Rounding Error				

4.1.5.5 Soil Reclamation Suitability

Soil Reclamation suitability for the LSA is summarized in Table 9 and shown in Figure A.8 (Appendix A of this report). Approximately 5,510 ha (32.6 %) of the surface layer in the LSA/RSA has a Good, Good to Fair reclamation suitability rating while 444 ha (2.6 %) of the subsurface layer has a Fair reclamation suitability rating. Approximately 109 ha (0.6 %) of the surface layer and 10,252 ha (60.7 %) of the subsurface layer have a Poor to Fair reclamation suitability rating. Approximately 2,906 ha (17.2 %) of the surface layer and 5,742 ha (34.0 %) of the subsurface layer have a Poor reclamation suitability rating. Soil with a Poor or Poor to Fair reclamation suitability rating were usually limited by texture (either coarse textured loamy sand and sand Brunisols or silty clay, clay loam, clay and heavy clay Glaciolacustrine/Lacustro-Till deposits) and/or $CaCO_3$ equivalent values.

The very poorly drained organic surface layer (47.9 % of the LSA/RSA) was not rated for reclamation suitability and would need to be mixed with other soils to be more suitable for reclamation. Its use for reclamation material will be further evaluated as part of closure planning.

Table 9 Reclamation Suitability Ratings for Soils in the Local Study Area (LSA/RSA)

Rating	Reclamation Suitability			
	Surface Layer Lift Area (ha)	Surface Layer Lift Area (%)	Subsurface Layer Lift Area (ha)	Subsurface Layer Lift Area (%)
Organic	7,912	46.9	-	-
Good	4,600	27.2		
Good to Fair	911	5.4		
Fair	-	-	444	2.6
Poor to Fair	109	0.6	10,252	60/7
Poor	2,906	17.2	5,742	34.0
Rock	1	<0.1	1	<0.1
Disturbed	297	1.6	297	1.6
Water	160	0.9	160	0.9
Total	**16,453**	**100**	**16,453**	**100**
Note: Numbers may not add up due to rounding error				

4.1.6 Geohazards

The following sections summarize baseline conditions related to the occurrence of geohazards within the LSA/RSA.

4.1.6.1 Landslide Processes

Landslides are created by the downslope movement (i.e., mass wasting) of surficial materials and/or bedrock fragments, often mixed with organic topsoil and vegetation debris. They are generally triggered on moderate to steep slopes by a combination of factors including (but not limited to) intense rainfall or snowmelt events, permafrost degradation, forest fires, river erosion, groundwater flow, and/or earthquakes. Landslides can also occur in areas of low relief, especially where the landscape includes soils that are non-cohesive (e.g., loose, sandy soils or soils with high clay content) and susceptible to liquefaction. The occurrence of landslides can also be associated to a wide range of anthropogenic activities (e.g., slope failures associated with cut-and-fill activities).

The background data review did not inform on the occurrence of landslides within the LSA/RSA. Similarly, no ground deformation potentially related to landslides activity (either historical or recent) were identified within the limits of the LSA/RSA. The main reason for the absence of landslide features within the limits of the LSA/RSA is due to the overall subdued topography.

Although no significant mass movement problems are expected to occur within undisturbed terrain units, the occurrence of small landslides remains a possibility. Whenever occurring, these small landslides are expected to occur predominantly along the moderately steep to steep slopes leading to river systems.

The occurrence of landslides triggered from construction-related activities is possible, especially where soils consist of glaciolacustrine clays.

4.1.6.2 Hydrotechnical Hazards

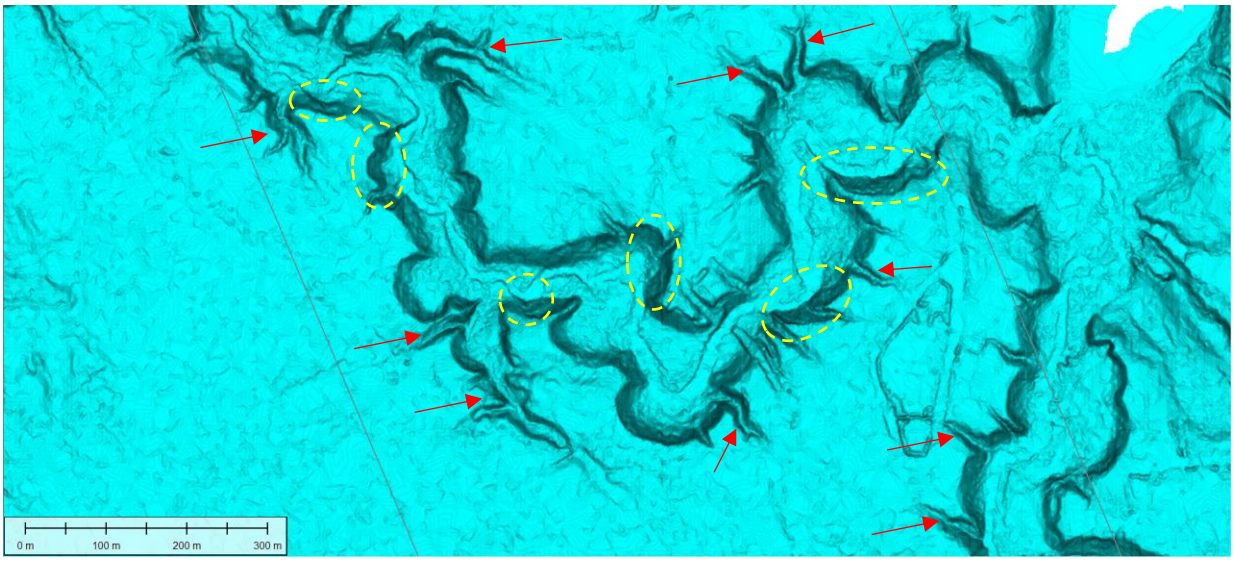
Riverine processes such as bank erosion, flooding and gullying were noted as part of the terrain mapping, primarily within the southern portion of the LSA/RSA along Jocko Creek.

Jocko Creek flows within a floodplain that is for the most part vegetated by grasses, shrubs and deciduous trees. The stream channel, generally under 10 m-wide, follows a meandering course which is contained within a 50 to 150 m wide floodplain. Although there is limited evidence of erosion due to the vegetation canopy, the examination of bare-earth hillshade images shows that the creek's floodplain is confined and characterized by an irregular meandering channel with high sinuosity. Moderately steep slopes reaching a maximum of approximately 50% (27 degrees) are found along the floodplain, often at outside meander bends, where the stream channel is eroding into the base of adjacent valley slopes (yellow areas in Figure 3 below). Some level of channel encroachment due to bank erosion is expected to take place at these locations, especially during high flow events. The overall stream morphology suggests that some flooding may occur; however, most likely that it would be localized and contained within the floodplain area.

Gullies were identified from the bare-earth hillshade images. The vast majority are found alongside Jocko Creek, with a few other poorly-defined features found along the North Driftwood River (i.e., south to north throughout the central portion of the PA). Gullies found along Jocko Creek are well-defined and show a distinctive V-shape. The gullies developed in glaciolacustrine clays above the riverbanks (Figure 3 below). The largest gullies are up to 8 m deep and 300 m long, with sidewall slopes reaching up to 40%. The gully stream gradients calculated from the LiDAR data were observed to average approximately 4%. Water flow within these gullies is expected to be intermittent, most likely limited to when the water table is high, for example following rain and/or snowmelt events.

Although not all gullies are expected to be actively eroding, further down-cutting into the glaciolacustrine clays is expected to occur over time. The extension of gullies uphill from the stream network are the most sensitive areas to erosion, and rapid gullying could occur where vegetation and organic topsoil is removed. This process could include the occurrence of small, localized failures along the gully side-slopes.

Figure 3 Bare-earth LiDAR hillshade view of erosion and gullying occurring along Jocko Creek.



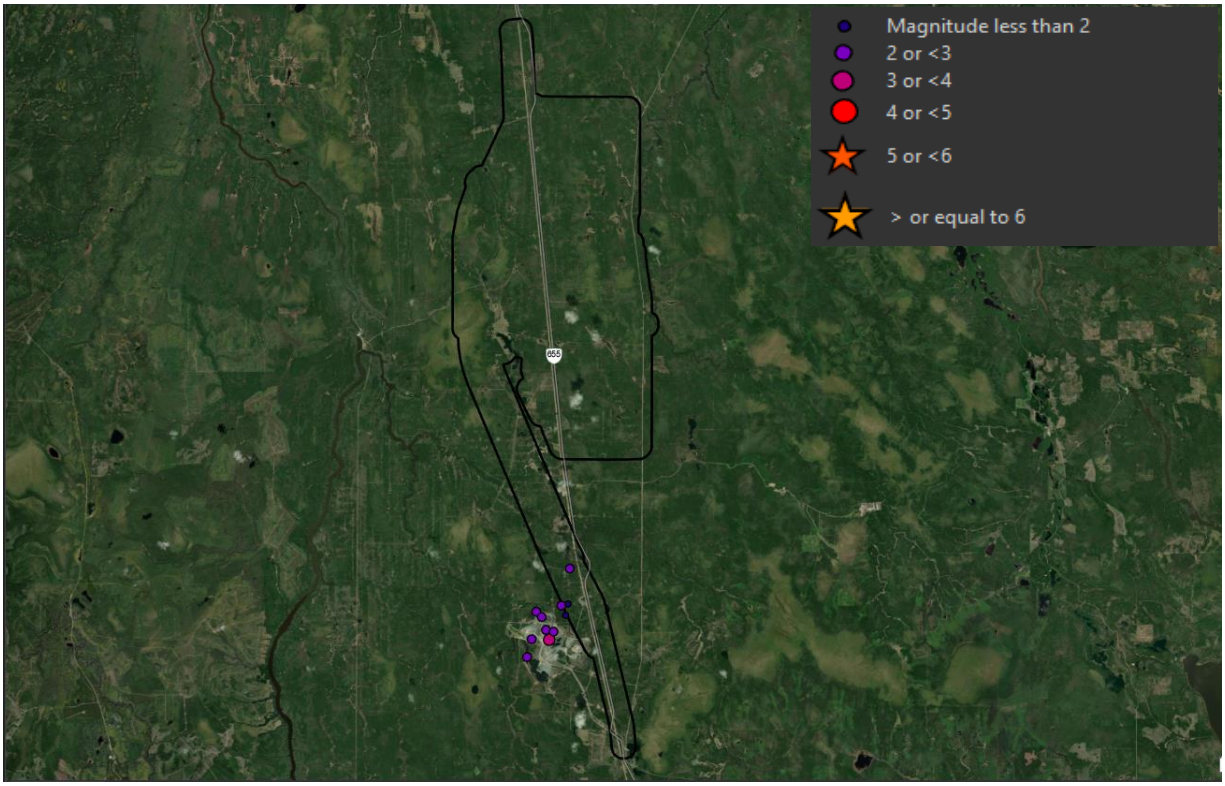
On the above figure, the LSA/RSA footprint is displayed in black, examples of areas where the stream channel is in contact with the edge of the floodplain in yellow. Example of gullies having developed in the glaciolacustrine clays above from the floodplain are shown in red.

4.1.6.3 Other Geohazards

Seismic activity: Eastern Canada is located in a stable continental region within the North American Plate and, as a consequence, has a relatively low level of seismic activity (Earthquake Canada, 2024). Earthquakes recorded for the 2010-2019 period[1] show only 1 or 2 magnitude events for the Timmins area (Figure 4 below); all are assumed related to blasting events associated to nearby mining activities (e.g., Kidd Creek Mine, southwest from the Project LSA/RSA).

[1] https://www.arcgis.com/apps/mapviewer/index.html?layers=25e36eb0d93d49859f73a4c98b1d3484

Figure 4 Earthquakes in the vicinity of the Project LSA/RSA



Karst: Karst topography typically forms by the dissolution of soluble carbonate rocks such as limestone and dolomite, or other highly soluble rocks such as halite, gypsum, and anhydrite. The geological processes involved can result in unusual surface and subsurface features ranging from irregular, often hummocky topography, sinkholes, disappearing and reappearing springs as well as complex underground drainage systems, and caves. Other karst-related features include pitted rock, clints and grikes, fissures, voids and shafts.

The background data review and terrain mapping did not inform on the occurrence of karst-susceptible terrain within the PA or LSA/RSA.

Subsidence: Land (or ground) subsidence consists of gradual settling or sudden sinking of the Earth's surface due to removal or displacement of subsurface earth materials. The principal causes include aquifer-system compaction associated with groundwater withdrawals, drainage of organic soils, underground mining, natural compaction or collapse, such as with sinkholes or thawing permafrost.

Although the localized occurrence of subsidence could occur following anthropogenic activities related to the Project, the background data and review and terrain mapping did not inform on the occurrence of subsidence within the PA or LSA/RSA.

5 Summary

The information presented in this baseline report is intended to summarize the existing conditions of soils and terrain to support the preparation of the Impact Statement. Key findings are as follows:

- The topography across the PA and LSA/RSA is flat to gently undulating, generally ranging between 265 and 290 m asl. and averaging about 15 m in local relief. The few rare areas of relief are associated to an esker complex, locally entrenched river systems, and a few rare bedrock-controlled hills.
- The terrain mapping and field work conducted for the LSA/RSA confirmed that surficial materials were related to both the glacial and post-glacial history of the region. Fine-grained glaciolacustrine deposits are the dominant mineral material origin in the LSA/RSA, followed by till, and glaciofluvial material. Organic materials found within wetlands and other poorly drained terrain units are very widespread throughout the landscape and are inherited from the extensive presence of glaciolacustrine clays.
- The most notable glacial landform presents within LSA/RSA consist of a north-south trending esker complex located west of the planned Tailings Management Facility. The top of the esker sits approximately 15 m above the surrounding terrain, with sand and gravel expected to reach approximately 42 m below ground surface.
- Approximately 670 Soil Mapping Units (SMUs) polygons were delineated following the field survey program. These SMUs were attributed into 19 closed legend labels that describe the dominant and associated soil subgroup, dominant slope classes, parent material, drainage, topsoil thickness and subsoil textures.
- Very poorly to poorly drained Organic and Gleysolic soils developed on nearly level to very gently sloped Lacustro-Till or Glaciolacustrine parent materials were mapped for most (84.8%) of the LSA/RSA. Moderately well to imperfectly drained Luvisols were mapped on approximately 12.5% of the LSA/RSA. Coarse textured, well drained Brunisols with juvenile pedogenesis were mapped on well drained Glaciofluvial deposits and occupy 2.7% of the LSA.
- Surface layer water erosion risk is Very Low to Low for approximately 29.6% of the LSA and subsurface layer water erosion is Low, and Low to Moderate for approximately 73.7% of the LSA. There is a High to Severe water erosion risk on escarpments along Jocko Creek.
- Compaction risk is High for most soils in the LSA/RSA due to the combination of clay loam, clay, silt loam. silty clay loam, silty clay and clay textures and imperfect to very poor drainage regime.
- Approximately 32.6% of the surface layer has a Good or Good to Fair reclamation suitability rating and approximately 47.9% surface layer in the LSA/RSA are organic soils. Approximately 17.8 % of the surface layer and 94.7% of the subsurface layer have a Poor or Poor to Fair reclamation suitability rating. Soil limitations to reclamation suitability are usually due to texture and/or $CaCO_3$ equivalent values.

- Overall, there a limited occurrences of geohazards within the PA and LSA/RSA. The terrain mapping and filed survey program did not inform on the occurrence of landslides within the LSA/RSA. Similarly, no ground deformation potentially related to landslides activity (either historical or recent) were identified within the limits of the LSA/RSA. Although no significant mass movement problems are expected to occur within undisturbed terrain units, the occurrence of small landslides remains a possibility.
- Riverine processes such as bank erosion, flooding and gullying were noted as part of the terrain mapping, primarily within the southern portion of the LSA/RSA along Jocko Creek. Although not all gullies are expected to be actively eroding, further down-cutting into the glaciolacustrine clays is expected to occur over time.

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Appendices

Appendix A Figures

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area
- Contour (10 m Interval)
- Major Road
- Minor Road
- Railway
- Existing Transmission Line
- Watercourse
- Municipal Boundary - Lower Tier
- Waterbody

Elevation (masl)

327.17

251.03

0 2.5 5 km

1:150,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © King's Printer for Ontario, 2023.
3. Elevation: Provincial Digital Elevation Model (PDEM), updated 2023-100-16, Ontario Ministry of Natural Resources and Forestry.

Project Location
Timmins, Ontario

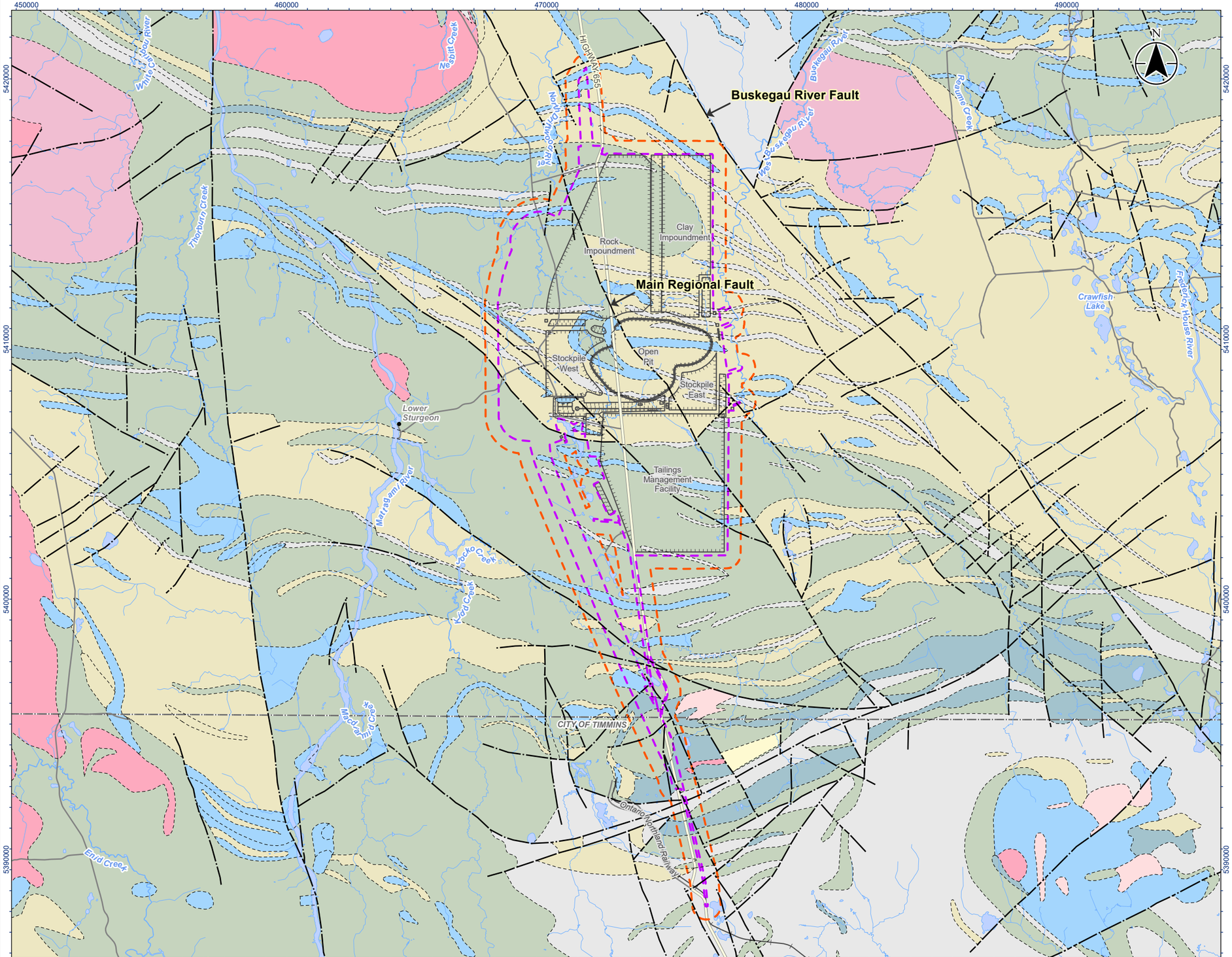
160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.1

Title
Study Area

\\cd1004-f01\01609\active\160903456\160903456\gis_cad\gis\mxds\ISBaseline\160903456_IS_BL_GeoTopo3.aprx\160903456_BL_Ter_Fig\A.01_LSA Revised: 2024-04-24 By: awhite



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Base Features

- Major Road
- Minor Road
- Railway
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Bedrock Geology

- Contact, Sharp, Trend
- Fault
- 4: Mafic to ultramafic metavolcanic rocksgt: mafic metavolcanic and basaltic rocks with minor komatiitic flows, metasedimentary and pyroclastic rocks
- 5: Mafic to intermediate metavolcanic rocksgt: basaltic and andesitic flows, tuffs and breccias, chert, iron formation, minor metasedimentary and intrusive rocks, related migmatites
- 6a: Dacitic and andesitic flows, tuffs and breccias
- 6b: Rhyolitic, rhyodacitic flows, tuffs and breccias
- 7: Metasedimentary rockseg: wacke, siltstone, arkose, argillite, slate, mudstone, marble, chert, iron formation, minor metavolcanic rocks, conglomerate, arenite, paragneiss, migmatites
- 7c: Marble, chert, iron formation, minor metavolcanic rocks
- 9b: Alkaline metavolcanic rocks: mafic to felsic metavolcanic flows, tuffs and breccias
- 10: Mafic and ultramafic rocksq: gabbro, anorthosite, ultramafic rocks
- 10c: Ultramafic rocks
- 12: Foliated tonalite suite: tonalite to granodiorite - foliated to massive
- 14: Diorite-monzodiorite-granodiorite suite: diorite, quartz diorite, minor tonalite, monzonite, granodiorite, syenite and hypabyssal equivalents (saturated to oversaturated suite)
- 15: Massive granodiorite to granite: massive to foliated granodiorite to granite

0 5 10 km

1:150,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © King's Printer for Ontario, 2023.
3. Ontario Geological Survey 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release---Data 126-Revision 1. ISBN 978-1-4435-5704-7 (CD) ISBN 978-1-4435-5705-4

Project Location
Timmins, Ontario

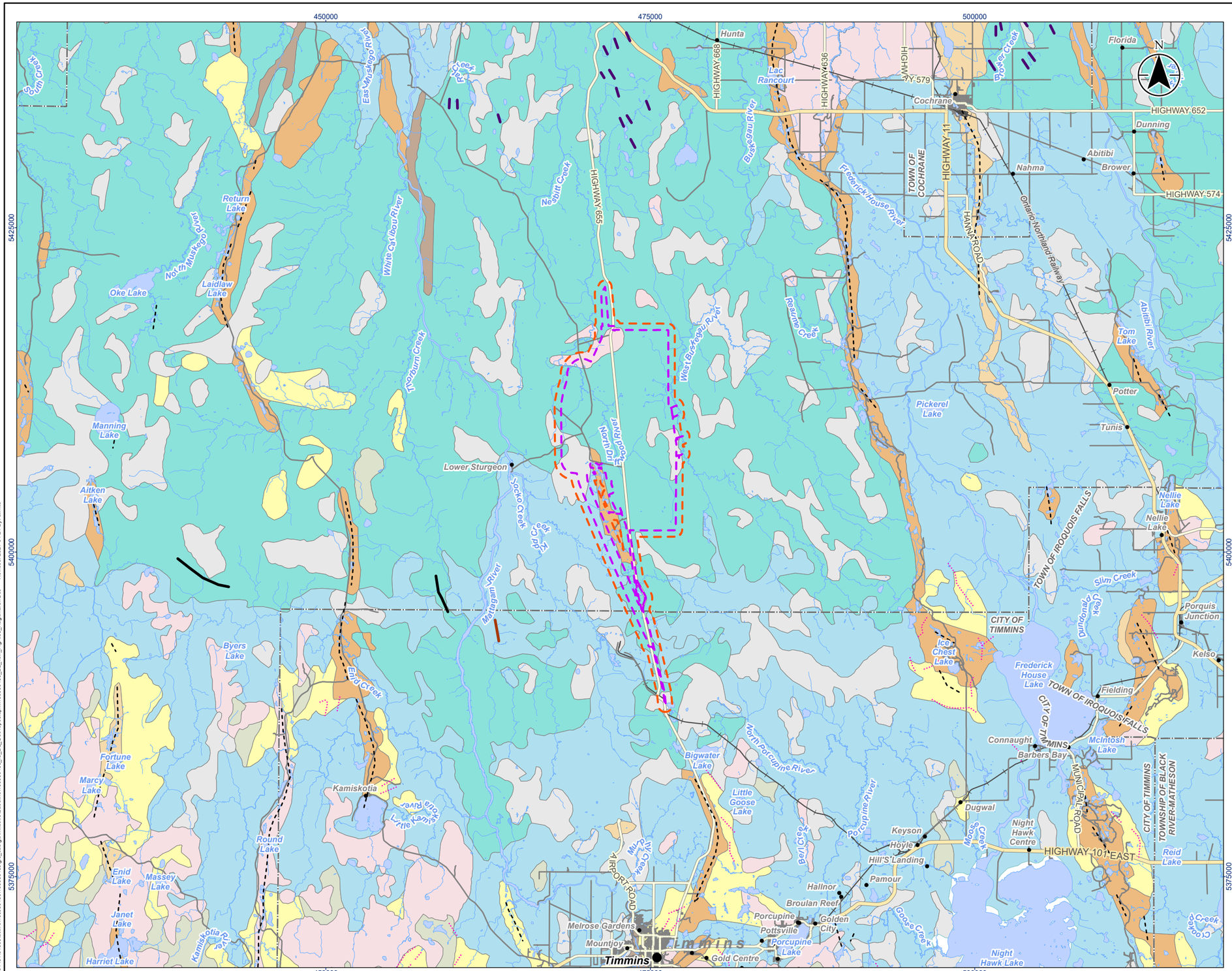
160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.2

Title
Bedrock Geology

\\cd1004-f01\01609\active\160903456\gis_cad\gis\mxds\ISBaseline\160903456_IS_B1_CleoTopo3.aprx\160903456_B1_Ter_Fig\A.02_BdrkGeo Revised: 2024-04-24 By: awhite



Legend

- Project Area
- Local/Regional Study Area
- Expressway / Highway
- Major Road
- Minor Road
- Railway
- Watercourse
- Municipal Boundary - Lower Tier
- Waterbody

Surficial Geology

- Beach, bar or spit
- Drumlin or area of drumlins
- Esker or area of eskers; direction of flow know or assumed
- Terrace escarpment (abandoned shore bluff)
- Trend of end moraine crest
- 1: Bedrock
- 18: Till
- 21: Till, fine-grained
- 22: Glaciofluvial Ice
- 23: Glaciofluvial Outwash deposits
- 24: Glaciolacustrine deposits
- 25: Glaciolacustrine deposits
- 31: Fluvial deposits
- 32: Organic deposits
- 33: Lakes

0 10 20 km

1:300,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
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3. Ontario Geological Survey, 1997. Quaternary geology, seamless coverage of the province of Ontario: Ontario Geological Survey, Data Set 14.

Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.3

Title
Regional Surficial Geology

\\cn1004-f01\01609\active\160903456\160903456\gis_cad\gis\mxd\ISBaseline\160903456_IS_BL_GeoTopo3.aprx\160903456_BL_Ter...Fig4.03_RegionalSrfGeo Revised: 2024-04-24 By: awhite

Dominant subsurface material and expression; glaciolacustrine (LG); plain (p)

Secondary surficial material and surface expression; fluvial (F); plain (p)

Ob[LGp] / Fp – U

Dominant surficial material and surface expression; organic (O); blanket (b)

Geomorphological process; inundation (U)

Surficial Material

A	Anthropogenic
R	Bedrock
C	Colluvium
F	Fluvial
FG	Glaciofluvial
LG	Glaciolacustrine
N	Not classified
O	Organic
M	Till

Surface Expression

v	Veneer (<1m)
b	Blanket (>1m)
p	Plain (0-5%)
j	Gentle slope (6-26%)
a	Moderate slope (27-49%)
k	Moderately steep slope (50-70%)
u	Undulating (<26%)
h	Hummock (>26%)
r	Ridge

Geomorphological Processes

E	Channeled by meltwater
R	Fast mass movement
V	Gullying
U	Inundated
H	Kettled

Composite Symbols

[ ]	Underlying surface material
/	Component in front of the symbol is more extensive

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CANADA NICKEL COMPANY

Legend

- Mapbook Index
- Project Area
- Local/Regional Study Area
- Contour (10 m Interval)
- Major Road
- Minor Road
- Railway
- Existing Transmission Line
- Watercourse
- Municipal Boundary - Lower Tier
- Waterbody

0 2.5 5 km

1:175,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
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Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.0

Title
Terrain Mapbook Index

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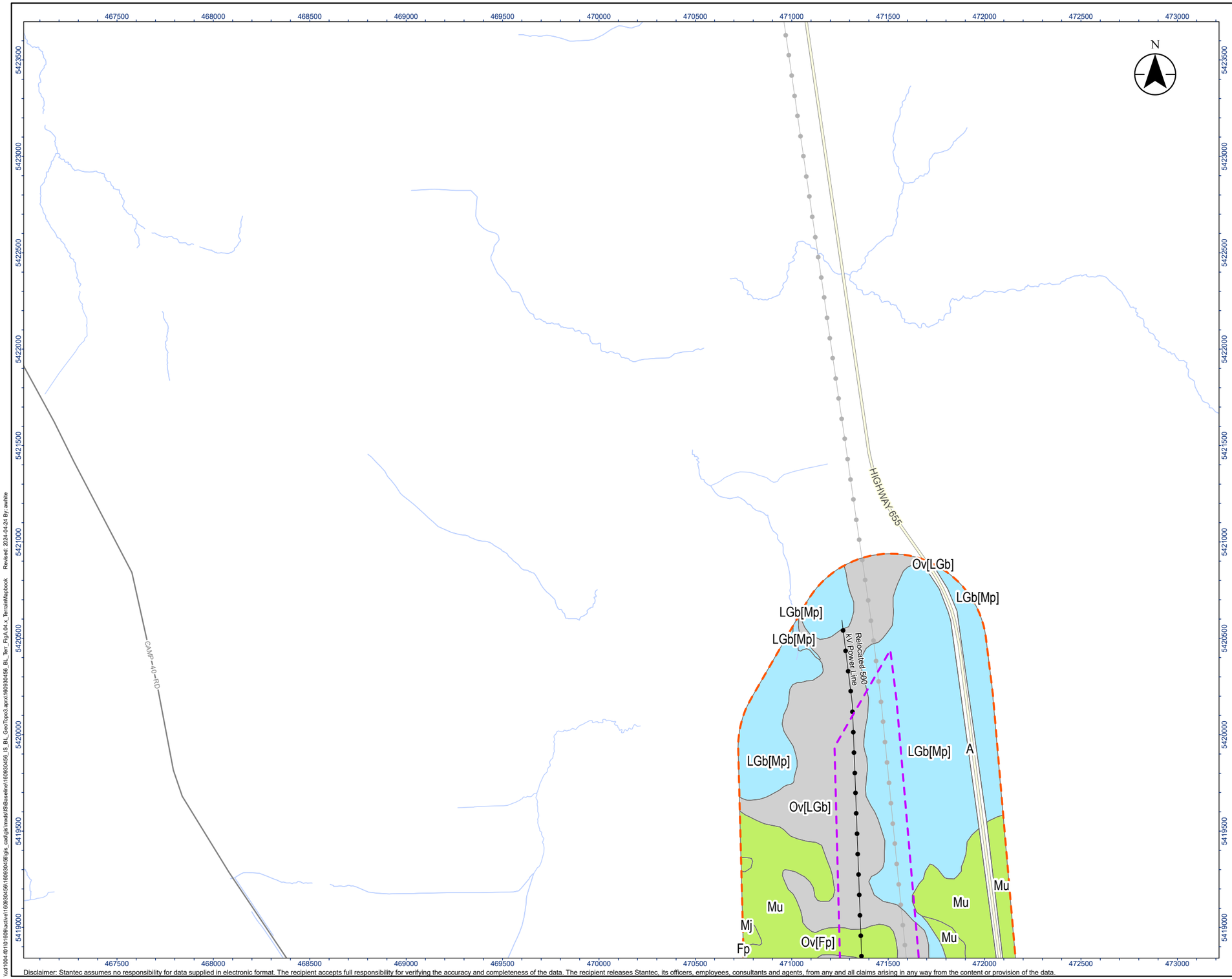

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Transmission Line
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Anthropogenic
- Fluvial
- Glaciolacustrine
- Organic
- Till

See Index Map A.4.0 for full key.

Dominant subsurface material and expression; glaciolacustrine (LG); plain (p)

Secondary surficial material and surface expression; fluvial (F); plain (p)

Ob[LGp] / Fp – U

Dominant surficial material and surface expression; organic (O); blanket (b)

Geomorphological process; inundation (U)

0 500 1,000 m

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Notes

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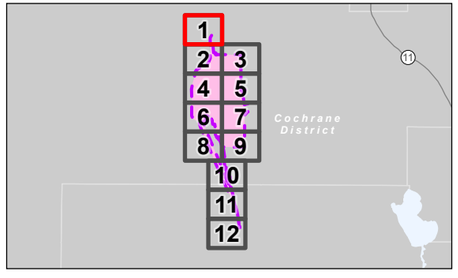

Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.1

Title
Terrain Mapbook

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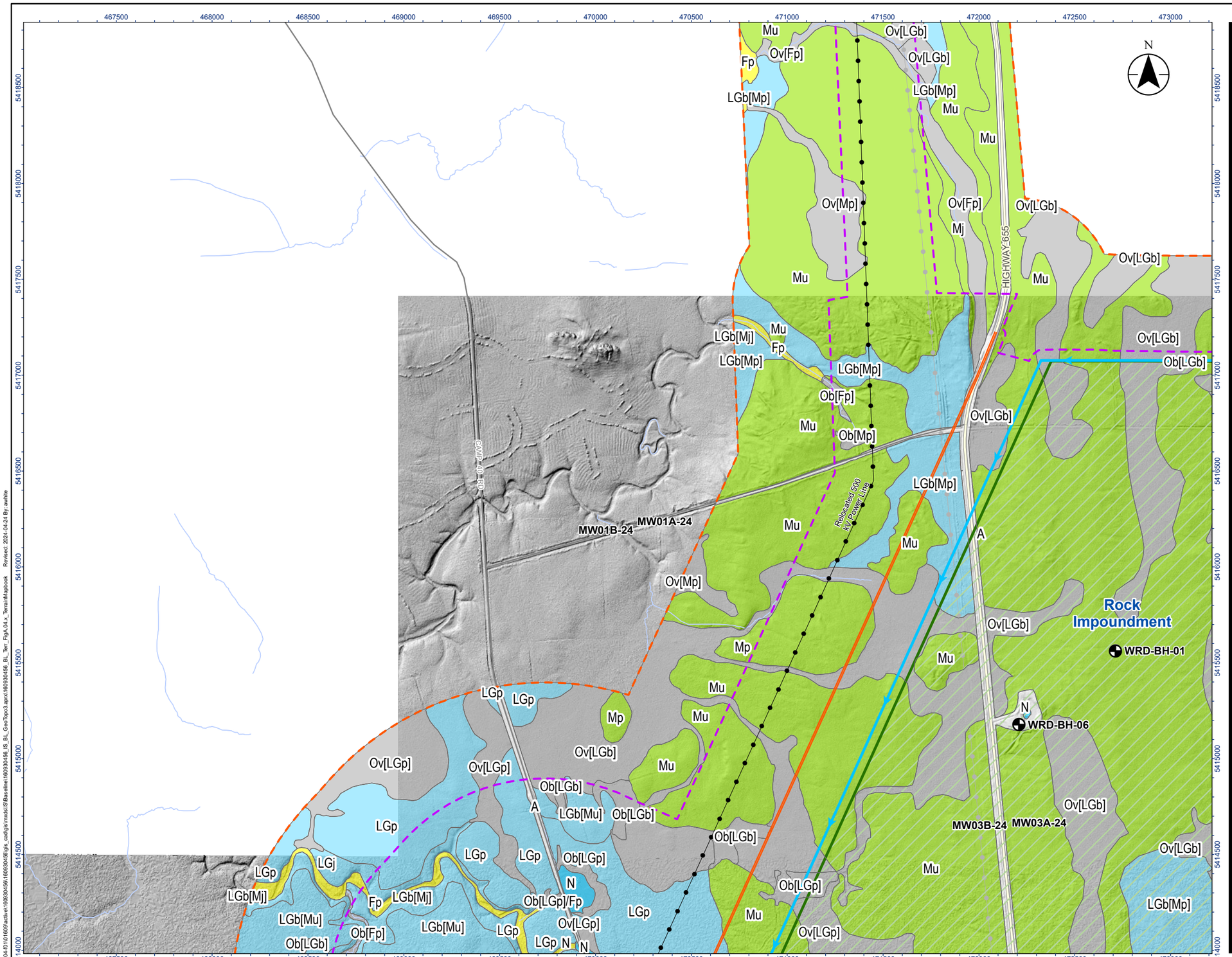

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Transmission Line
- Relocated Hwy 655 ROW
- Site Ditch Centerline
- Rock Impoundment
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse

Boreholes

- Borehole

- Anthropogenic
- Fluvial
- Glaciolacustrine
- Organic
- Till
- Waterbody

See Index Map A.4.0 for full key.

Dominant subsurface material and expression; glaciolacustrine (LG); plain (p)

Secondary surficial material and surface expression; fluvial (F); plain (p)

Ob[LGp] / Fp – U

Dominant surficial material and surface expression; organic (O); blanket (b)

Geomorphological process; inundation (U)

0 500 1,000 m

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Notes

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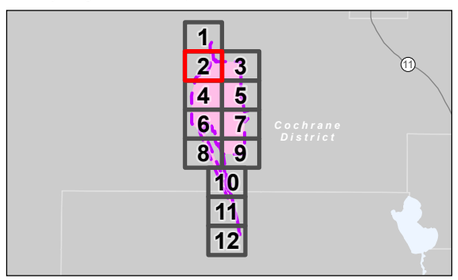

Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.2

Title
Terrain Mapbook

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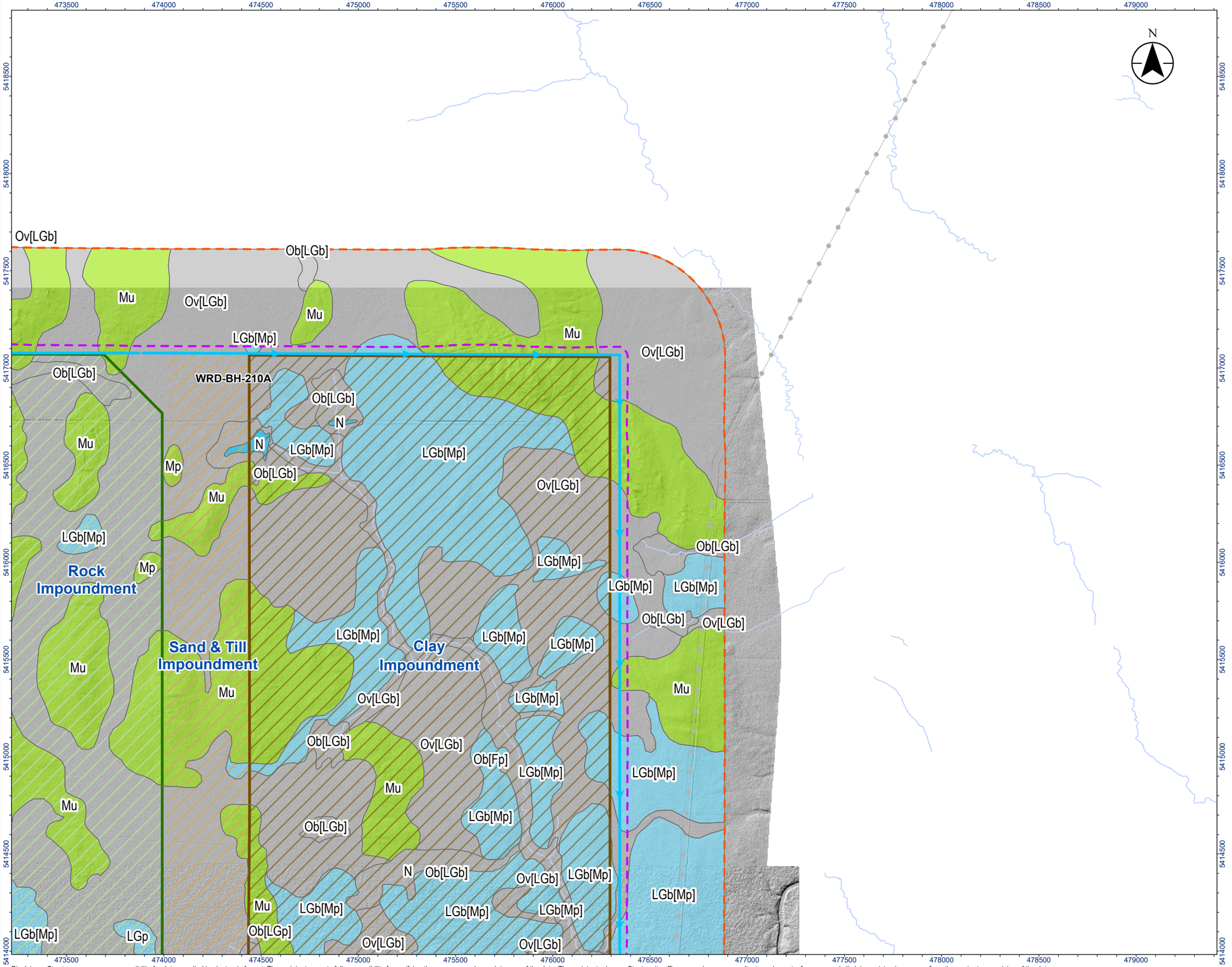

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Site Ditch Centerline
- Clay Impoundment
- Rock Impoundment
- Sand & Till Impoundment
- Existing Transmission Line
- Watercourse
- Glaciolacustrine
- Organic
- Till
- Waterbody

See Index Map A.4.0 for full key.

Dominant subsurface material and expression; glaciolacustrine (LG); plain (p)

Secondary surficial material and surface expression; fluvial (F); plain (p)

Ob[LGp] / Fp – U

Dominant surficial material and surface expression; organic (O); blanket (b)

Geomorphological process; inundation (U)

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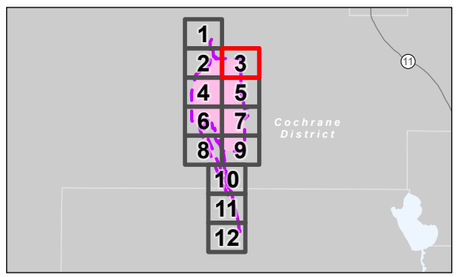


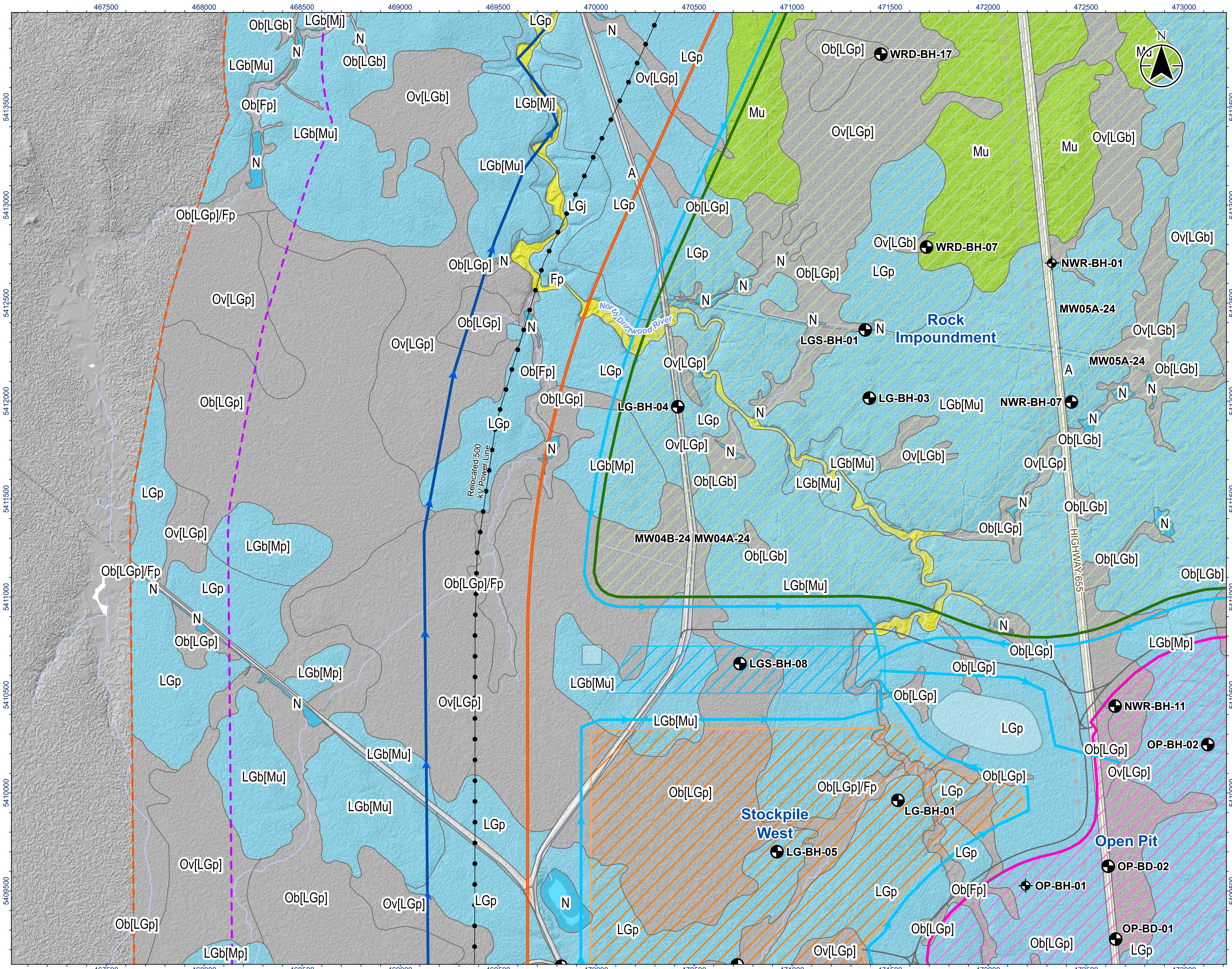
Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.3

Title
Terrain Mapbook



Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Non Contact Diversion Channel Centerline
- Transmission Line
- Relocated Hwy 655 ROW
- Site Ditch Centerline
- Site Road Centerline
- Building
- Low Grade Ore Stockpile
- Open Pit
- Pond
- Rock Impoundment
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse

Boreholes

- Monitoring Well
- Borehole
- Anthropogenic
- Fluvial
- Glaciolacustrine
- Organic
- Till
- Waterbody

See Index Map A.4.0 for full key.

Ob[LGp] / Fp – U

- Dominant subsurface material and expression; glaciolacustrine (LG); plain (p)
- Secondary surficial material and surface expression; fluvial (F); plain (p)
- Dominant surficial material and surface expression; organic (O); blanket (b)
- Geomorphological process; inundation (U)

0 500 1,000 m

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Notes

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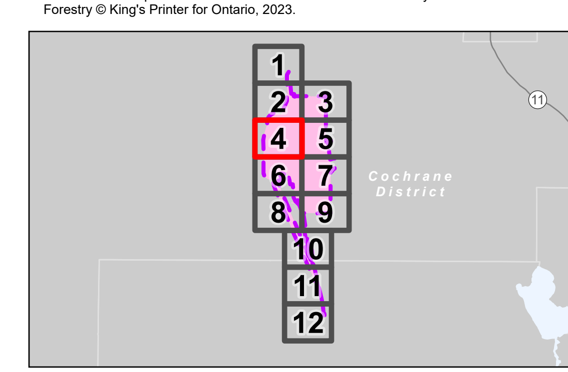


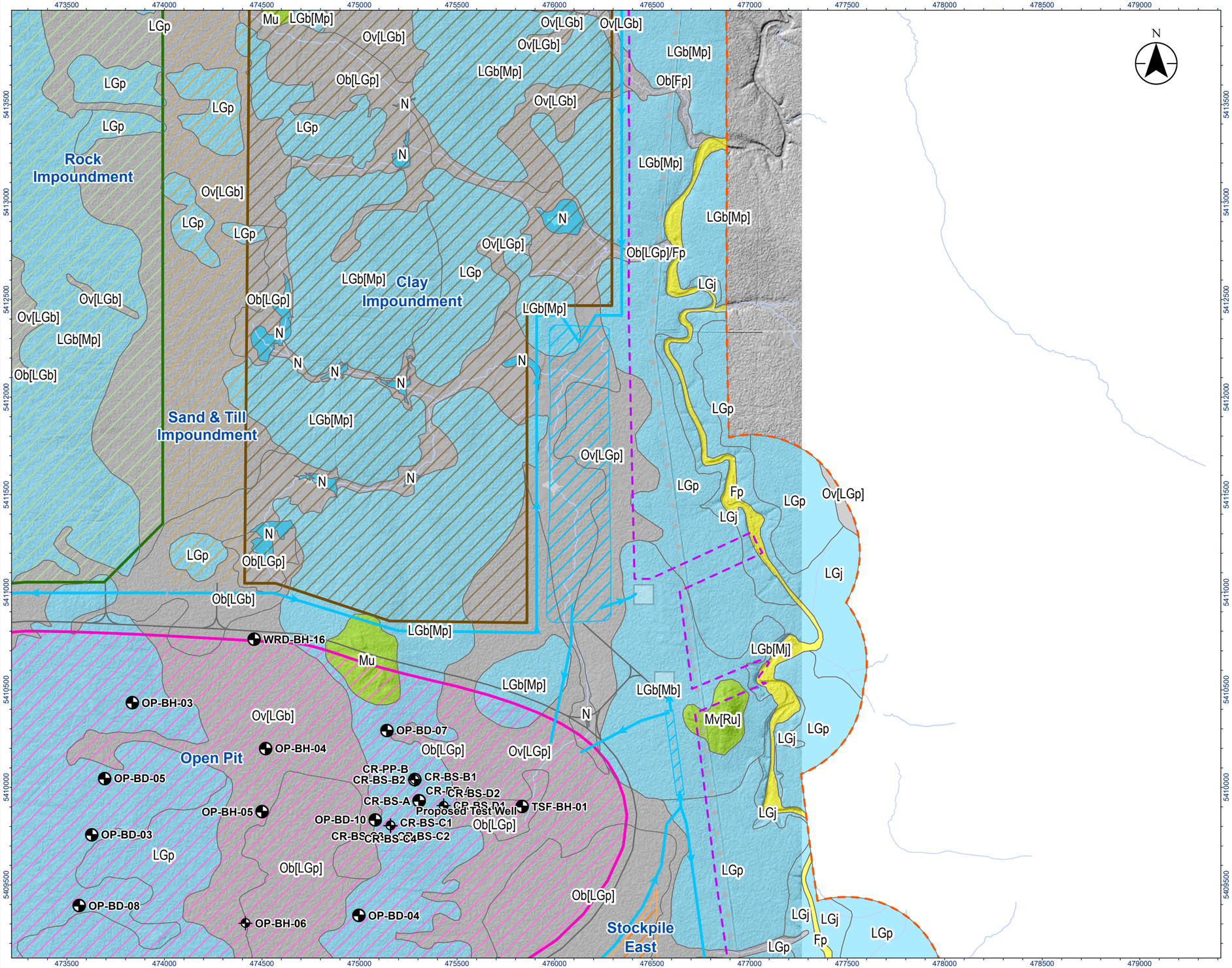
Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.4

Title
Terrain Mapbook



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Site Ditch Centerline
- Site Road Centerline
- Building
- Low Grade Ore Stockpile
- Open Pit
- Clay Impoundment
- Pond
- Rock Impoundment
- Sand & Till Impoundment
- Existing Transmission Line
- Watercourse

Boreholes

- Monitoring Well
- Borehole
- Fluvial
- Glaciolacustrine
- Organic
- Till
- Waterbody

See Index Map A.4.0 for full key.

Dominant subsurface material and expression; glaciolacustrine (LG); plain (p)

Secondary surficial material and surface expression; fluvial (F); plain (p)

Ob[LGp] / Fp – U

Dominant surficial material and surface expression; organic (O); blanket (b)

Geomorphological process; inundation (U)

0 500 1,000 m

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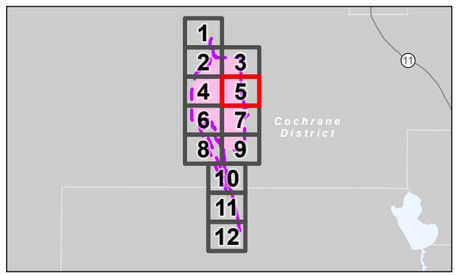

Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.5

Title
Terrain Mapbook

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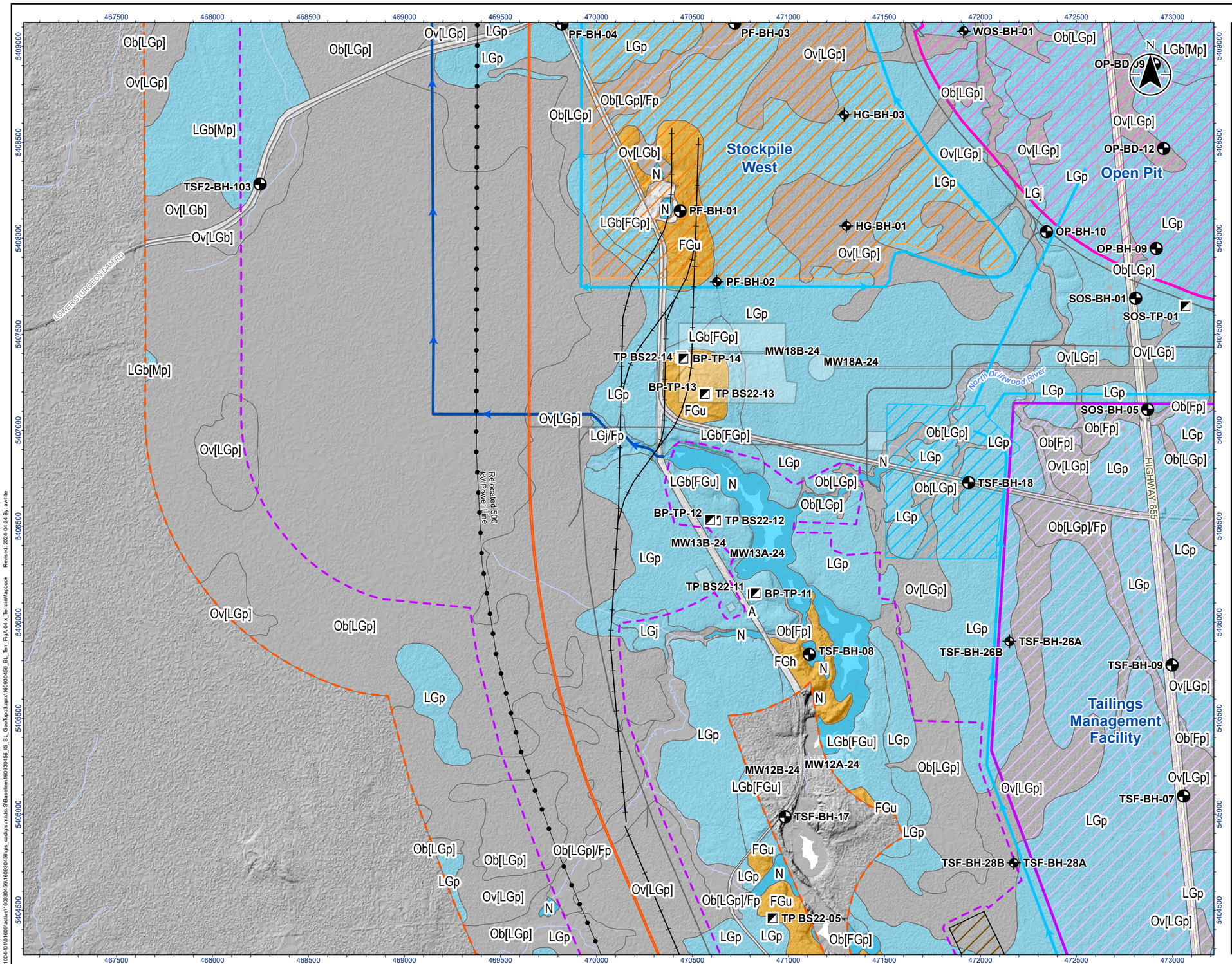

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Non Contact Diversion Channel Centerline
- Transmission Line
- Rail Line
- Relocated Hwy 655 ROW
- Site Ditch Centerline
- Site Road Centerline
- Building
- Low Grade Ore Stockpile
- Open Pit
- Pond
- Tailings Management Facility
- Reclaim Stockpile
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse

Boreholes

- Monitoring Well
- Borehole
- Test Pit

- Anthropogenic
- Glaciofluvial
- Glaciolacustrine
- Organic
- Waterbody

See Index Map A.4.0 for full key.

Dominant subsurface material and expression; glaciolacustrine (LG); plain (p)

Secondary surficial material and surface expression; fluvial (F); plain (p)

Ob[LGp] / Fp – U

Dominant surficial material and surface expression; organic (O); blanket (b)

Geomorphological process; inundation (U)

0 500 1,000 m

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Notes

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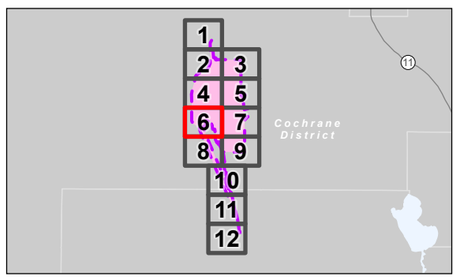

Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.6

Title
Terrain Mapbook

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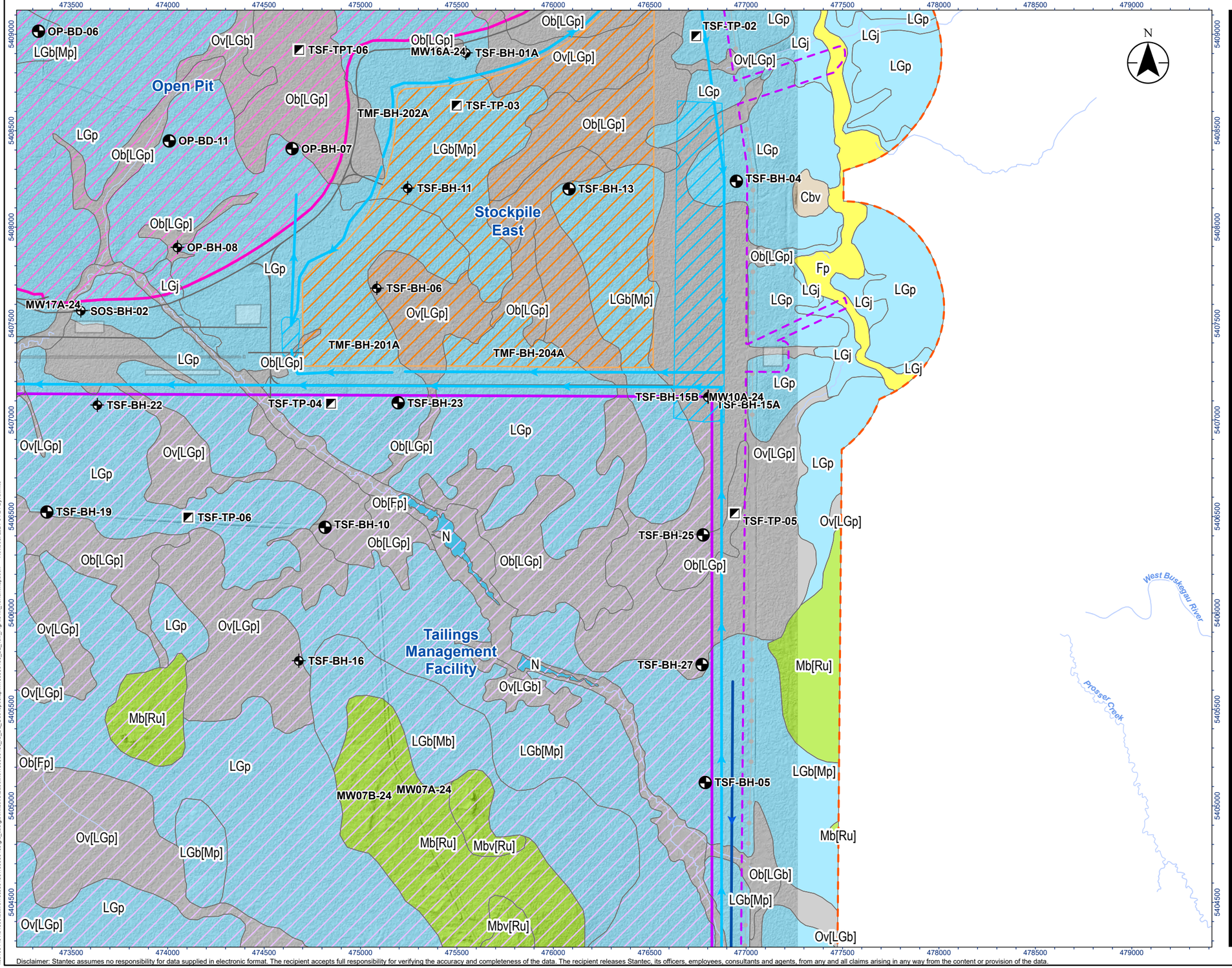

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Non Contact Diversion Channel Centerline
- Site Ditch Centerline
- Site Road Centerline
- Building
- Low Grade Ore Stockpile
- Open Pit
- Pond
- Tailings Management Facility
- Existing Transmission Line
- Watercourse

Boreholes

- Monitoring Well
- Borehole
- Test Pit

- Colluvium
- Fluvial
- Glaciolacustrine
- Organic
- Till
- Waterbody

See Index Map A.4.0 for full key.

Dominant subsurface material and expression; glaciolacustrine (LG); plain (p)

Secondary surficial material and surface expression; fluvial (F); plain (p)

Ob[LGp] / Fp – U

Dominant surficial material and surface expression; organic (O); blanket (b)

Geomorphological process; inundation (U)

0 500 1,000 m

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Notes

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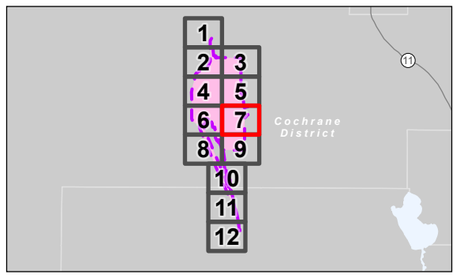

Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.7

Title
Terrain Mapbook

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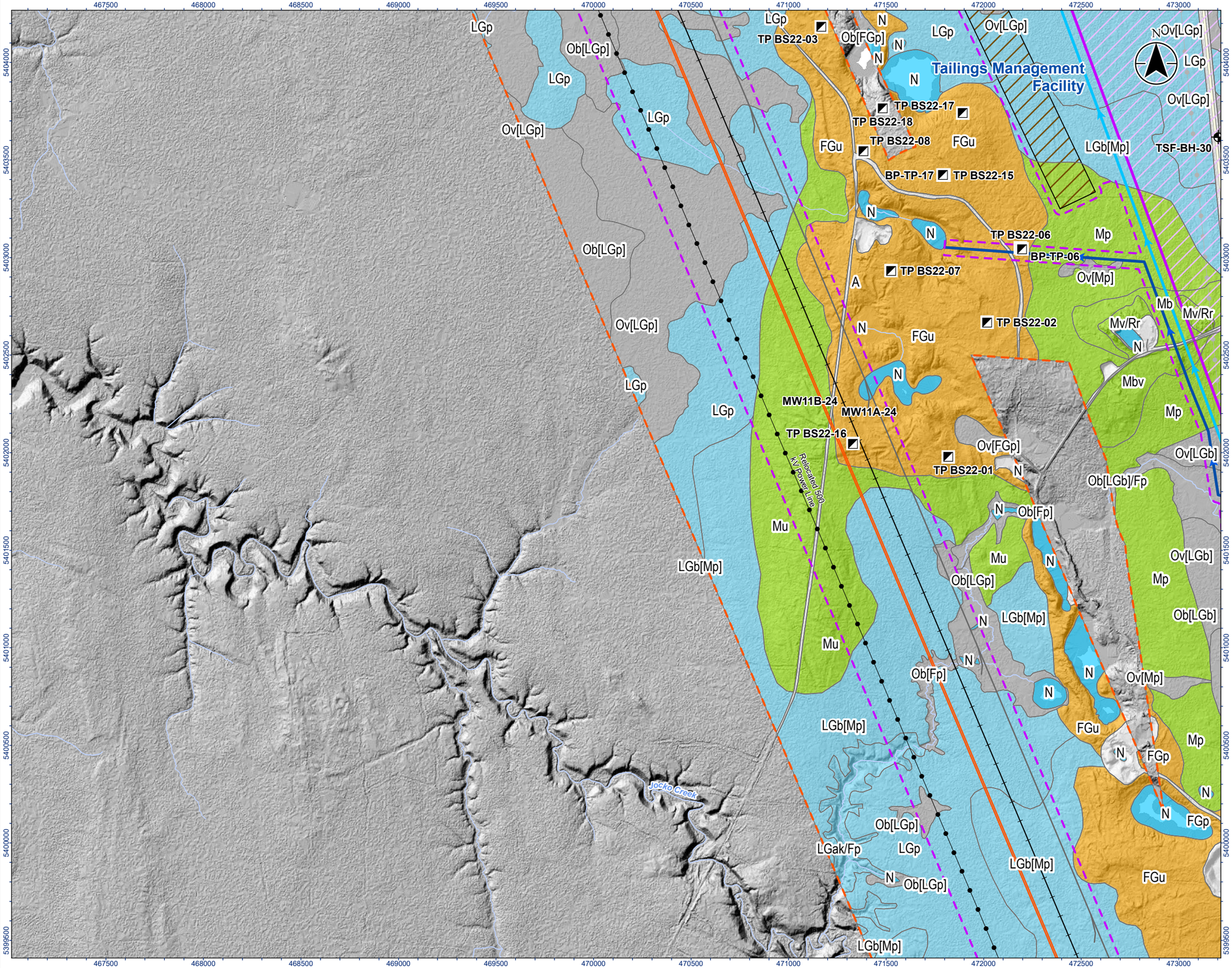

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Non Contact Diversion Channel Centerline
- Transmission Line
- Rail Line
- Relocated Hwy 655 ROW
- Site Ditch Centerline
- Site Road Centerline
- Tailings Management Facility
- Reclaim Stockpile
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse

Boreholes

- Monitoring Well
- Test Pit

- Anthropogenic
- Glaciofluvial
- Glaciolacustrine
- Organic
- Till
- Waterbody

See Index Map A.4.0 for full key.

Dominant subsurface material and expression; glaciolacustrine (LG); plain (p)

Secondary surficial material and surface expression; fluvial (F); plain (p)

Ob[LGp] / Fp – U

Dominant surficial material and surface expression; organic (O); blanket (b)

Geomorphological process; inundation (U)

0 500 1,000 m

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Notes

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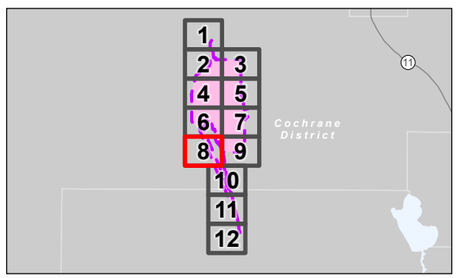

Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.8

Title
Terrain Mapbook

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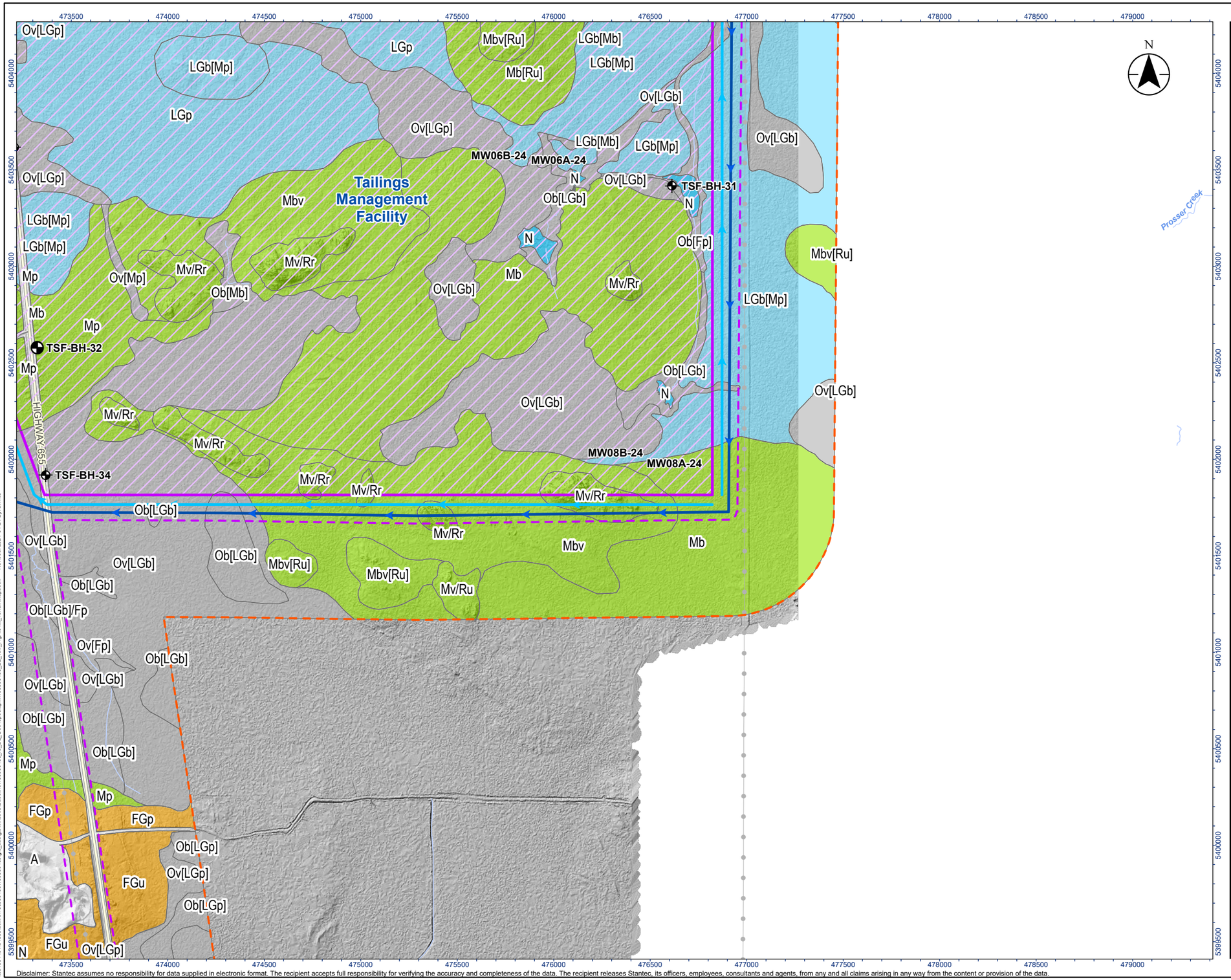

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Non Contact Diversion Channel Centerline
- Site Ditch Centerline
- Tailings Management Facility
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse

Boreholes

- Monitoring Well
- Borehole

- Anthropogenic
- Glaciofluvial
- Glaciolacustrine
- Organic
- Till
- Waterbody

See Index Map A.4.0 for full key.

Dominant subsurface material and expression; glaciolacustrine (LG); plain (p)

Secondary surficial material and surface expression; fluvial (F); plain (p)

Ob[LGp] / Fp – U

Dominant surficial material and surface expression; organic (O); blanket (b)

Geomorphological process; inundation (U)

0 500 1,000 m

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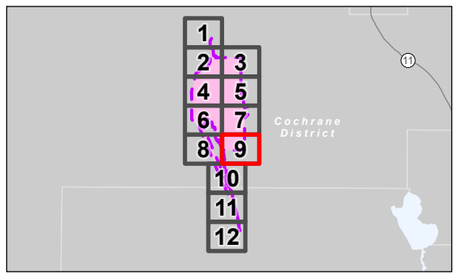

Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.9

Title
Terrain Mapbook

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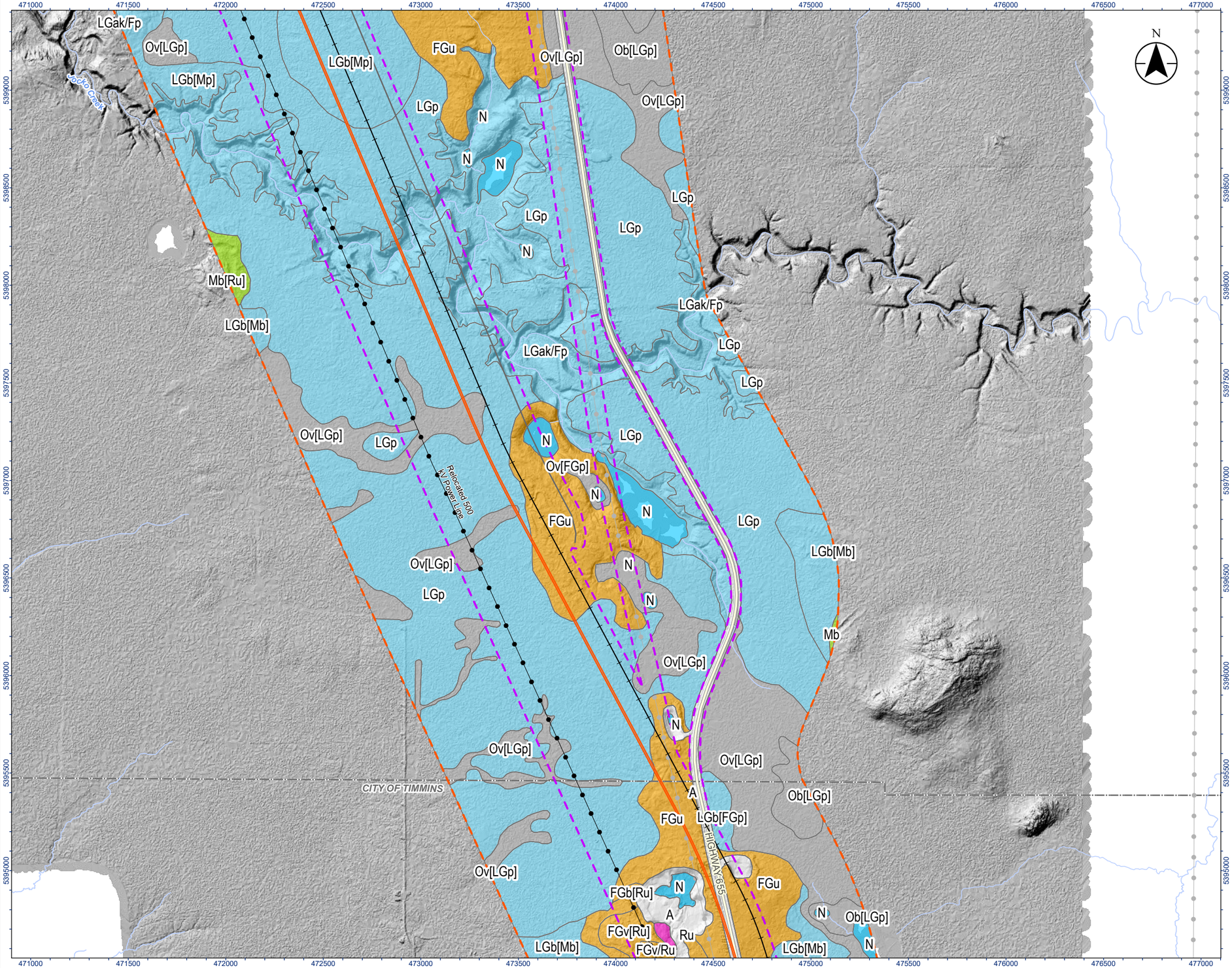

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Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area
- Municipal Boundary - Lower Tier

Major Project Components

- Transmission Line
- Rail Line
- Relocated Hwy 655 ROW
- Site Road Centerline
- Major Road
- Existing Transmission Line
- Watercourse

- Anthropogenic
- Bedrock
- Glaciofluvial
- Glaciolacustrine
- Organic
- Till
- Waterbody

See Index Map A.4.0 for full key.

Dominant subsurface material and expression; glaciolacustrine (LG); plain (p)

Secondary surficial material and surface expression; fluvial (F); plain (p)

Ob[LGp] / Fp – U

Dominant surficial material and surface expression; organic (O); blanket (b)

Geomorphological process; inundation (U)

0 500 1,000 m

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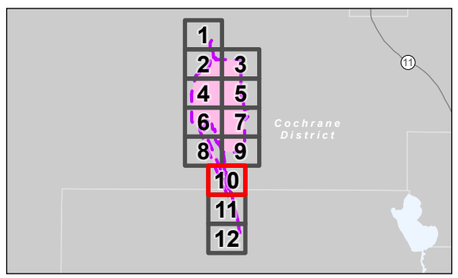

Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.10

Title
Terrain Mapbook

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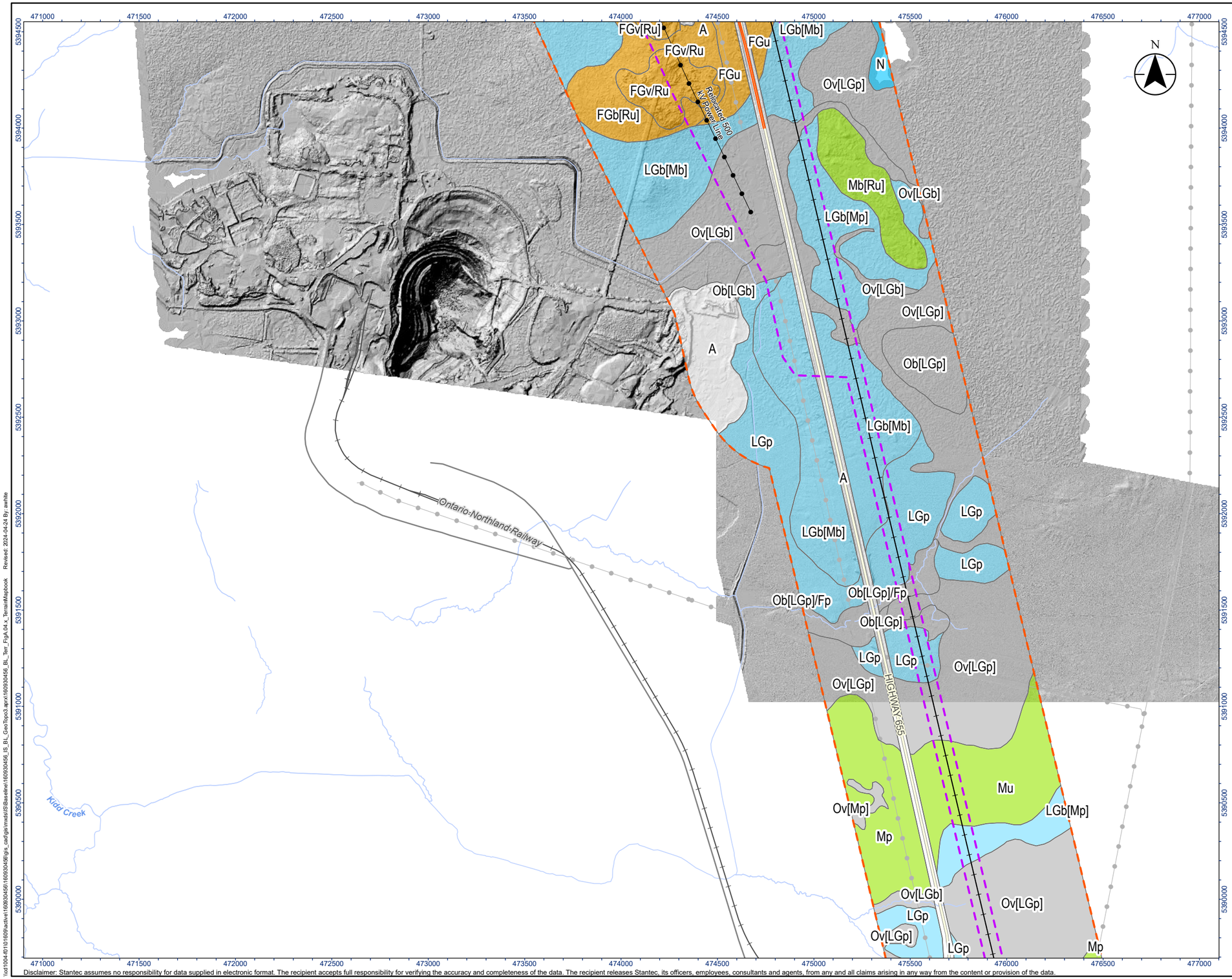

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Transmission Line
- Rail Line
- Relocated Hwy 655 ROW
- Major Road
- Minor Road
- Railway
- Existing Transmission Line
- Watercourse
- Municipal Boundary - Lower Tier
- Anthropogenic
- Glaciofluvial
- Glaciolacustrine
- Organic
- Till
- Waterbody

See Index Map A.4.0 for full key.

Dominant subsurface material and expression; glaciolacustrine (LG); plain (p)

Secondary surficial material and surface expression; fluvial (F); plain (p)

Ob[LGp] / Fp – U

Dominant surficial material and surface expression; organic (O); blanket (b)

Geomorphological process; inundation (U)

0 500 1,000 m

1:20,000 (At original document size of 11x17)

Notes

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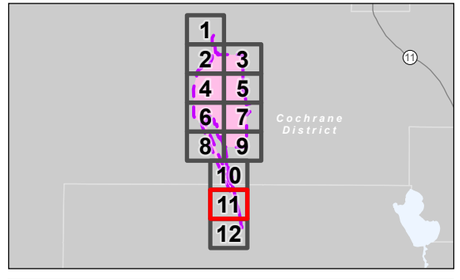

Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.11

Title
Terrain Mapbook

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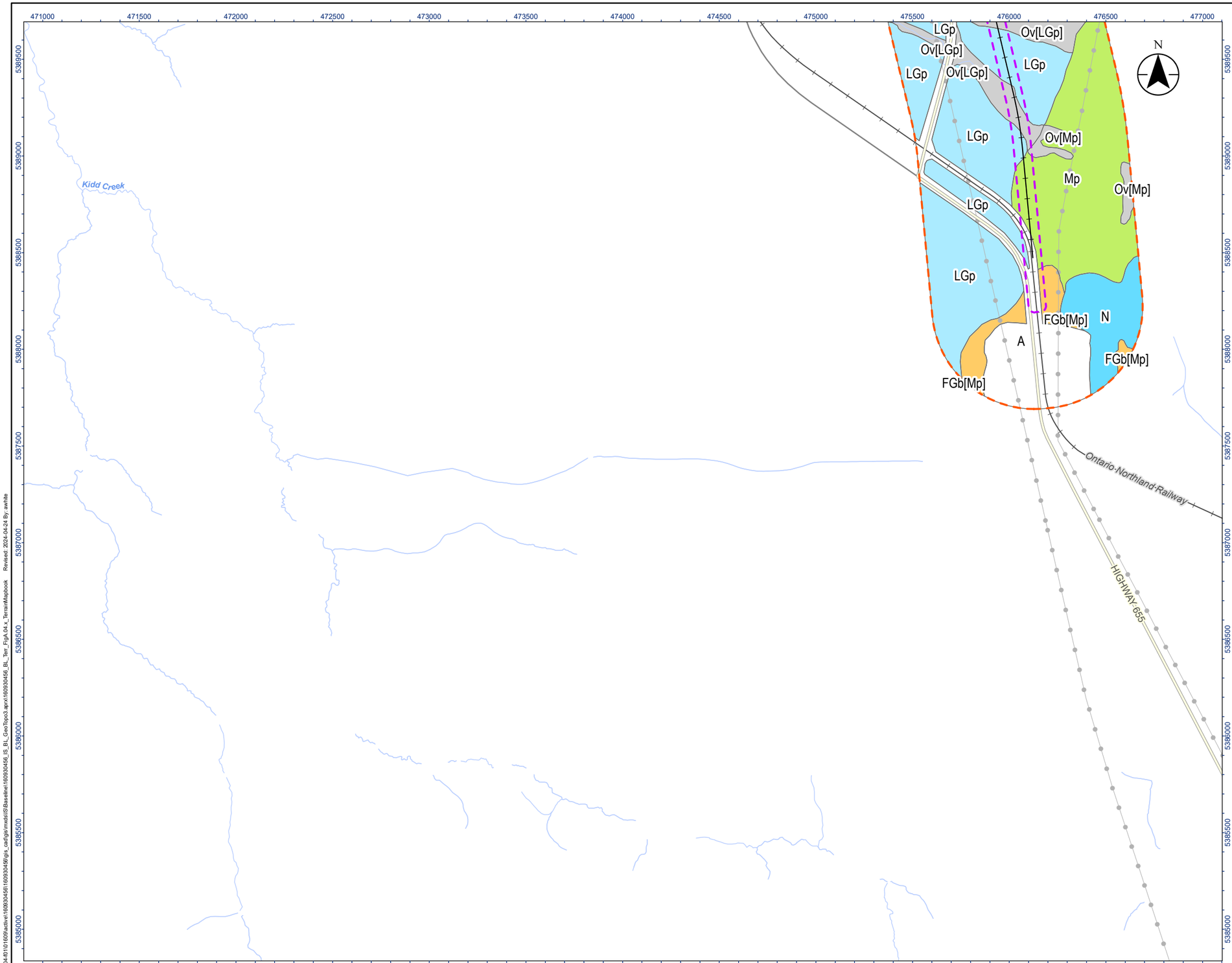

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area
- Municipal Boundary - Lower Tier

Major Project Components

- Rail Line
- Major Road
- Minor Road
- Railway
- Existing Transmission Line
- Watercourse

- Anthropogenic
- Glaciofluvial
- Glaciolacustrine
- Organic
- Till
- Waterbody

See Index Map A.4.0 for full key.

Dominant subsurface material and expression; glaciolacustrine (LG); plain (p)

Secondary surficial material and surface expression; fluvial (F); plain (p)

Ob[LGp] / Fp – U

Dominant surficial material and surface expression; organic (O); blanket (b)

Geomorphological process; inundation (U)

0 500 1,000 m

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Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
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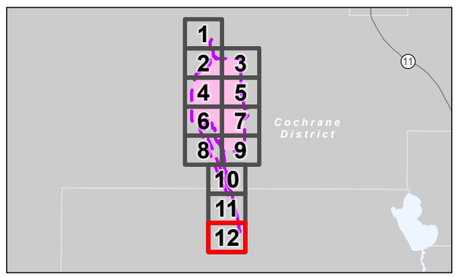


Project Location
Timmins, Ontario

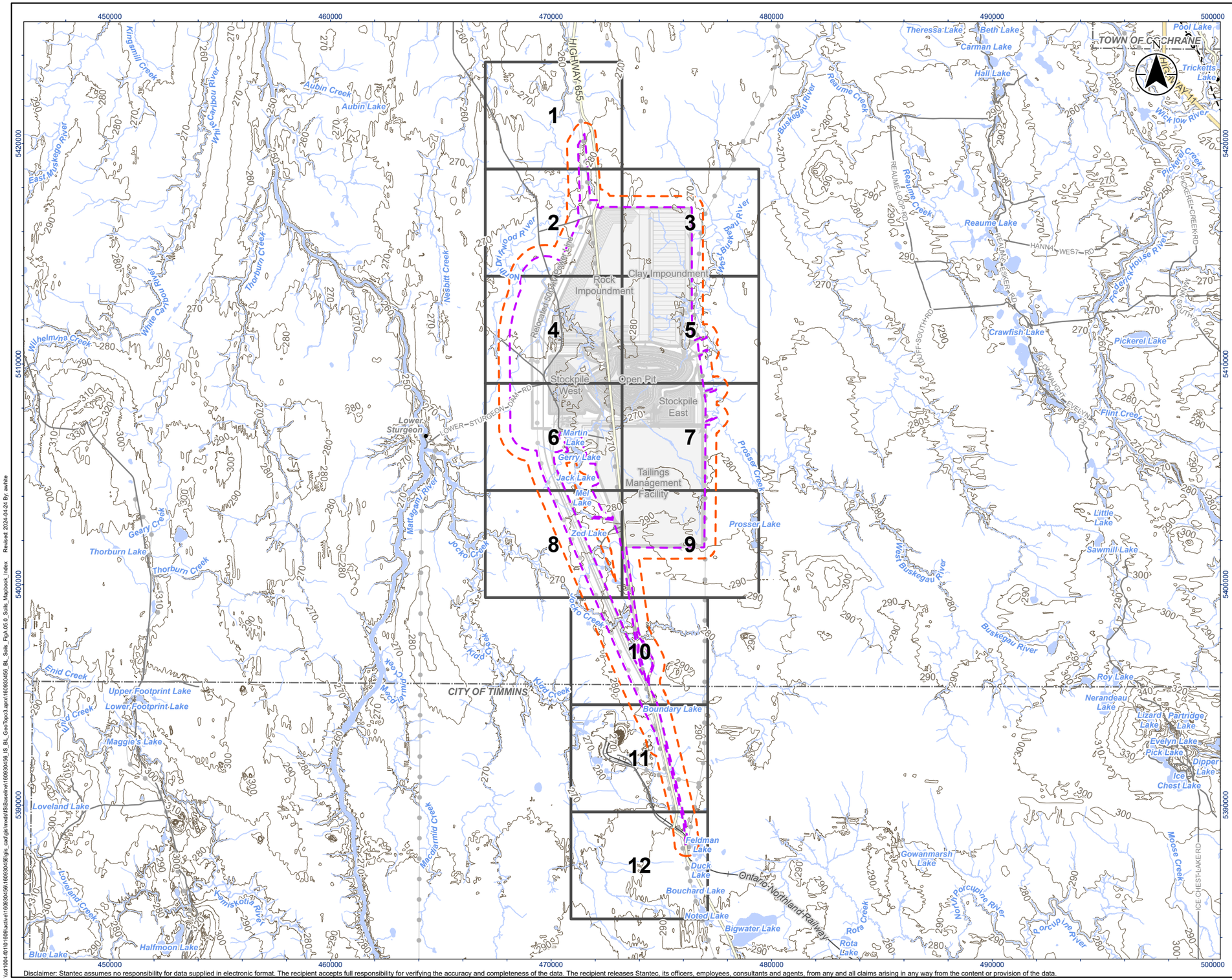
160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.4.12

Title
Terrain Mapbook

\\cd1004-f01\01609\active\160903456\160930456\gis_cad\gis\mxds\ISBaseline\160930456_IS_BL_CreoTopo3.aprx\160930456_BL_Ter_Fig\A.04.x_TerrainMapbook Revised: 2024-04-24 By: awhite



Stantec

CANADA NICKEL COMPANY

Legend

- Mapbook Index
- Project Area
- Local/Regional Study Area
- Contour (10 m Interval)
- Expressway / Highway
- Major Road
- Minor Road
- Railway
- Existing Transmission Line
- -GAS- Natural Gas Pipeline
- Watercourse
- Municipal Boundary - Lower Tier
- Waterbody

0 2.5 5 km

1:175,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
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Project Location
Timmins, Ontario

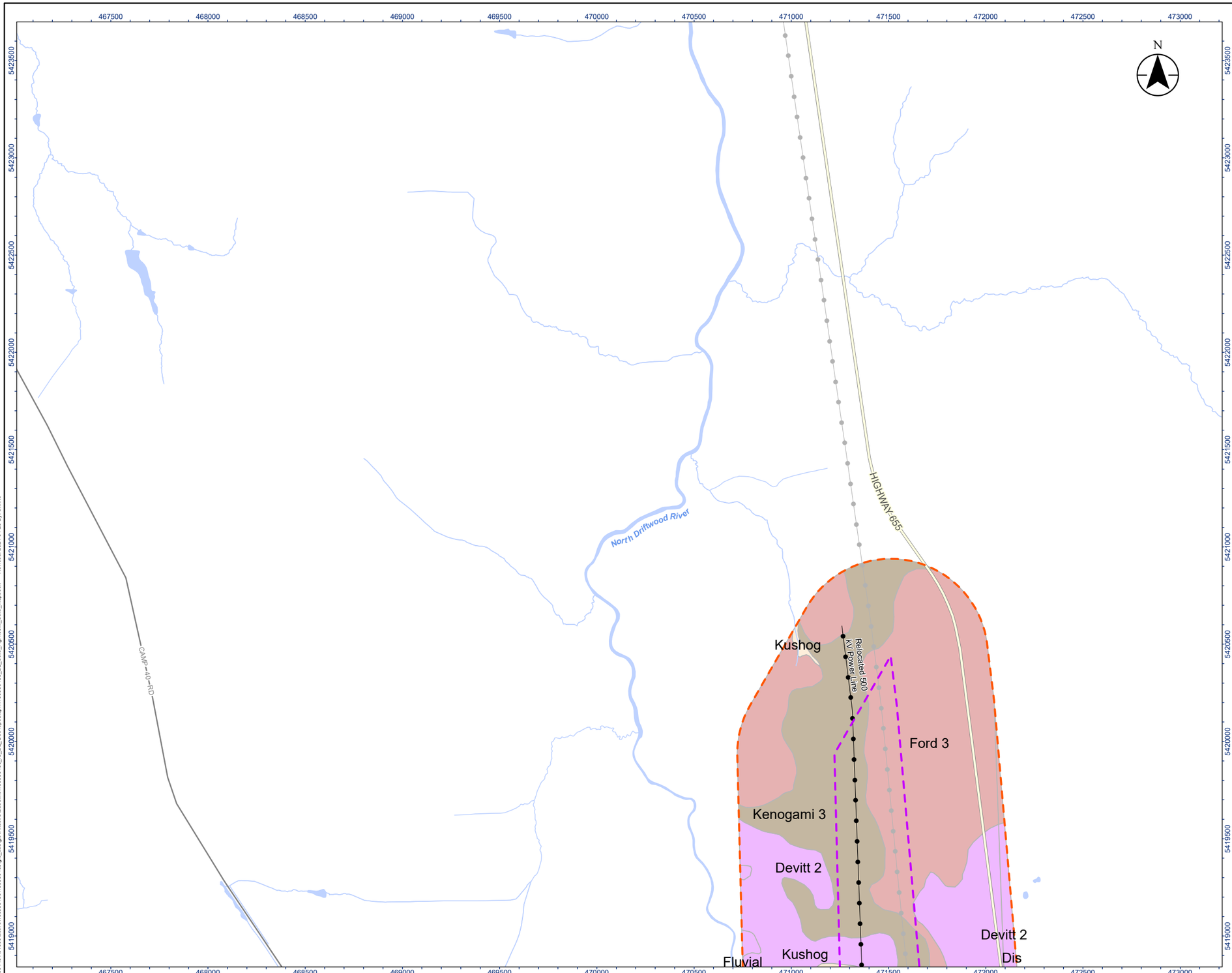
160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.0

Title
Soil Management Unit (SMU) Mapbook Index

\\cn1004-f01\01609\active\160903456\160903456gis_cad\gis\mxd\ISBaseline\160903456_IS_BL_CanTopo3.aprx\160903456_BL_Soils_Fig5.05.0_Soils_Mapbook_Index Revised: 2024-04-24 By: awhite



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Transmission Line
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody

Soil Management Units

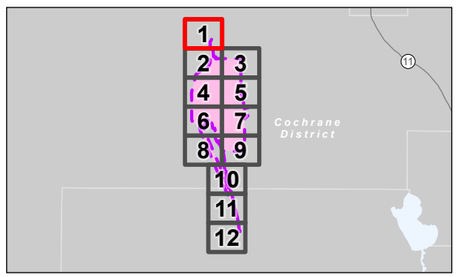
- Devitt 2
- Dis
- Fluvial
- Ford 3
- Kenogami 3
- Kushog

0 500 1,000 m

1:20,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © King's Printer for Ontario, 2023.



Project Location
Timmins, Ontario

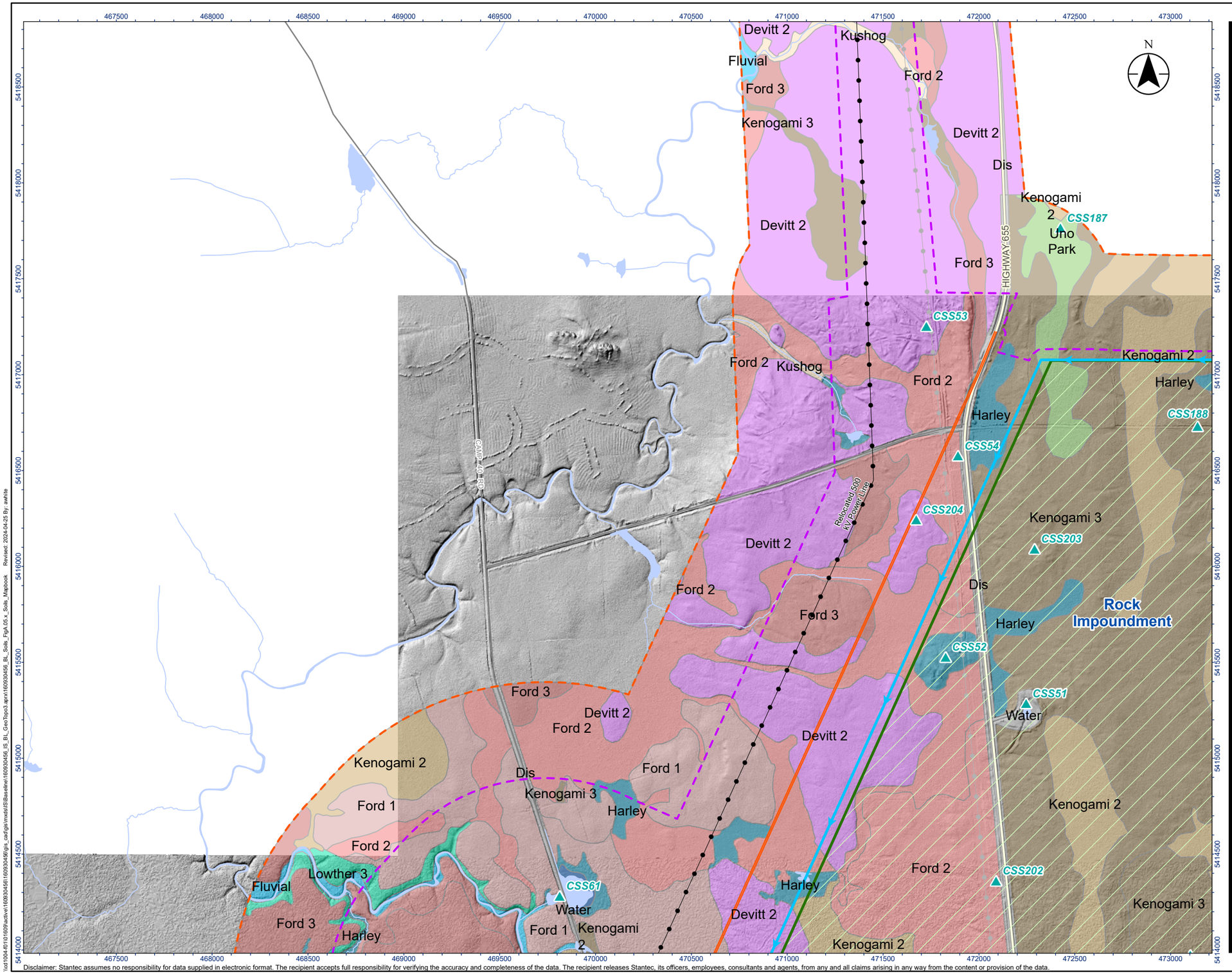
160903456 REVA
Prepared by awhite on 2024-04-25

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.1

Title
Soil Management Unit (SMU) Mapbook

\\ca1004-f01\01609\active\160903456\160903456\gis_cad\gis\mxd\SI\Baseline\160903456_IS_BL_GeoTopo3.aprx\160903456_BL_Soils_FigA.05.x_Soils_Mapbook Revised: 2024-04-25 By: awhite



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Transmission Line
- Relocated Hwy 655 ROW
- Site Ditch Centerline
- Rock Impoundment
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody
- Soil Survey Location

Soil Management Units

- Devitt 2
- Dis
- Fluvial
- Ford 1
- Ford 2
- Ford 3
- Harley
- Kenogami 2
- Kenogami 3
- Kushog
- Larder
- Lowther 3
- Uno Park
- Water

0 500 1,000 m

1:20,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
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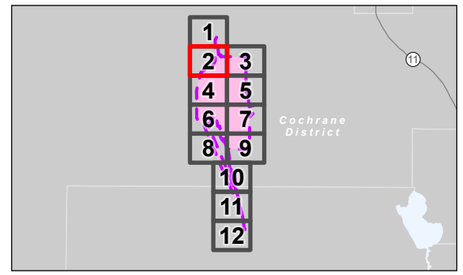

Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-25

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.2

Title
Soil Management Unit (SMU) Mapbook

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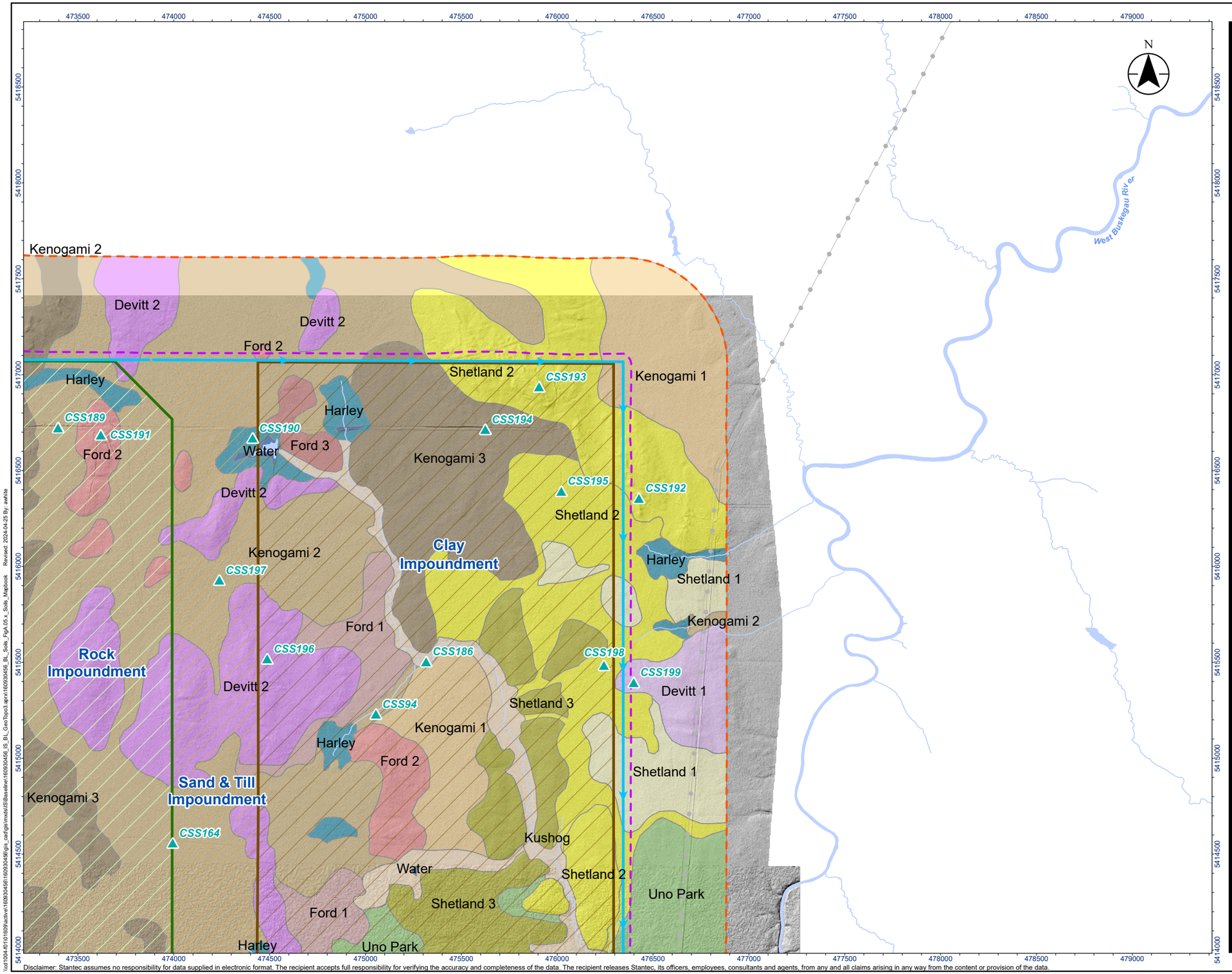

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Site Ditch Centerline
- Clay Impoundment
- Rock Impoundment
- Sand & Till Impoundment
- Existing Transmission Line
- Watercourse
- Waterbody
- Soil Survey Location

Soil Management Units

- Devitt 1
- Devitt 2
- Ford 1
- Ford 2
- Ford 3
- Harley
- Kenogami 1
- Kenogami 2
- Kenogami 3
- Kushog
- Shetland 1
- Shetland 2
- Shetland 3
- Uno Park
- Water

0 500 1,000 m

1:20,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
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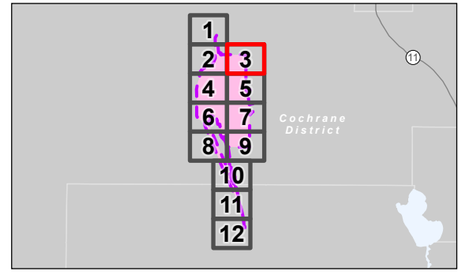

Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-25

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.3

Title
Soil Management Unit (SMU) Mapbook

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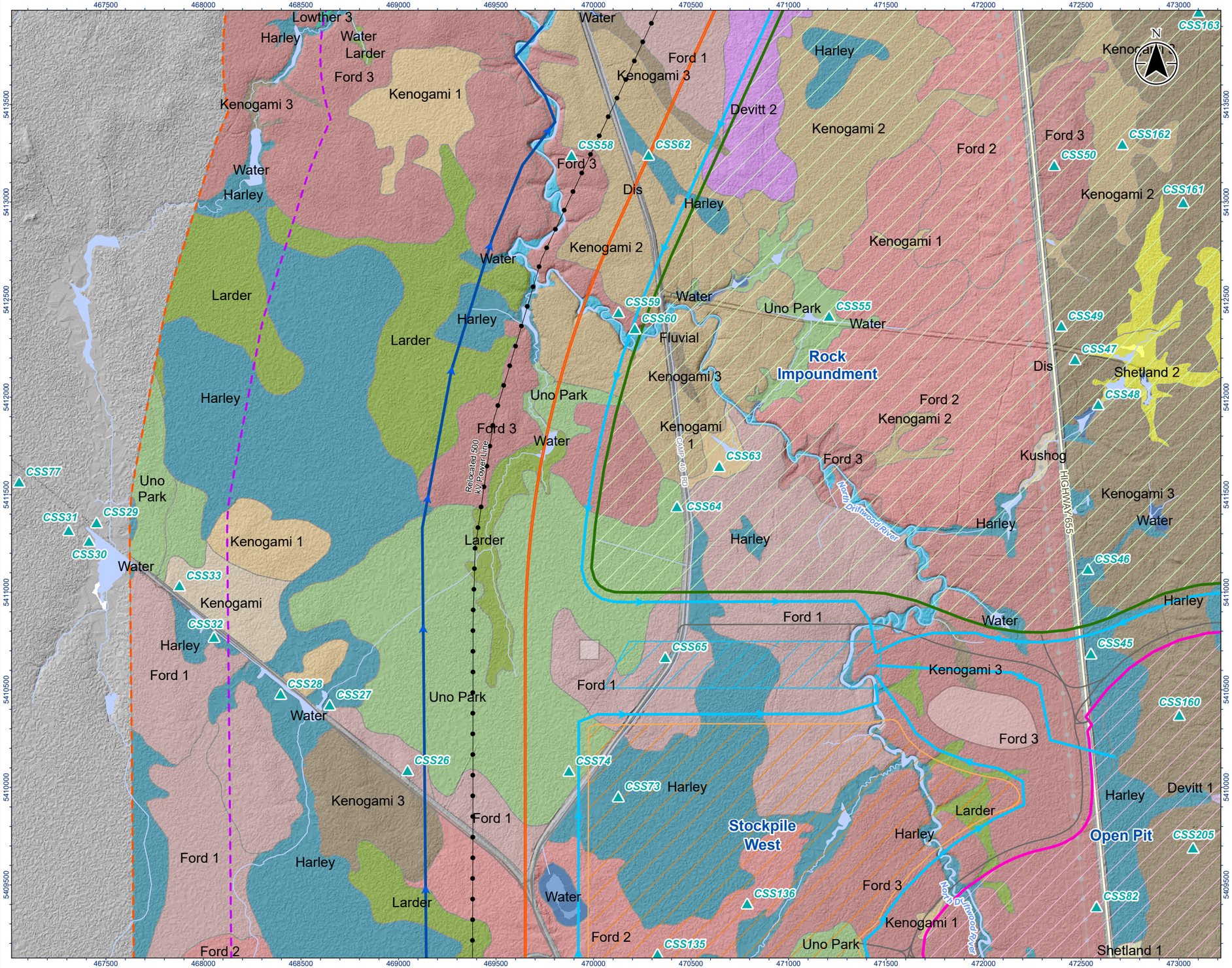


Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Non Contact Diversion Channel Centerline
- Transmission Line
- Relocated Hwy 655 ROW
- Site Ditch Centerline
- Site Road Centerline
- Building
- Low Grade Ore Stockpile
- Open Pit
- Pond
- Rock Impoundment
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody
- Soil Survey Location

Soil Management Units

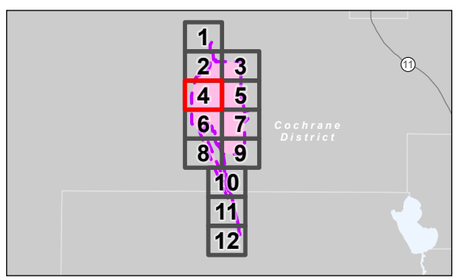
- Devitt 1
- Devitt 2
- Dis
- Fluvial
- Ford 1
- Ford 2
- Ford 3
- Harley
- Kenogami
- Kenogami 1
- Kenogami 2
- Kenogami 3
- Kushog
- Larder
- Lowther 3
- Shetland 1
- Shetland 2
- Uno Park
- Water

0 500 1,000 m

1:20,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © King's Printer for Ontario, 2023.



Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-25

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.4

Title
Soil Management Unit (SMU) Mapbook

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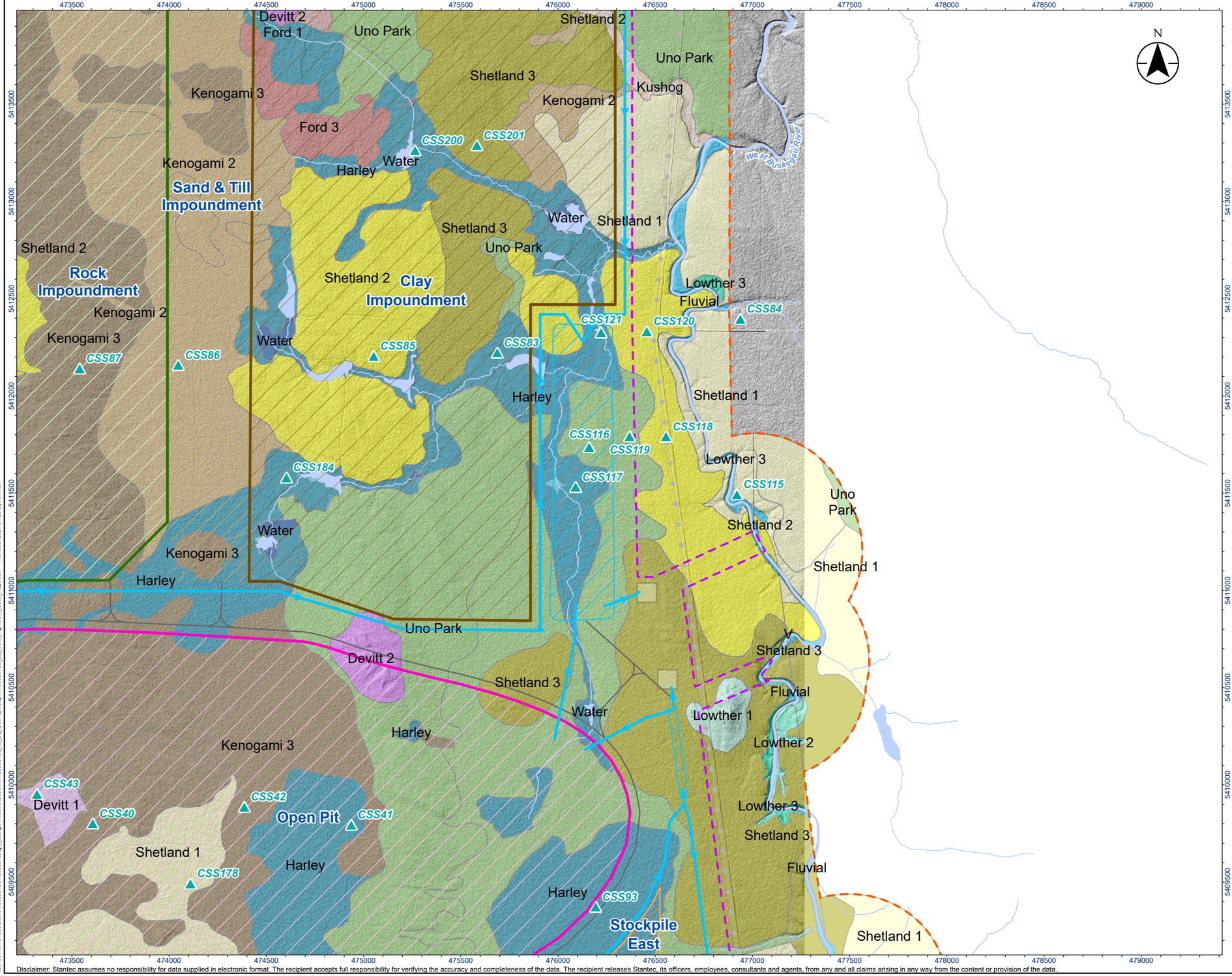

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Site Ditch Centerline
- Site Road Centerline
- Building
- Low Grade Ore Stockpile
- Open Pit
- Clay Impoundment
- Pond
- Rock Impoundment
- Sand & Till Impoundment
- Existing Transmission Line
- Watercourse
- Waterbody
- Soil Survey Location

Soil Management Units

- Devitt 1
- Devitt 2
- Fluvial
- Ford 1
- Ford 3
- Harley
- Kenogami 2
- Kenogami 3
- Kushog
- Lowther 1
- Lowther 2
- Lowther 3
- Shetland 1
- Shetland 2
- Shetland 3
- Uno Park
- V
- Water

0 500 1,000 m

1:20,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
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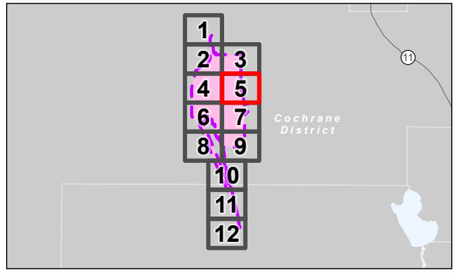

Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-25

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.5

Title
Soil Management Unit (SMU) Mapbook

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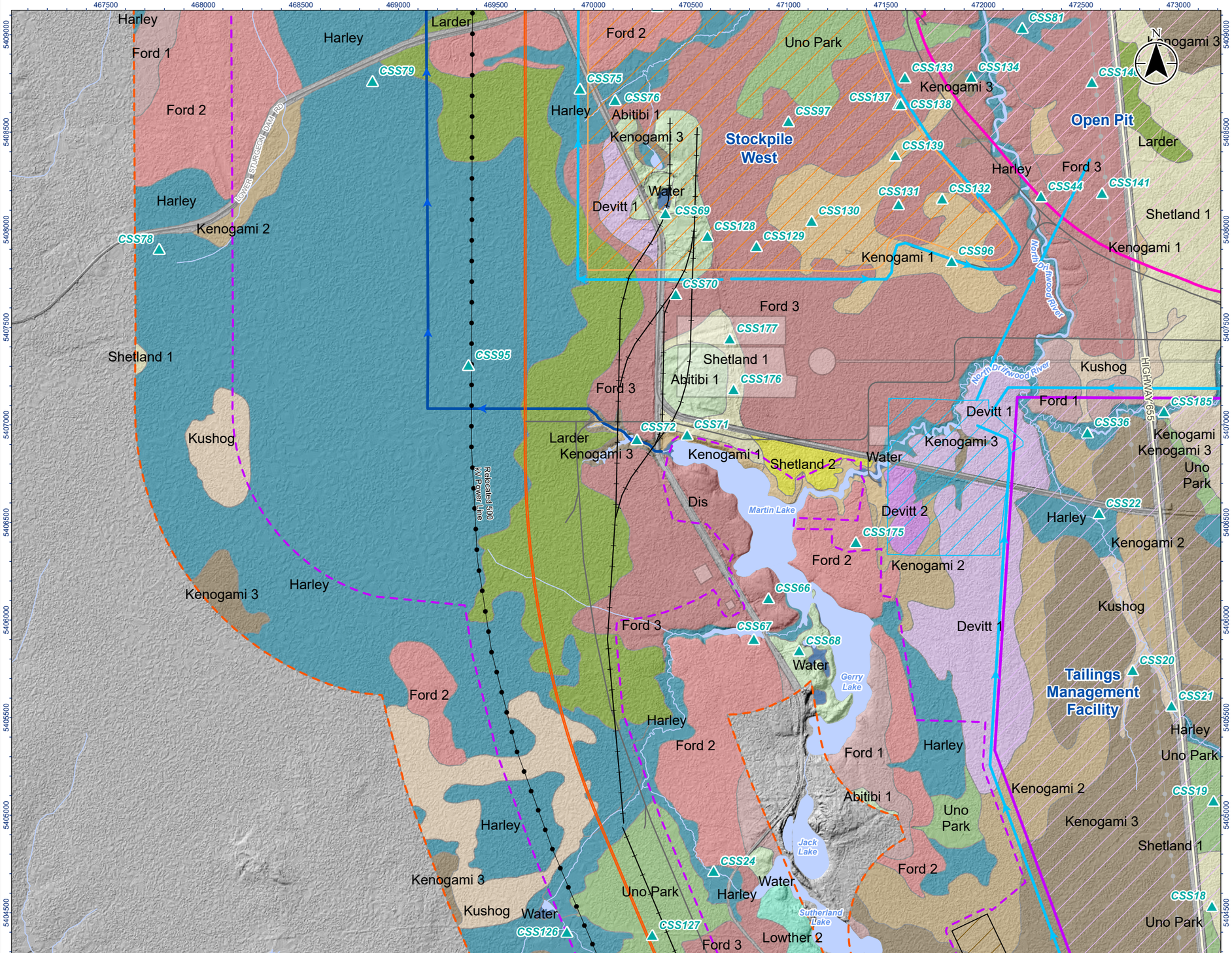


Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Non Contact Diversion Channel Centerline
- Transmission Line
- Rail Line
- Relocated Hwy 655 ROW
- Site Ditch Centerline
- Site Road Centerline
- Building
- Low Grade Ore Stockpile
- Open Pit
- Pond
- Tailings Management Facility
- Reclaim Stockpile
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody
- Soil Survey Location

Soil Management Units

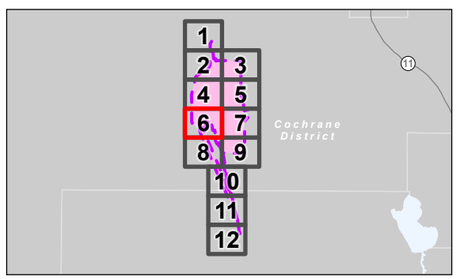
- Abitibi 1
- Devitt 1
- Devitt 2
- Dis
- Ford 1
- Ford 2
- Ford 3
- Harley
- Kenogami
- Kenogami 1
- Kenogami 2
- Kenogami 3
- Kushog
- Larder
- Lowther 2
- Shetland 1
- Shetland 2
- Uno Park
- Water

0 500 1,000 m

1:20,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © King's Printer for Ontario, 2023.



Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-25

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.6

Title
Soil Management Unit (SMU) Mapbook

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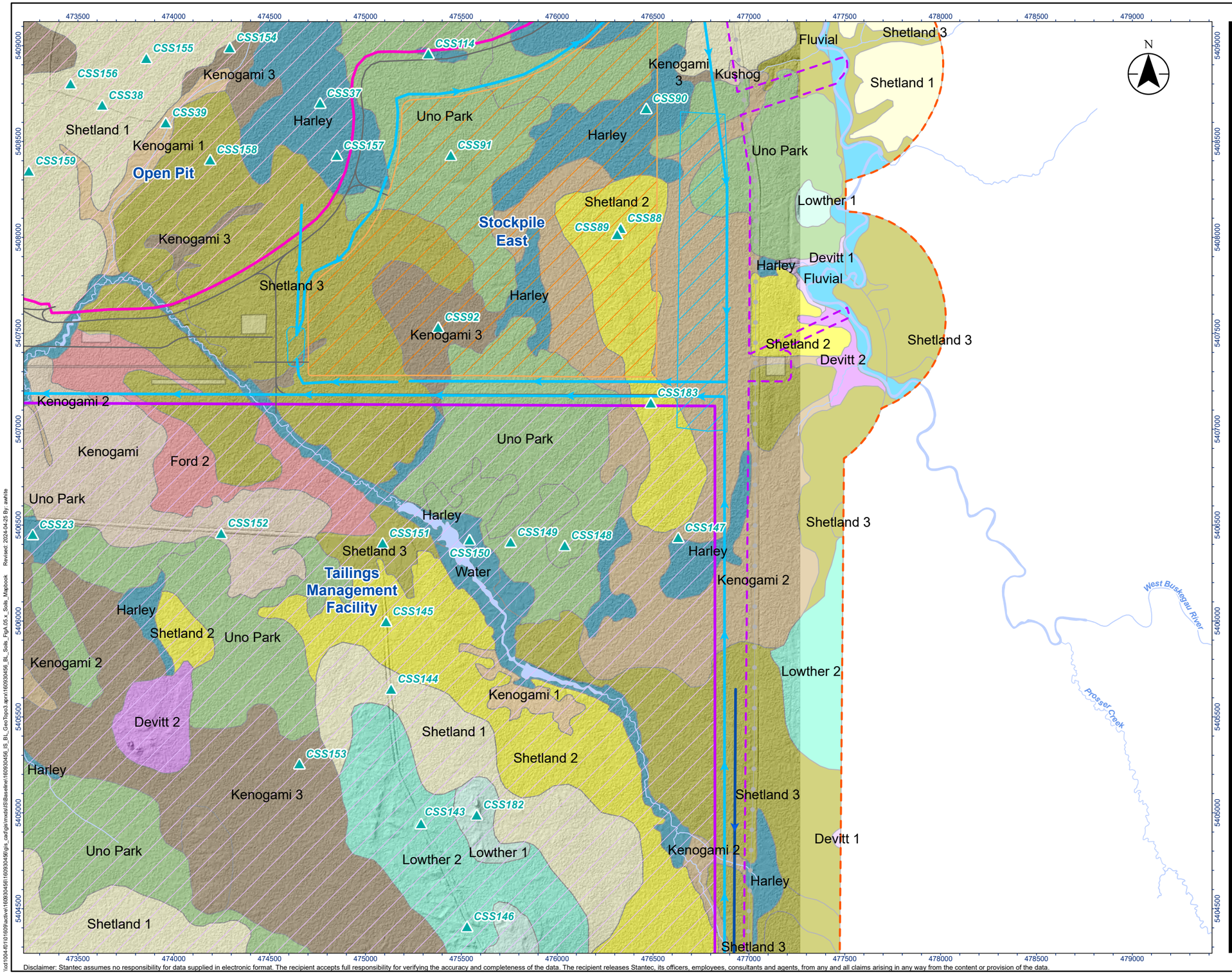


Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Non Contact Diversion Channel Centerline
- Site Ditch Centerline
- Site Road Centerline
- Building
- Low Grade Ore Stockpile
- Open Pit
- Pond
- Tailings Management Facility
- Existing Transmission Line
- Watercourse
- Waterbody
- Soil Survey Location

Soil Management Units

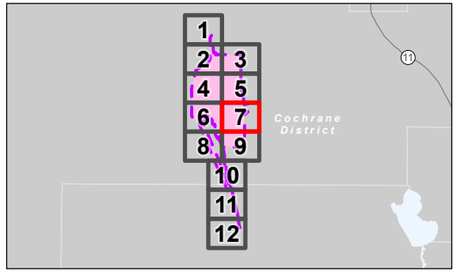
- Devitt 1
- Devitt 2
- Fluvial
- Ford 2
- Harley
- Kenogami
- Kenogami 1
- Kenogami 2
- Kenogami 3
- Kushog
- Lowther 1
- Lowther 2
- Shetland 1
- Shetland 2
- Shetland 3
- Uno Park
- Water

0 500 1,000 m

1:20,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © King's Printer for Ontario, 2023.



Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-25

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.7

Title
Soil Management Unit (SMU) Mapbook

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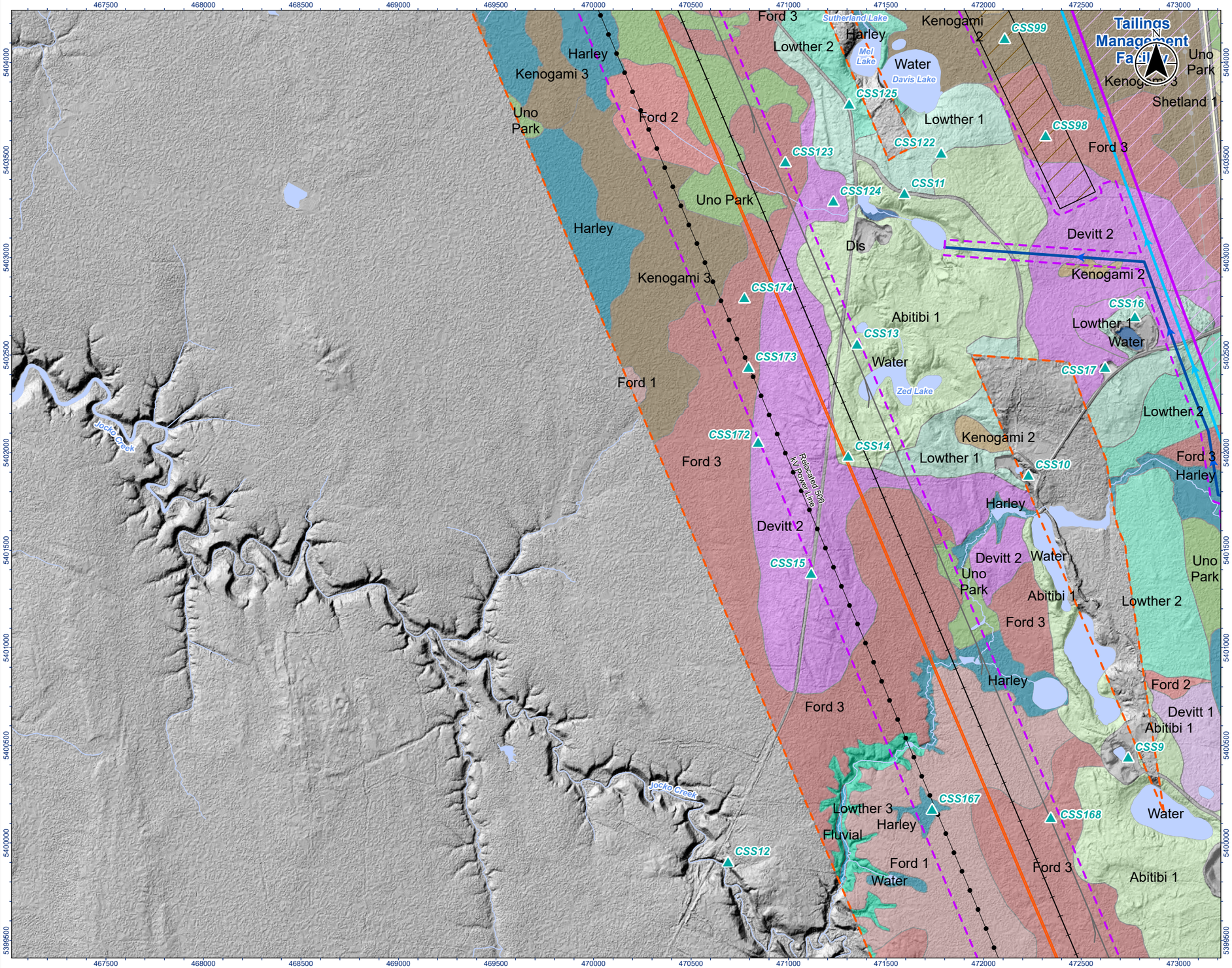


Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Non Contact Diversion Channel Centerline
- Transmission Line
- Rail Line
- Relocated Hwy 655 ROW
- Site Ditch Centerline
- Site Road Centerline
- Tailings Management Facility
- Reclaim Stockpile
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody
- Soil Survey Location

Soil Management Units

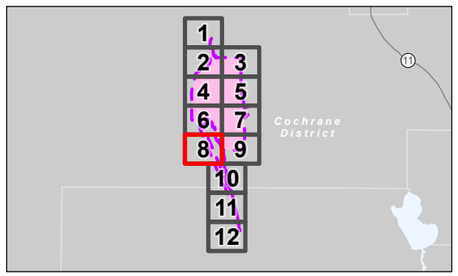
- Abitibi 1
- Devitt 1
- Devitt 2
- Dis
- Fluvial
- Ford 1
- Ford 2
- Ford 3
- Harley
- Kenogami 2
- Kenogami 3
- Lowther 1
- Lowther 2
- Lowther 3
- Shetland 1
- Uno Park
- Water

0 500 1,000 m

1:20,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © King's Printer for Ontario, 2023.



Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-25

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.8

Title
Soil Management Unit (SMU) Mapbook

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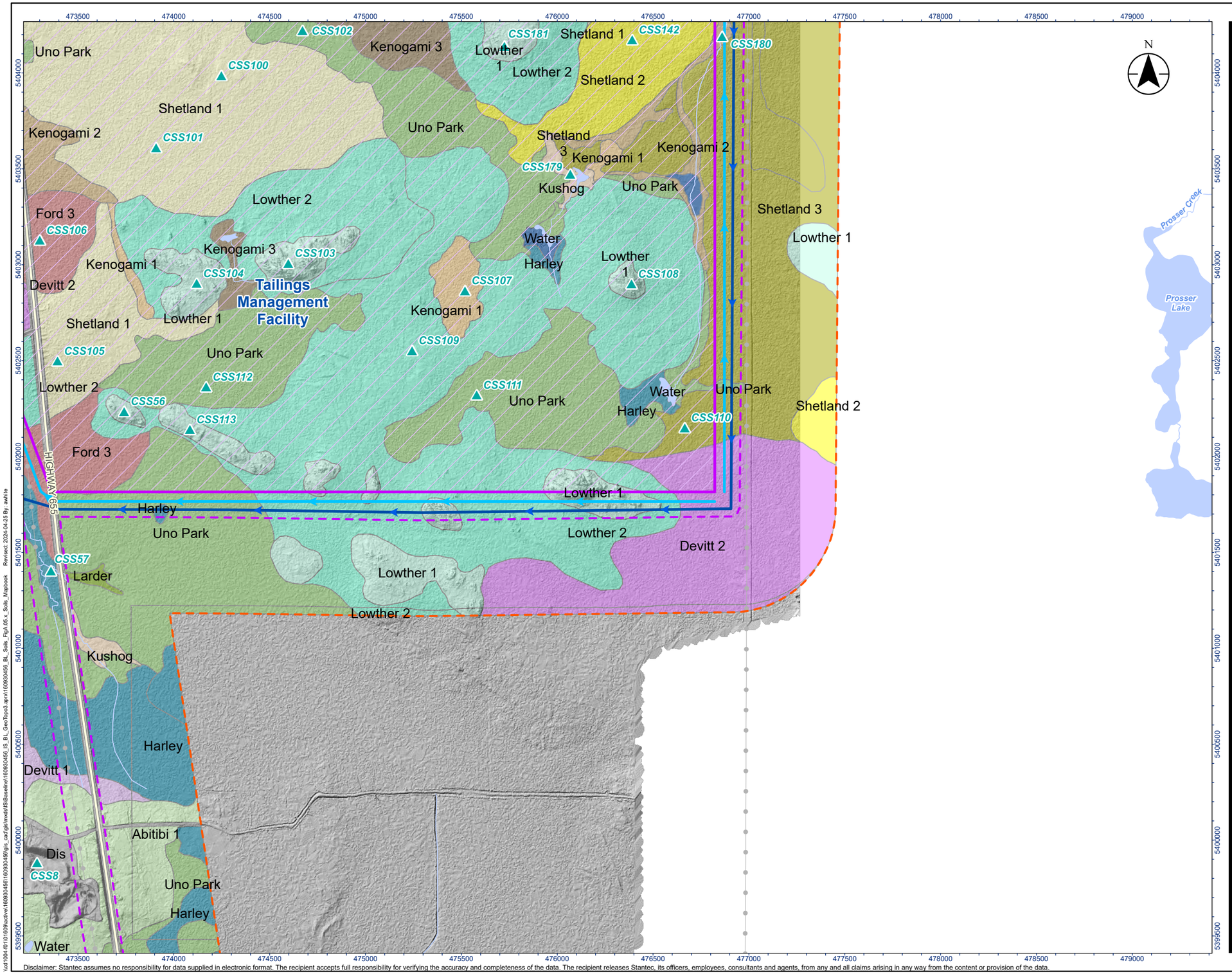


Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Non Contact Diversion Channel Centerline
- Site Ditch Centerline
- Tailings Management Facility
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody
- Soil Survey Location

Soil Management Units

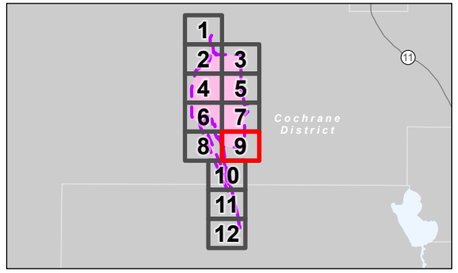
- Abitibi 1
- Devitt 1
- Devitt 2
- Dis
- Ford 3
- Harley
- Kenogami 1
- Kenogami 2
- Kenogami 3
- Kushog
- Larder
- Lowther 1
- Lowther 2
- Shetland 1
- Shetland 2
- Shetland 3
- Uno Park
- Water

0 500 1,000 m

1:20,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © King's Printer for Ontario, 2023.



Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-25

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.9

Title
Soil Management Unit (SMU) Mapbook

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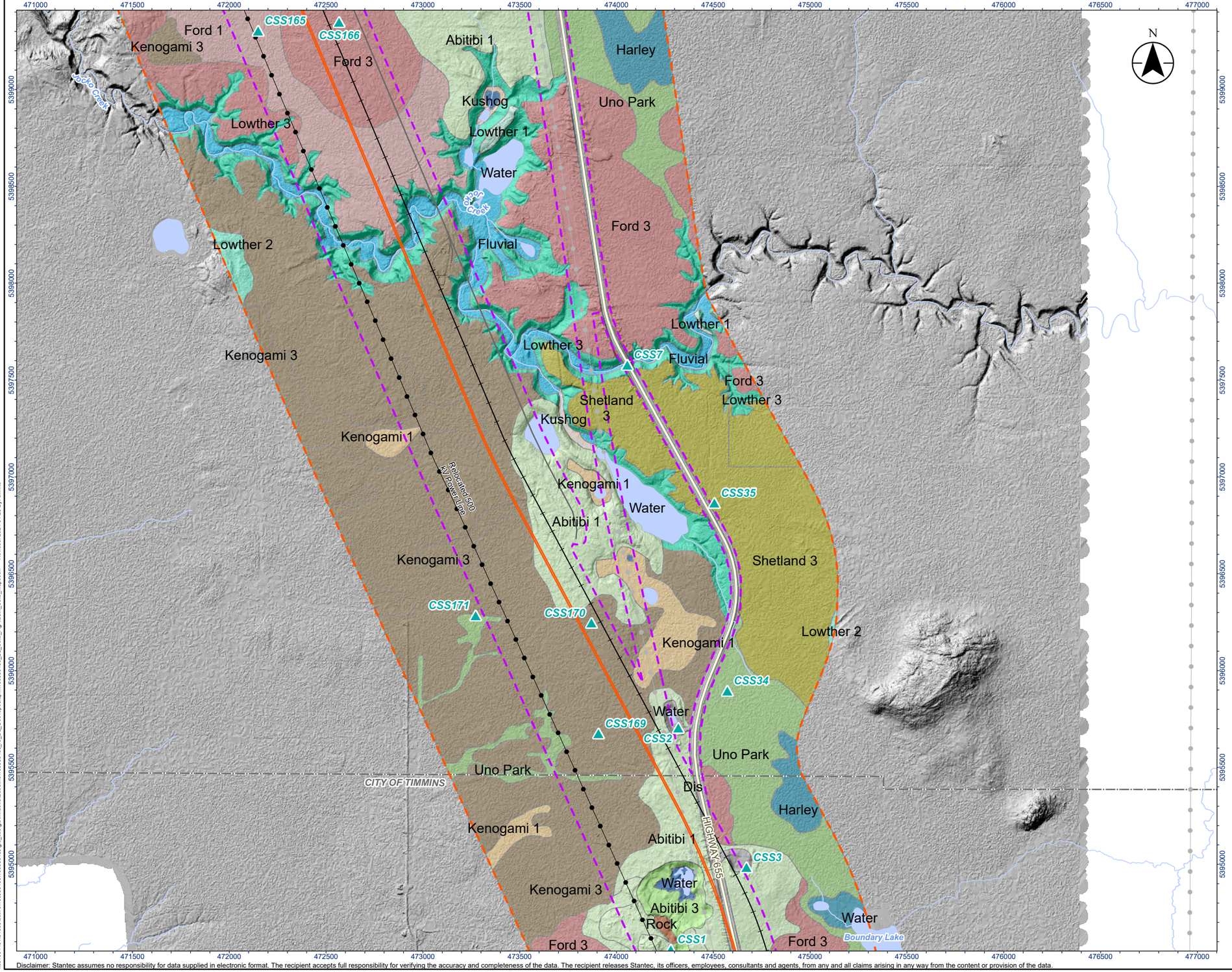


Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Transmission Line
- Rail Line
- Relocated Hwy 655 ROW
- Site Road Centerline
- Major Road
- Existing Transmission Line
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier
- Soil Survey Location

Soil Management Units

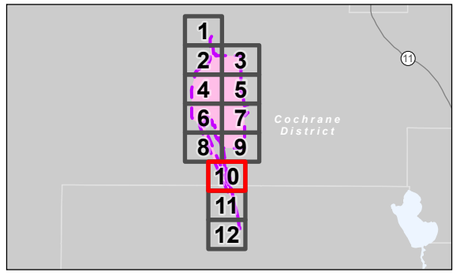
- Abitibi 1
- Abitibi 3
- Dis
- Fluvial
- Ford 1
- Ford 3
- Harley
- Kenogami 1
- Kenogami 3
- Kushog
- Lowther 1
- Lowther 2
- Lowther 3
- Rock
- Shetland 3
- Uno Park
- Water

0 500 1,000 m

1:20,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © King's Printer for Ontario, 2023.



Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-25

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.10

Title
Soil Management Unit (SMU) Mapbook

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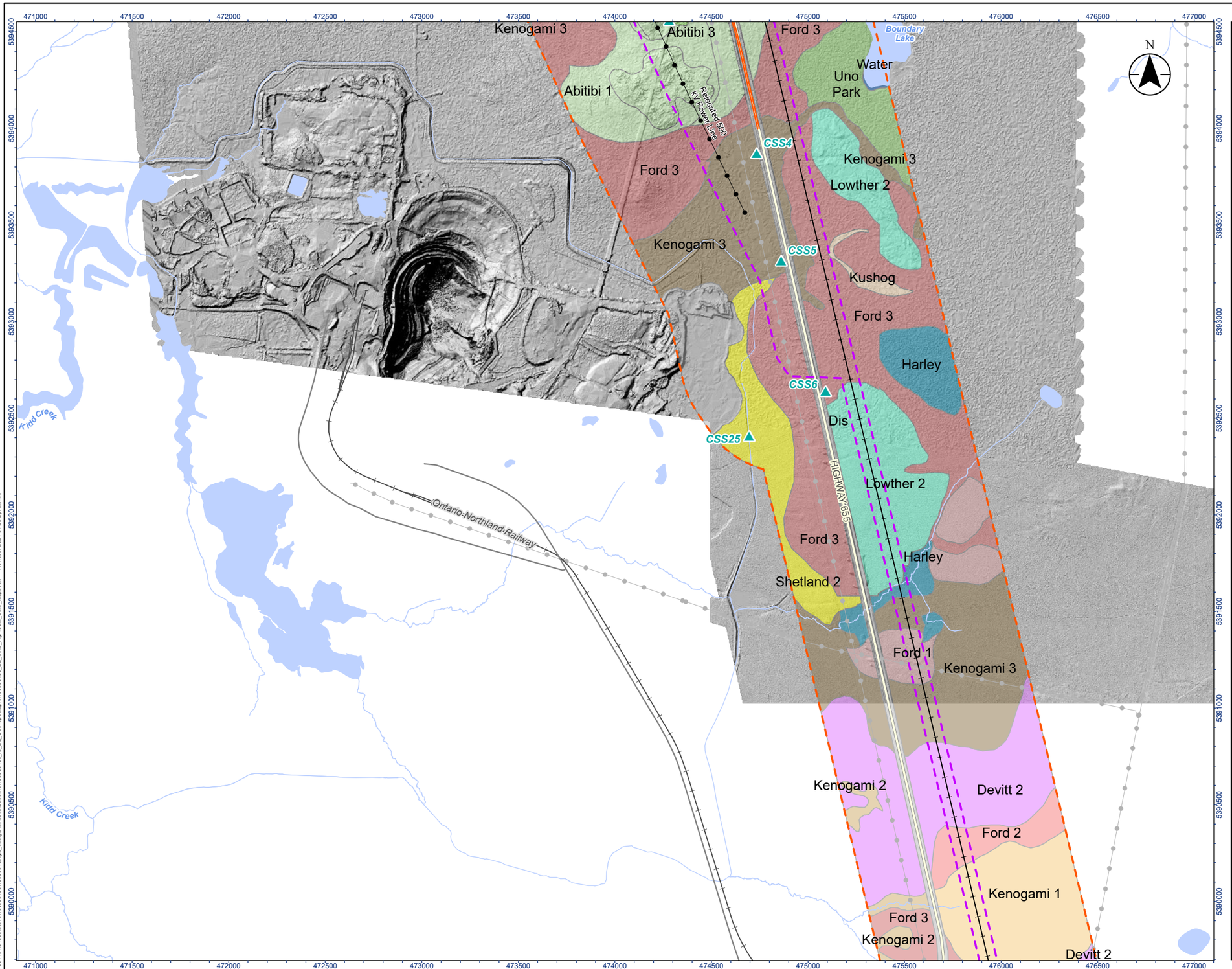

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Transmission Line
- Rail Line
- Relocated Hwy 655 ROW
- Major Road
- Minor Road
- Railway
- Existing Transmission Line
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier
- Soil Survey Location

Soil Management Units

- Abitibi 1
- Abitibi 3
- Devitt 2
- Dis
- Ford 1
- Ford 2
- Ford 3
- Harley
- Kenogami 1
- Kenogami 2
- Kenogami 3
- Kushog
- Lowther 2
- Shetland 2
- Uno Park
- Water

0 500 1,000 m

1:20,000 (At original document size of 11x17)

Notes

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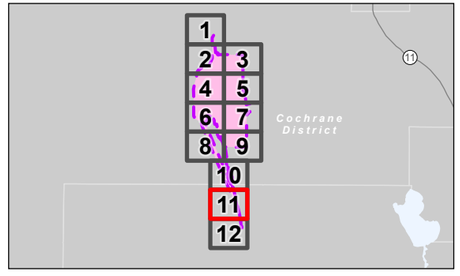


Project Location
Timmins, Ontario

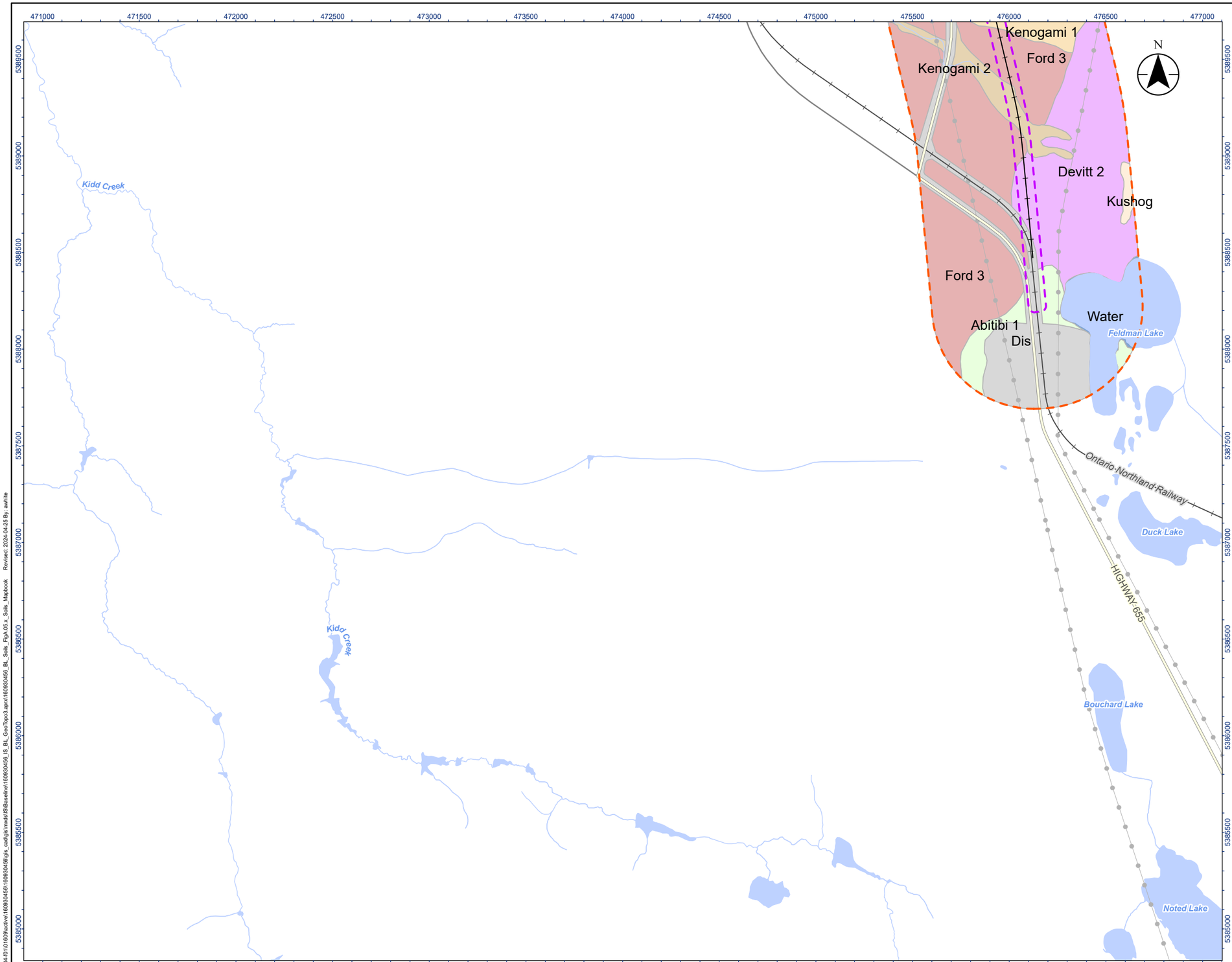
160903456 REVA
Prepared by awhite on 2024-04-25

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.11

Title
Soil Management Unit (SMU) Mapbook

\\cd1004-f01\01609\active\160903456\160903456\gis_cad\gis\mxd\SI\Baseline\160903456_IS_BL_GeoTopo3.aprx\160903456_BL_Soils_FigA.05.x_Soils_Mapbook Revised: 2024-04-25 By: awhite



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Major Project Components

- Rail Line
- Major Road
- Minor Road
- Railway
- Existing Transmission Line
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Soil Management Units

- Abitibi 1
- Devitt 2
- Dis
- Ford 3
- Kenogami 1
- Kenogami 2
- Kushog
- Water

0 500 1,000 m

1:20,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
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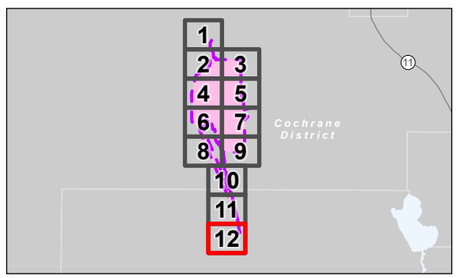


Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-25

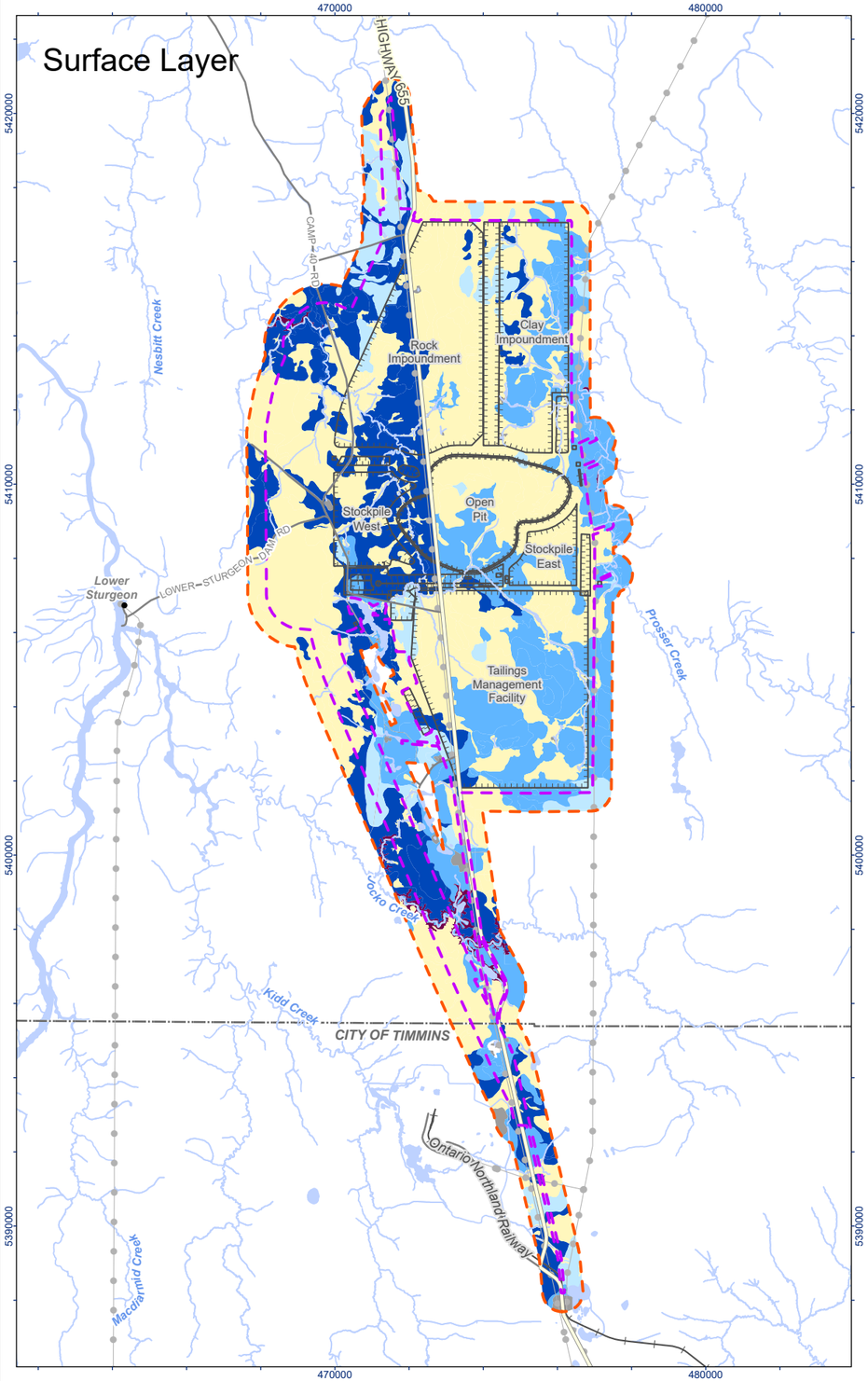
Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.5.12

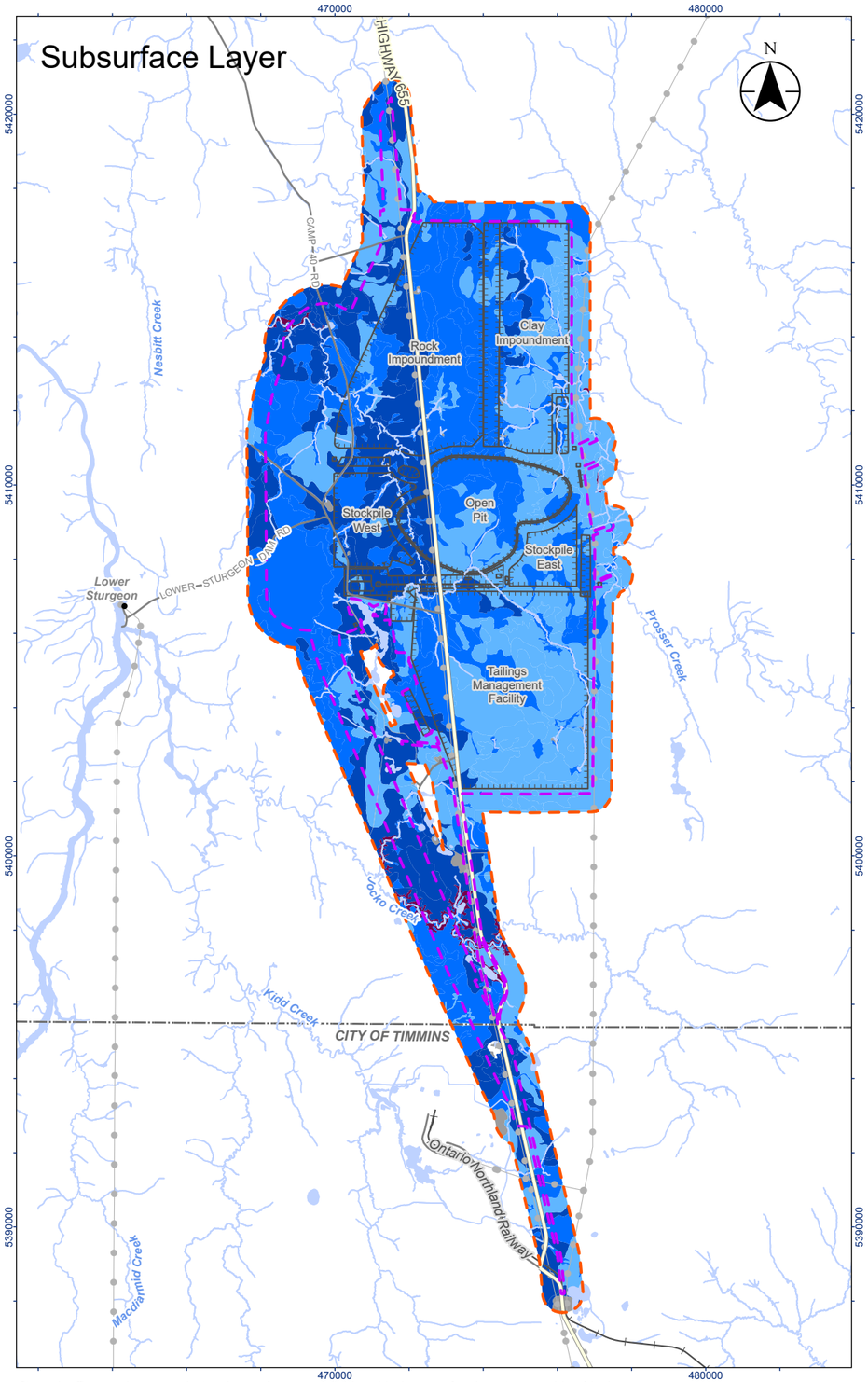
Title
Soil Management Unit (SMU) Mapbook

\\cat1004-01\1609\active\160903456\160903456_IS_BL_GeoTopo3.aprx\160903456_BL_Soils_Fig\A.05.x_Soils_Mapbook Revised: 2024-04-25 By: awhite

Surface Layer



Subsurface Layer



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area
- Major Road
- Minor Road
- Railway
- Existing Transmission Line
- Watercourse
- Municipal Boundary - Lower Tier
- Waterbody

Water Erosion Risk

- High to Severe
- Moderate
- Low to Moderate
- Low
- Very Low
- Organic
- na

0 2.5 5 km

1:150,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
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Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-24

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.6

Title
Water Erosion Risk
Surface Layer and Subsurface Layer

\\cn1004-f01\01609\active\160903456\160903456gis_cad\gis\mxd\ISBaseline\160903456_IS_BL_CaseTopo3.aprx\160903456_BL_Soils_FigA.06_Soils_WaterErosionRisk Revised: 2024-04-24 By: awhite

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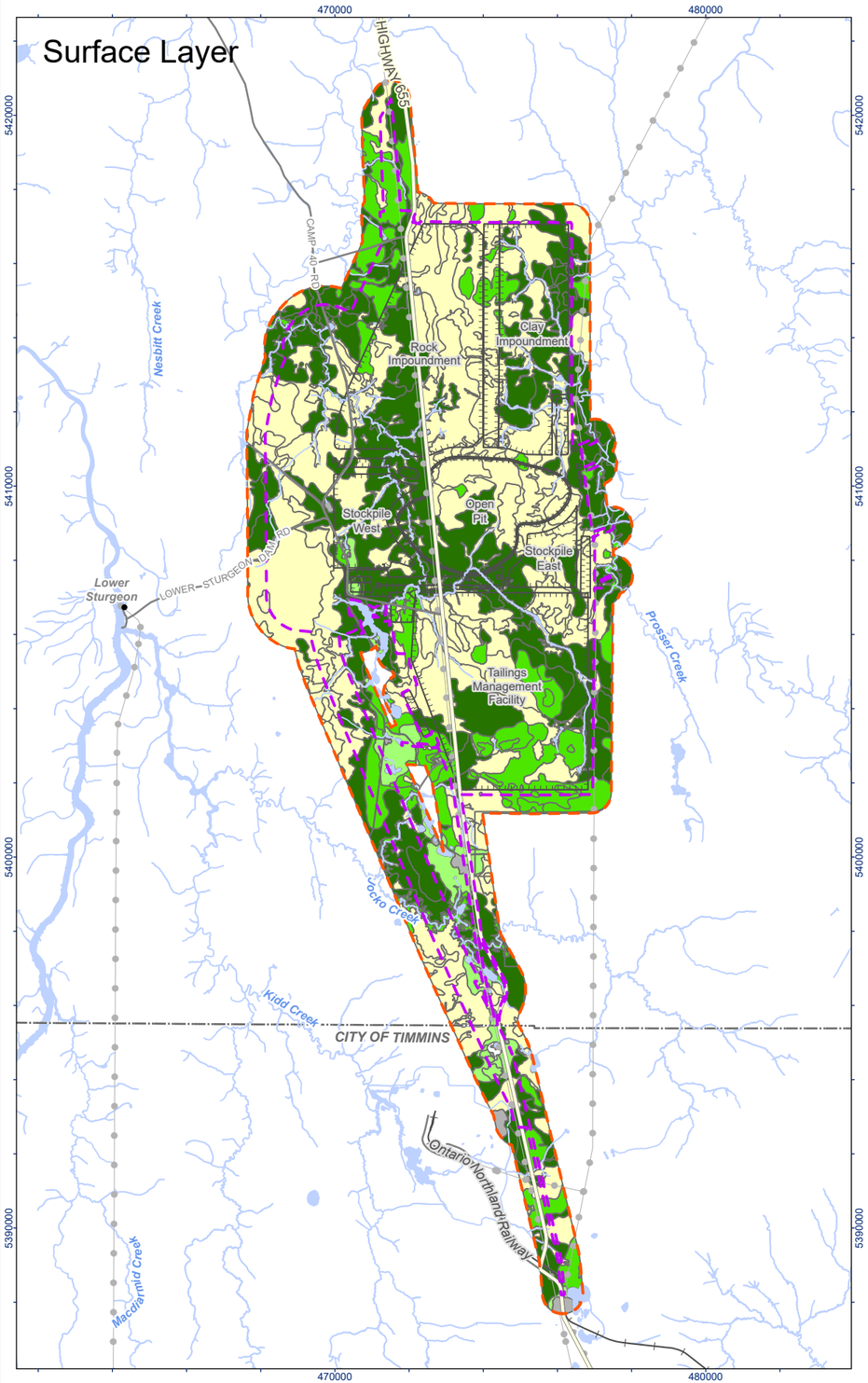
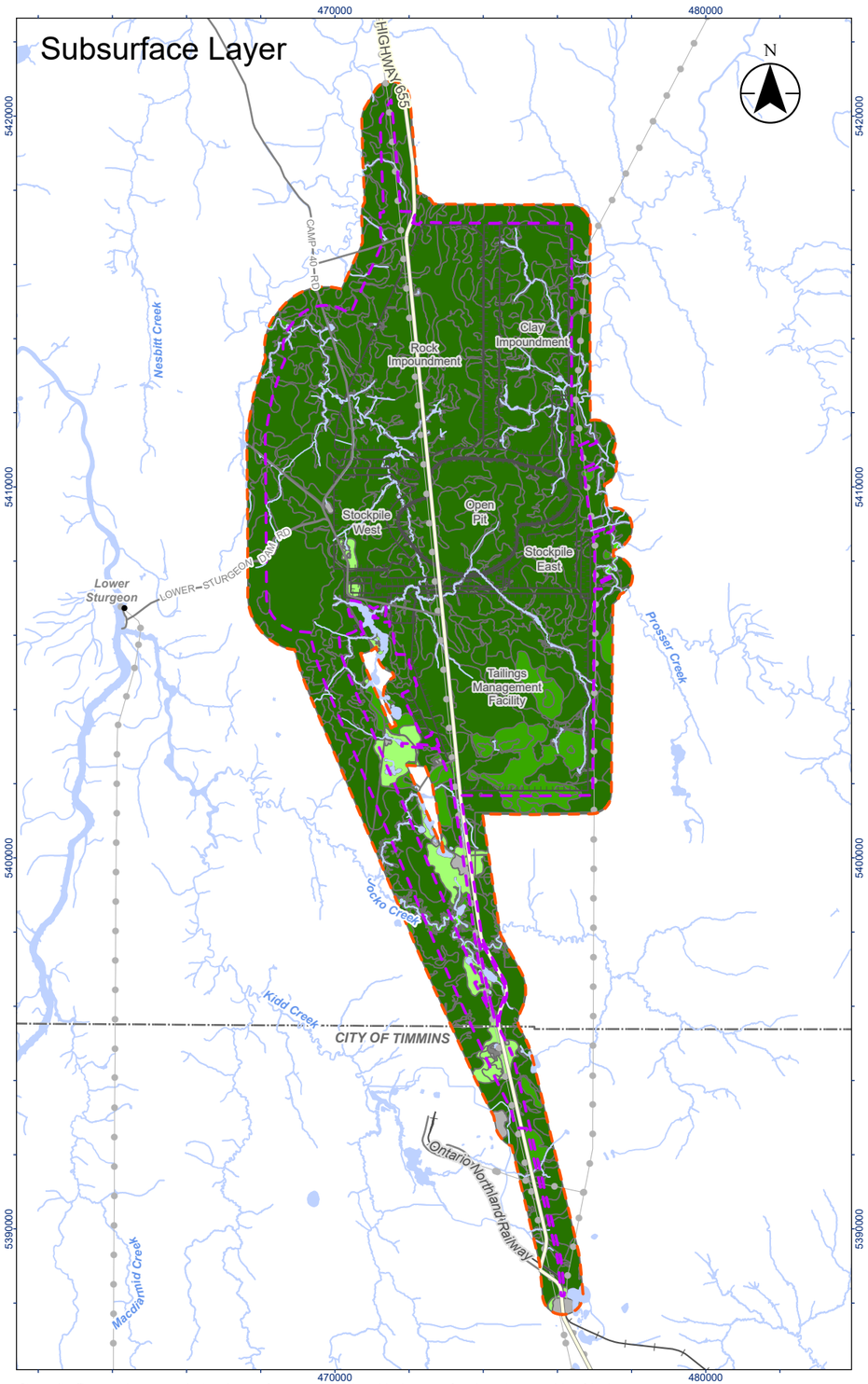


Subsurface Layer



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area
- Major Road
- Minor Road
- Railway
- Existing Transmission Line
- Watercourse
- Municipal Boundary - Lower Tier
- Waterbody

Compaction Risk

- High
- Moderate to High
- Moderate
- Low
- Organic
- na

0 2.5 5 km

1:150,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
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Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-24

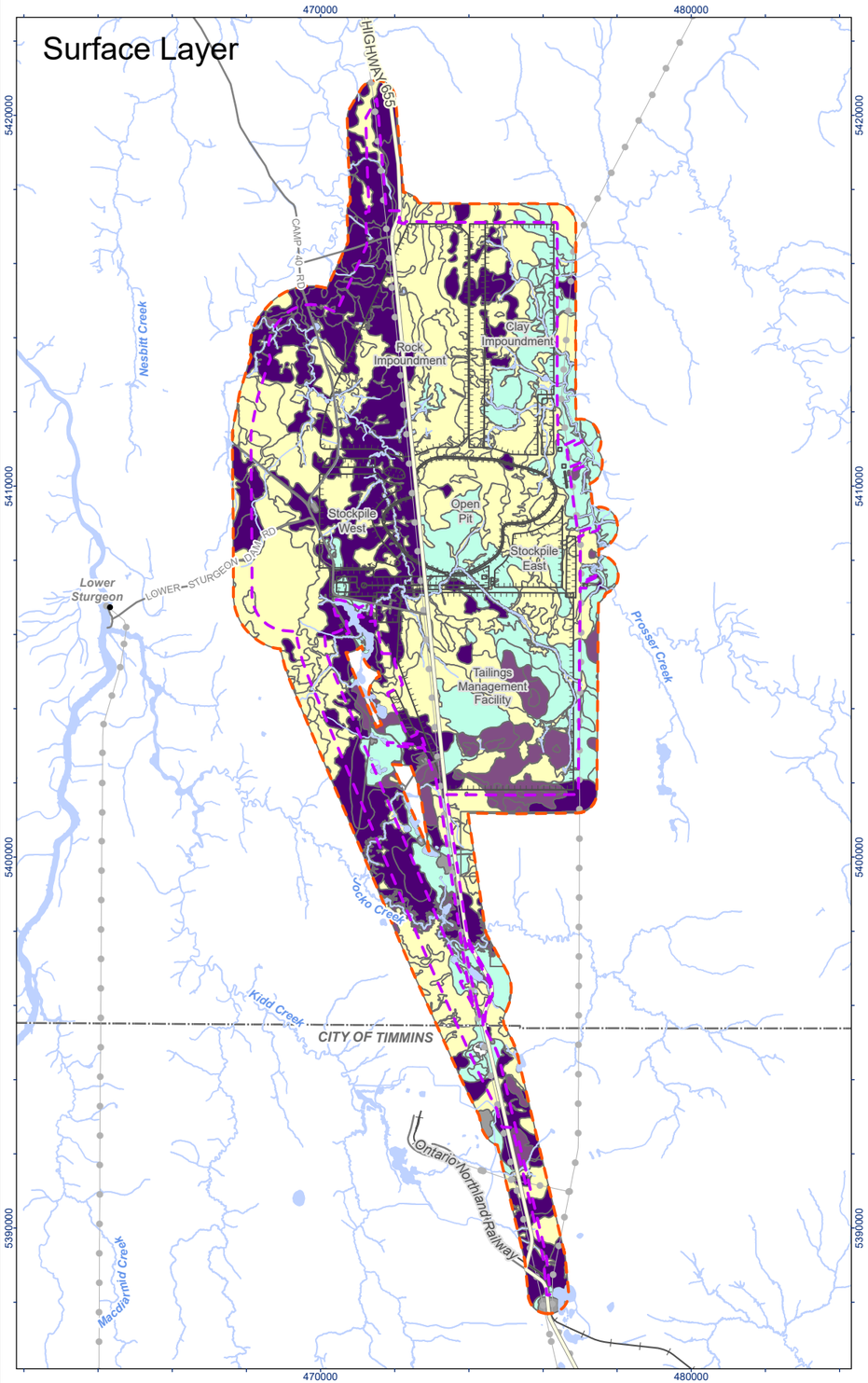
Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.7

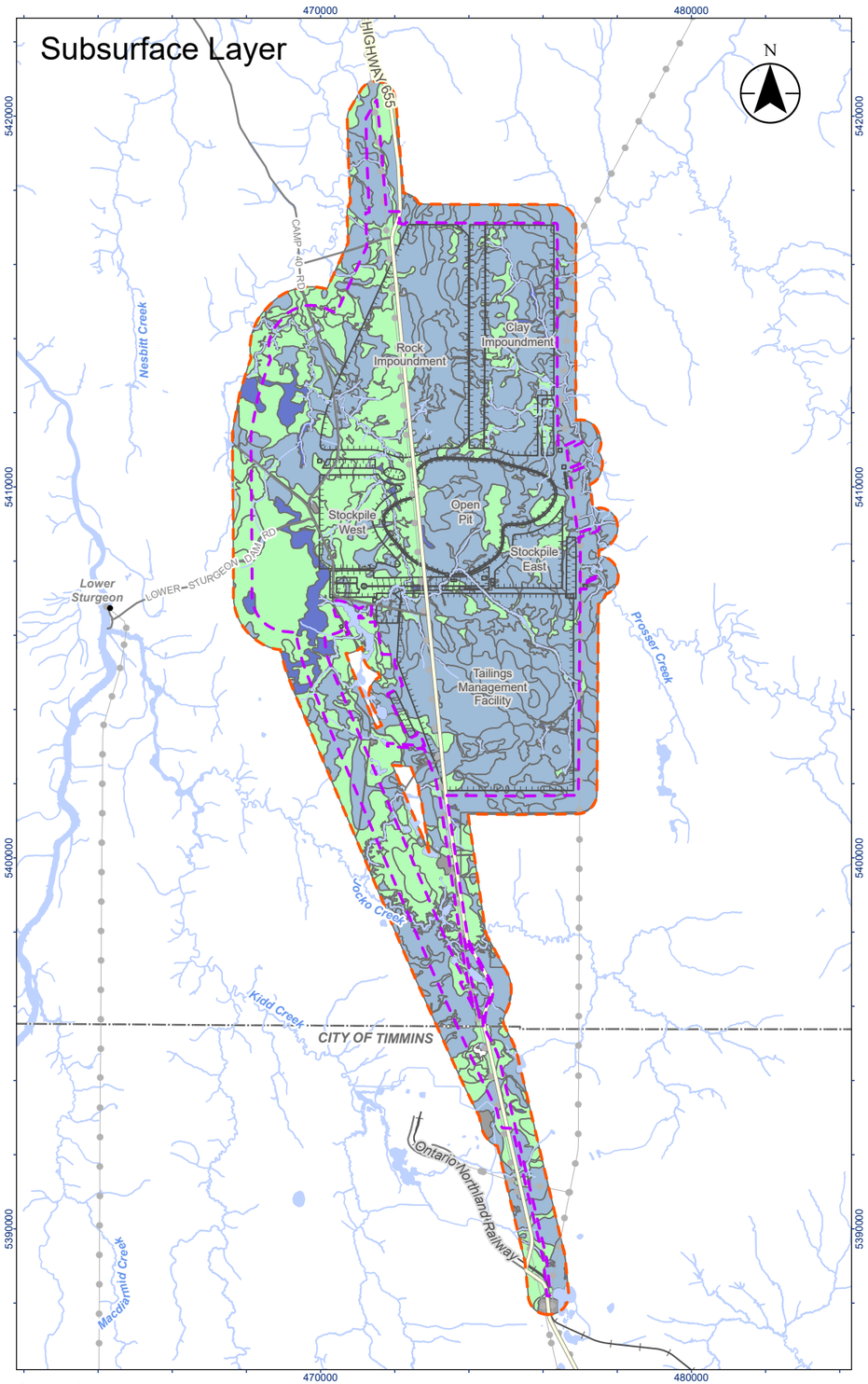
Title
Compaction Risk
Surface Layer and Subsurface Layer

\\cn1004-f01\01606\active\160903456\160903456\gis_cad\gis\mxd\ISBaseline\160903456_IS_BL_CanTopo3.aprx\160903456_BL_Soils_FigA.07_Soils_CompactionRisk Revised: 2024-04-24 By: awhite

Surface Layer



Subsurface Layer



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area
- Major Road
- Minor Road
- Railway
- Existing Transmission Line
- Watercourse
- Municipal Boundary - Lower Tier
- Waterbody

Reclamation Suitability

- Good
- Good- Fair
- Fair
- Poor - Fair
- Poor
- Organic
- na

0 2.5 5 km

1:150,000 (At original document size of 11x17)

Notes

1. Coordinate System:NAD 1983 UTM Zone 17N
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Project Location
Timmins, Ontario

160903456 REVA
Prepared by awhite on 2024-04-25

Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.8

Title
Soil Reclamation Suitability
Surface Layer and Subsurface Layer

\\cn1004-f01\1609\active\160903456\1609034561609034569\gis_cad\gis\mxd\ISBaseline\160903456_IS_BL_CanTopo3.aprx\160903456_BL_Soils_FigA.08_Soils_Reclamation Suitability Revised: 2024-04-25 By: awhite

Appendix B Soil Profile Descriptions

Characteristics of Abitibi Soil

Parameter	Description
Soil Classification	**Eluviated Dystric Brunisol**
Parent Material	Glaciofluvial or Glaciofluvial over Till
Texture	Topsoil: Loany Sand Subsoil: Sand, Clay Loam
Slope Class / Percent Slope	2-3 / 0.5-5%
Surface Stoniness	<0.01%
Drainage Class	Well
Land Use	Woodland
Reclamation Suitability	Poor – Topsoil Poor to Fair– Subsoil
Water Erosion Risk (severity)	Topsoil: Low (0 to 5% Slopes) Moderate (5 to 9% Slopes) Subsoil: Low (0 to 5 % Slope) Moderate (5 to 9% Slopes)
Compaction Risk (severity)	Topsoil: - Low (texture) Subsoil: - Low (Texture)
Note: Bolded soil classification indicates modal	

Representative site: Abitibi -CSS - 168								
Horizon	**Depth (cm)**	**Texture**	**Consistence**	**Structure (grade/ class/ kind)**	**Colour (hue value/ chroma)**	**Coarse Fragment Content (%)**	**Mottles (abundance, size, contrast)**	**Effervescence**
LFH	3-0	-	-	-	-	-	-	-
Ahj	0-10	Loamy Sand	Very Friable	Single Grain	2.5Y 3/1	0	0	-
Ae	10 - 22	Sand	Loose	Single Grain	2.5Y 5/2	0	0	-
Bfj	22 - 33	Sand	Loose	Single Grain		0	0	-
BC	33 - 70	Loamy Sand	Loose	-		0	0	-
IICk	70 - 105	Clay Loam	Firm	-		1	0	

Representative site: Abitibi - CSS 168											
				Exchangeable Cations							
Horizon	**Depth (cm)**	**pH**	**Cation Exchange Capacity (MEQ/100gm)**	**Ca**	**Mg**	**K**	**Na**	**Base Saturation**	**Calcium Carbonate Equivalent**	**Total Organic Carbon (%)**	**Total Kjeldahl Nitrogen (mg/kg)**
LFH	3-0		-	-	-	-	-	-	-	5	2410
Ahj	0-10	5.85	4.55	3.44	0.57	0.38	0.04	97.3	1,8	2	885
Ae	10 - 22	4.78	0.80	0.4	0.13	0.05	0.03	87.1	<1	-	-
Bfj	22 - 33	4.1	0.73	0.44	0.09	0.06	0.04	86.9	2.3	-	-
BC	33 - 70	4.7	1.51	0.84	0.17	0.07	0.05	74.7	5	-	-
IICkj	70 - 105	6.69	12.1	9.5	2.03	0.43	0.15	99.9	4.1	-	-

Characteristics of Ford (Orthic Phase) Soil

Parameter	Description
Soil Classification	**Orthic Gleysol**
Parent Material	Organic veneer over Lacustro-Till
Texture	Topsoil - Organic Subsoil - Silty Clay Loam, Clay
Slope Class / Percent Slope	1-2 / 0-2%
Surface Stoniness	<0.01%
Drainage Class	Poor
Land Use	Woodland
Reclamation Suitability	Topsoil: – Poor Subsoil: - Poor (Texture and CaCO3 are limitations)
Water Erosion Risk (severity)	Topsoil: Low (0 to 2% Slope) Subsoil: Low (0 to 2% Slope)
Compaction Risk (severity)	Topsoil: - High Subsoil: - High
Note: Bolded soil classification indicates modal	

Representative site: Ford - CSS - 198								
Horizon	**Depth (cm)**	**Texture**	**Consistence**	**Structure (grade/ class/ kind)**	**Colour (hue value/ chroma)**	**Coarse Fragment Content (%)**	**Mottles (abundance, size, contrast)**	**Effervescence**
Om	32 - 0	-	-	-	-	-	-	-
Bg	0 - 50	Silty Clay	Firm	Weak/fine/ Subangular blocky	2.5Y 5/3	0		
BCg	50 - 65	Silty Clay Loam	Firm	-	2.5Y 5/3	0	Common/Fine/Distinct	Very Weak
Cgk	65 - 80	Silty Clay Loam	Firm	-	2.5Y 6/4	2		Moderate

Representative site: Ford CSS 198											
				Exchangeable Cations							
Horizon	**Depth (cm)**	**pH**	**Cation Exchange Capacity (MEQ/100 gm)**	**Ca**	**Mg**	**K**	**Na**	**Base Saturation**	**Calcium Carbonate Equivalent**	**Total Organic Carbon**	**Total Kjeldahl Nitrogen (%)**
Om	32 - 0	4.92	-	-	-	-	-	-	-		
Bg	0 - 50	6.48	12.75	9.40	2.82	0.42	0.10	99.9	<1	-	-
BCg	50 - 65	6.65	13.85	10.94	2.25	0.50	0.15	99.9	8.6	-	-
Cgk	65 - 80	7.2	10.30	8.50	1.13	0.35	0.11	99.9	35.9	-	-

Characteristics of Ford (Peaty Luvic phase) Soil

Parameter	Description
Soil Classification	**Humic Luvic Gleysol**
Parent Material	Lacustro-Till
Texture	Topsoil: Silt Loam/Organic Subsoil: Silt Loam, Silty Clay Loam
Slope Class / Percent Slope	2/ 0.5-2%
Surface Stoniness	<0.01%
Drainage Class	Poor
Land Use	Woodland
Reclamation Suitability	Topsoil: - Good /Organic Subsoil: – Poor (CaC03 equivalent are limitations)
Water Erosion Risk (severity)	Topsoil: Moderate Subsoil: Moderate
Compaction Risk (severity)	Topsoil: - High Subsoil: - High
Note: Bolded soil classification indicates modal	

Representative site: Ford CSS - 31								
Horizon	**Depth (cm)**	**Texture**	**Consistence**	**Structure (grade/ class/ kind)**	**Colour (hue value/ chroma)**	**Coarse Fragment Content (%)**	**Mottles (abundance, size, contrast)**	**Efferfesence**
Oh	35-0	-	-	-	-	-	-	-
Ah	0-18	Silt Loam	Friable	Weak/Medium/ Angular blocky	10YR 2/1	0	-	-
Btg	18 - 42	Silty Clay Loam	Firm	Weak/Fine/Sub angular blocky	2.5Y 5/3	0	Common/Fine/Distinct	Very Weak
Cgk	42 - 70	Silt Loam	Sticky	-	2.5Y 6/3	0	Common/Fine/Distinct	Moderate

Representative site: Ford CSS 31											
				Exchangeable Cations							
Horizon	**Depth (cm)**	**pH**	**Cation Exchange Capacity (MEQ/100 gm**	**Ca**	**Mg**	**K**	**Na**	**Base Saturation**	**Calcium Carbonate Equivalent**	**Total Organic Carbon**	**Total Kjeldahl Nitrogen**
Oh	35-0	4.77	-	-	-	-	-	-	-	36.6	7710
Ah	0-18	6.43	19.81	14.85	4.74	0.09	0.10	99.8	<1	13.2	2820
Btg	18 - 42	6.96	7.00	5.90	0.83	0.18	0.08	99.9	32.7	-	-
Cgk	42 - 70	7.28	8.88	7.61	0.85	0.31	0.11	99.9	39.6	-	-

Characteristics of Harley Soil

Parameter	Description
Soil Classification	**Typic Mesisol**
Parent Material	Organic
Texture	Topsoil: Organic Subsoil: Silty Clay Loam
Slope Class / Percent Slope	1-2/ 0-2%
Surface Stoniness	<0.01%
Drainage Class	Poor
Land Use	Woodland
Reclamation Suitability	Topsoil: - Organic Subsoil: – Poor (CaCO3 Equivalent are limitations)
Water Erosion Risk (severity)	Topsoil: Organic Subsoil: - Low (0 to 2% Slope)
Compaction Risk (severity)	Topsoil: - Organic Subsoil: - High
Note:	

Representative site: Harley CSS - 40								
Horizon	**Depth (cm)**	**Texture**	**Consistence**	**Structure (grade/ class/ kind)**	**Colour (hue value/ chroma)**	**Coarse Fragment Content (%)**	**Mottles (abundance, size, contrast)**	**Efferfesence**
Of	0 - 25	-	-	-	-	-	-	-
Om	25 – 150	-	-	-	-	-	-	-
Cg	150 – 180	Silty Clay Loam	Sticky	-	-	0	-	Weak

Representative site: Harley CSS 40											
				Exchangeable Cations							
Horizon	**Depth (cm)**	**pH**	**Cation Exchange Capacity (MEQ/100gm)**	**Ca**	**Mg**	**K**	**Na**	**Base Saturation**	**Calcium Carbonate Equivalent**	**Total Organic Carbon**	**Total Kjeldahl Nitrogen**
Of	0 - 25	3.32	-	-	-	-	-	-	-	26.8	5910
Om	25 – 150	3.69	-	-	-	-	-	-	-	46.2	7010
Cg	150 – 180	7.06	5.54	5.14	0.22	0.12	0.05	99.75	38.6	-	-

Characteristics of Lowther Soil

Parameter	Description
Soil Classification	**Orthic Gray Luvisol**
Parent Material	Till
Texture	Topsoil: Loam Subsoil: Clay, Clay Loam
Slope Class / Percent Slope	2-3 / 0.5-5%
Surface Stoniness	<0.01%
Drainage Class	Poor
Land Use	Woodland
Reclamation Suitability	Topsoil: - Good to Fair (pH are limitations) Subsoil: – Fair to Poor (pH, CaCO3 Equivalent are limitations)
Water Erosion Risk (severity)	Topsoil: Low (0 to 2% Slope) High (2 to 5% Slope) Severe (5 to 15% Slope Subsoil: : Low (0 to 2% Slope) High (2 to 5% Slope) Severe (5 to 15% Slope
Compaction Risk (severity)	Topsoil: - Moderate Subsoil: - Moderate to High
Note: Bolded soil classification indicates modal	

presentative site: Lowther -CSS - 182								
Horizon	**Depth (cm)**	**Texture**	**Consistence**	**Structure (grade/ class/ kind)**	**Colour (hue value/ chroma)**	**Coarse Fragment Content (%)**	**Mottles (abundance, size, contrast)**	**Efferfesence**
LFH	15 – 0	-	-	-	-	-	-	-
Ae	0 – 4	Silt Loam	Friable	Weak/Medium /Platy	10YR 5/2			-
Bt1	4 – 20	Silt Loam	Friable	Weak/Fine/Suban gular blocky	10YR 4/6	0		-
Bt2	20 - 55	Silt Loam	Friable	-	10YR 4/3	1		-
BC	55 - 80	Silt Loam	Firm	-	10YR 5/3	2	C F D	Very Weak
Ckgj	80 - 110	Silt Clay Loam	Firm		2.5 Y 5/4	1		Moderate

Representative site: Lowther CSS-182											
				Exchangeable Cations							
Horizon	**Depth (cm)**	**pH**	**Cation Exchange Capacity (MEQ/100gm)**	**Ca**	**Mg**	**K**	**Na**	**Base Saturation**	**Calcium Carbonate Equivalent**	**Total Organic Carbon**	**Total Kjeldahl Nitrogen**
LFH	15 – 0	5.82	-	-	-	-	-	-	-	5	2410
Ae	0 – 4	3.47	6.59	3.37	2.01	0.26	0.07	86.68	<1	2	886
Bt1	4 – 20	4.13	6.80	3.30	0.88	0.32	0.08	67.32	1.4	-	-
Bt2	20 - 55	5.71	13.7	11.2	1,96	0.44	0.09	99.89	7.7	-	-
BC	55 - 80	6.67	10.71	9.37	0.91	0.33	0.08	99.92	20	-	-
Ckgj	80 - 110	7.01	10.18	8.51	1.31	0.35	0.12	99.84	38.5	-	-

Characteristics of Shetland (Orthic Phase) Soil

Parameter	Description
Soil Classification	**Orthic Gleysol**
Parent Material	Glaciolacustrine
Texture	Clay/Silty Clay
Slope Class / Percent Slope	1-2/ 0 -2%
Surface Stoniness	<0.01%
Drainage Class	Very Poor
Land Use	Woodland
Reclamation Suitability	Topsoil: – Poor/Organic Subsoil: - Poor (Texture and CaCO3 are limitations)
Water Erosion Risk (severity)	Topsoil: - Low (0 to 2% Slope) Subsoil: - Low (0 to 2% Slope)
Compaction Risk (severity)	Topsoil: - High Subsoil: - High
Note: Bolded soil classification indicates modal	

Representative site: Shetland - CSS - 91								
Horizon	**Depth (cm)**	**Texture**	**Consistence**	**Structure (grade/ class/ kind)**	**Colour (hue value/ chroma)**	**Coarse Fragment Content (%)**	**Mottles (abundance, size, contrast)**	**Efferfesence**
Om	10 - 0	-	-	-	-	-	-	-
Bg	0 - 55	SiC	Firm	Weak/Coarse/ Subangulay blocky	2.5Y4/2	0	-	-
Cgkj	55 - 100	SiC	Very Sticky	-	10YR6/2	0	-	Very Weak

Representative site: Shetland -CSS 91											
				Exchangeable Cations							
Horizon	**Depth (cm)**	**pH**	**Cation Exchange Capacity (MEQ/100gm)**	**Ca**	**Mg**	**K**	**Na**	**Base Saturation**	**Calcium Carbonate Equivalent**	**Total Organic Carbon**	**Total Kjeldahl Nitrogen**
Om	10 - 0	5.96	-	-	-	-	-	-	-	-	-
Bg	0 - 55	5.22								-	-
Cgkj	55 - 100	6.55	7.15	5.88	0.95	0.22	0.08	99.75	45	-	-

Appendix C Site Photographs

Photo 1: Site CSS 104 – Humic Luvic Gleysol on Glaciolacustrine Material

Photo 2: **Site CSS 001 – peaty Orthic Gleysol on Glaciolacustrine Parent Material**

Photo 3: Site CSS 43 – Gleyed Gray Luvisol on Lacustro-till

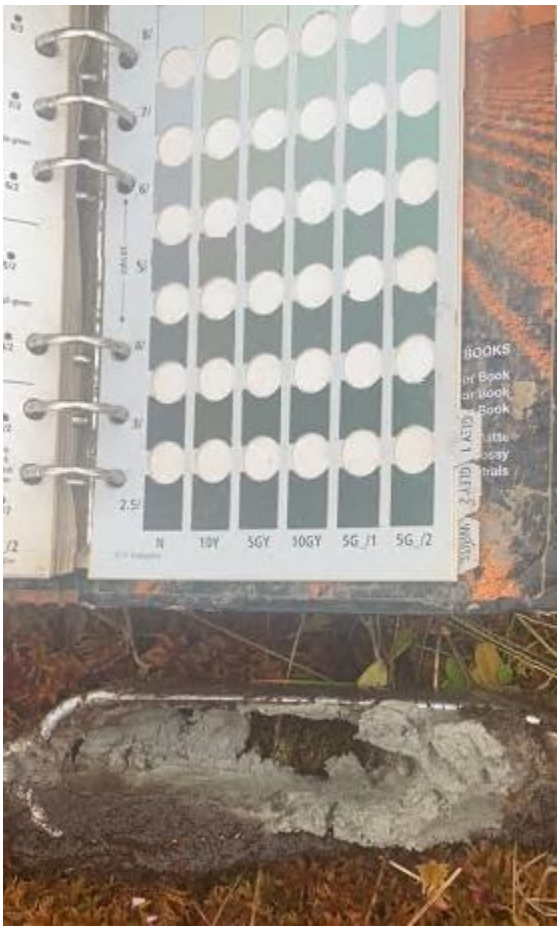

Photo 4: Site CSS 37 – Cg horizon on Mesic Fibrisol

Photo 5: Glaciofluvial deposit on former aggregate quarry

Photo 6: Erosion armouring/protection on cut slope along Highway 655.

Note - Soils are very erodible on recontoured moderate to strong slopes

Photo 7: Erosion armouring/protection on fill slope to Jocko Creek

Appendix D Certificate of Analysis

TESTMARK Laboratories Ltd.
Committed to Quality and Service

CERTIFICATE OF ANALYSIS

Client:	Adam Gauthier	Work Order Number:	517913
Company:	Canada Nickel Company Inc.	PO #:	
Address:	130 King St West, Ste 1900 Toronto, ON, M5X 1E3	Regulation: Project #:	Information not provided
Phone:	(705) 363-7397	DWS #:	
Email:	adamgauthier@canadanickel.com	Sampled By:	Mel Zwierink
Date Order Received:	11/1/2023	Analysis Started:	11/8/2023
Arrival Temperature:	10 C	Analysis Completed:	11/21/2023

WORK ORDER SUMMARY

ANALYSES WERE PERFORMED ON THE FOLLOWING SAMPLES. THE RESULTS RELATE ONLY TO THE ITEMS TESTED.

Sample Description	Lab ID	Matrix	Type	Comments	Date Collected	Time Collected
CSS168 - 1 (3 - 0 cm)	1948206	Soil	Grab		10/16/2023	
CSS168 - 2 (0 - 10 cm)	1948207	Soil	Grab		10/16/2023	
CSS168 - 3 (10 -22 cm)	1948208	Soil	Grab		10/16/2023	
CSS168 -4 (22 - 33 cm)	1948209	Soil	Grab		10/16/2023	
CSS168 - 5 (33 - 70 cm)	1948210	Soil	Grab		10/16/2023	
CSS168 - 6 (70 - 110 cm)	1948211	Soil	Grab		10/16/2023	
CSS65-1 (11- 0 cm)	1948212	Soil	Grab		10/15/2023	
CSS65-2 (0- 25 cm)	1948213	Soil	Grab		10/15/2023	
CSS65-3 (25- 50 cm)	1948214	Soil	Grab		10/15/2023	
CSS65-4 (50- 85 cm)	1948215	Soil	Grab		10/15/2023	
CSS65-5 (85- 110 cm)	1948216	Soil	Grab		10/15/2023	
CSS40-1 (0 - 25)	1948217	Soil	Grab		10/13/2023	
CSS40-1 (25 - 150)	1948218	Soil	Grab		10/13/2023	
CSS40-1 (150 - 180)	1948219	Soil	Grab		10/13/2023	
CSS91 - 1 (Om)	1948220	Soil	Grab		10/12/2023	
CSS91 - 2 (Bg)	1948221	Soil	Grab		10/12/2023	
CSS91 - 1 (Cg)	1948222	Soil	Grab		10/12/2023	

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Sample Description	Lab ID	Matrix	Type	Comments	Date Collected	Time Collected
CSS198 -1 (32 - 0 cm)	1948223	Soil	Grab			
CSS198 - 2 (0 - 50 cm)	1948224	Soil	Grab			
CSS198 - 3 (50 - 65 cm)	1948225	Soil	Grab			
CSS31 -1 (35 - 0 cm)	1948226	Soil	Grab		10/15/2023	
CSS31 - 2 (0 - 18 cm)	1948227	Soil	Grab		10/15/2023	
CSS31 -3 (18- 42 cm)	1948228	Soil	Grab		10/15/2023	
CSS31 - 4 (50 - 65 cm)	1948229	Soil	Grab		10/15/2023	
CSS182 - 1 (15-0 cm)	1948230	Soil	Grab		10/14/2023	
CSS182 - 2(0 - 4 cm)	1948231	Soil	Grab		10/14/2023	
CSS182 - 3 (4-20 cm)	1948232	Soil	Grab		10/14/2023	
CSS182 - 4 (20-55 cm)	1948233	Soil	Grab		10/14/2023	
CSS182 - 5 (55 - 80 cm)	1948234	Soil	Grab		10/14/2023	
CSS182 - 6 (80 - 110 cm)	1948235	Soil	Grab		10/14/2023	
CSS198 - 4 (65 - 80 cm)	1948236	Soil	Grab			

METHODS AND INSTRUMENTATION

THE FOLLOWING METHODS WERE USED FOR YOUR SAMPLE(S):

Method	Lab	Description	Reference
Moisture (A99)	Garson	Determination of Percent Moisture	In-House
Particle Size (R131)	Garson	Determination of Particle Size	Modified from ASTM
pH Soil (A2.0)	Garson	Determination of soil pH by Ion Selective Electrode	Modified from EPA SW-846 9045D
Special Testing (A99)	Garson	Special Testing	In-House
TKN Soil (A58)	Garson	Determination of Total Kjeldahl Nitrogen in Soils	Modified from EPA 351.2
TOC Soil (R55)	Garson	Determination of Total Organic Carbon in Soil	Modified from ASTM E1915-13

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REPORT COMMENTS

Due to the nature of the sample, the following pH extractions required a soil:extractant ratio of 1:4 as opposed to the normal 1:2 ratio used in the standard method:
1948206
1948217
1948218
1948220
1948223
1948226
Sample 1948230 required a soil:extractant ratio of 1:6.

This report has been approved by:

Adam Tam, M.Sc.
Laboratory Director

WORK ORDER RESULTS

Sample Description	CSS168 - 2 (0 - 10 cm)		CSS168 - 3 (10 - 22 cm)		CSS168 - 4 (22 - 33 cm)		CSS168 - 5 (33 - 70 cm)		
Sample Date	10/16/2023 12:00 AM		10/16/2023 12:00 AM		10/16/2023 12:00 AM		10/16/2023 12:00 AM		
Lab ID	1948207		1948208		1948209		1948210		
Custom Analysis	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
Custom Analysis	SeeAppendix	N/A	SeeAppendix	N/A	SeeAppendix	N/A	SeeAppendix	N/A	NA

Sample Description	CSS168 - 6 (70 - 110 cm)		CSS40 - 1 (150 - 180)		CSS91 - 2 (Bg)		CSS91 - 1 (Cg)		
Sample Date	10/16/2023 12:00 AM		10/13/2023 12:00 AM		10/12/2023 12:00 AM		10/12/2023 12:00 AM		
Lab ID	1948211		1948219		1948221		1948222		
Custom Analysis	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
Custom Analysis	SeeAppendix	N/A	SeeAppendix	N/A	SeeAppendix	N/A	SeeAppendix	N/A	NA

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Sample Description	CSS198 - 2 (0 - 50 cm)		CSS198 - 3 (50 - 65 cm)		CSS31 - 2 (0 - 18 cm)		CSS31 - 3 (18 - 42 cm)		
Sample Date	[Not Provided]		[Not Provided]		10/15/2023 12:00 AM		10/15/2023 12:00 AM		
Lab ID	1948224		1948225		1948227		1948228		
Custom Analysis	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
Custom Analysis	SeeAppendix	N/A	SeeAppendix	N/A	SeeAppendix	N/A	SeeAppendix	N/A	NA

Sample Description	CSS31 - 4 (50 - 65 cm)		CSS182 - 2(0 - 4 cm)		CSS182 - 3 (4 - 20 cm)		CSS182 - 4 (20 - 55 cm)		
Sample Date	10/15/2023 12:00 AM		10/14/2023 12:00 AM		10/14/2023 12:00 AM		10/14/2023 12:00 AM		
Lab ID	1948229		1948231		1948232		1948233		
Custom Analysis	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
Custom Analysis	SeeAppendix	N/A	SeeAppendix	N/A	SeeAppendix	N/A	SeeAppendix	N/A	NA

Sample Description	CSS182 - 5 (55 - 80 cm)		CSS182 - 6 (80 - 110 cm)		CSS198 - 4 (65 - 80 cm)				
Sample Date	10/14/2023 12:00 AM		10/14/2023 12:00 AM		[Not Provided]				
Lab ID	1948234		1948235		1948236				
Custom Analysis	Result	MDL	Result	MDL	Result	MDL	Units		
Custom Analysis	SeeAppendix	N/A	SeeAppendix	N/A	SeeAppendix	N/A	NA		

Sample Description	CSS168 - 1 (3 - 0 cm)		CSS168 - 2 (0 - 10 cm)		CSS168 - 3 (10 - 22 cm)		CSS168 - 4 (22 - 33 cm)		
Sample Date	10/16/2023 12:00 AM		10/16/2023 12:00 AM		10/16/2023 12:00 AM		10/16/2023 12:00 AM		
Lab ID	1948206		1948207		1948208		1948209		
General Chemistry	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
% Moisture	37.4	0.1	11.2	0.1					%
pH	5.82	N/A	5.85	N/A	4.78	N/A	4.11	N/A	pH
Total Organic Carbon	5.0	0.1	2.0	0.1					%

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Sample Description	CSS168 - 5 (33 - 70 cm)		CSS168 - 6 (70 - 110 cm)		CSS40 - 1 (0 - 25)		CSS40 - 1 (25 - 150)		
Sample Date	10/16/2023 12:00 AM		10/16/2023 12:00 AM		10/13/2023 12:00 AM		10/13/2023 12:00 AM		
Lab ID	1948210		1948211		1948217		1948218		
General Chemistry	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
% Moisture					91.1	0.1	87.2	0.1	%
pH	4.7	N/A	6.69	N/A	3.32	N/A	3.69	N/A	pH
Total Organic Carbon					26.8	0.1	46.2	0.1	%

Sample Description	CSS40 - 1 (150 - 180)		CSS91 - 1 (Om)		CSS91 - 2 (Bg)		CSS91 - 1 (Cg)		
Sample Date	10/13/2023 12:00 AM		10/12/2023 12:00 AM		10/12/2023 12:00 AM		10/12/2023 12:00 AM		
Lab ID	1948219		1948220		1948221		1948222		
General Chemistry	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
% Moisture			80.6	0.1	24.6	0.1			%
pH	7.06	N/A	5.96	N/A	5.22	N/A	6.55	N/A	pH
Total Organic Carbon			38.1	0.1	4.1	0.1			%

Sample Description	CSS198 - 1 (32 - 0 cm)		CSS198 - 2 (0 - 50 cm)		CSS198 - 3 (50 - 65 cm)		CSS31 - 1 (35 - 0 cm)		
Sample Date	[Not Provided]		[Not Provided]		[Not Provided]		10/15/2023 12:00 AM		
Lab ID	1948223		1948224		1948225		1948226		
General Chemistry	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
% Moisture	71.3	0.1	22.8	0.1			68.7	0.1	%
pH	4.92	N/A	6.48 [6.43]	N/A	6.65	N/A	4.77	N/A	pH
Total Organic Carbon	38.2	0.1	2.4	0.1			36.6	0.1	%

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Sample Description	CSS31 - 2 (0 - 18 cm)		CSS31 - 3 (18 - 42 cm)		CSS31 - 4 (50 - 65 cm)		CSS182 - 1 (15 - 0 cm)		
Sample Date	10/15/2023 12:00 AM		10/15/2023 12:00 AM		10/15/2023 12:00 AM		10/14/2023 12:00 AM		
Lab ID	1948227		1948228		1948229		1948230		
General Chemistry	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
% Moisture	43.6	0.1					70.6	0.1	%
pH	6.43	N/A	6.96	N/A	7.28	N/A	3.84	N/A	pH
Total Organic Carbon	13.2	0.1					44.0	0.1	%

Sample Description	CSS182 - 2(0 - 4 cm)		CSS182 - 3 (4 - 20 cm)		CSS182 - 4 (20 - 55 cm)		CSS182 - 5 (55 - 80 cm)		
Sample Date	10/14/2023 12:00 AM		10/14/2023 12:00 AM		10/14/2023 12:00 AM		10/14/2023 12:00 AM		
Lab ID	1948231		1948232		1948233		1948234		
General Chemistry	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
% Moisture	24.2	0.1							%
pH	3.47	N/A	4.13	N/A	5.71	N/A	6.67	N/A	pH
Total Organic Carbon	1.8 [1.8]	0.1							%

Sample Description	CSS182 - 6 (80 - 110 cm)		CSS198 - 4 (65 - 80 cm)		
Sample Date	10/14/2023 12:00 AM		[Not Provided]		
Lab ID	1948235		1948236		
General Chemistry	Result	MDL	Result	MDL	Units
pH	7.01	N/A	7.2 [7.28]	N/A	pH

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Sample Description	CSS168 - 1 (3 - 0 cm)		CSS168 - 2 (0 - 10 cm)		CSS40 - 1 (0 - 25)		CSS40 - 1 (25 - 150)		
Sample Date	10/16/2023 12:00 AM		10/16/2023 12:00 AM		10/13/2023 12:00 AM		10/13/2023 12:00 AM		
Lab ID	1948206		1948207		1948217		1948218		
General Chemistry (Soil)	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
Total Kjeldahl Nitrogen	2410	100	886	50	5910	400	7010	300	mg/kg

Sample Description	CSS91 - 1 (Om)		CSS91 - 2 (Bg)		CSS198 - 1 (32 - 0 cm)		CSS198 - 2 (0 - 50 cm)		
Sample Date	10/12/2023 12:00 AM		10/12/2023 12:00 AM		[Not Provided]		[Not Provided]		
Lab ID	1948220		1948221		1948223		1948224		
General Chemistry (Soil)	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
Total Kjeldahl Nitrogen	12400	600	1050	50	2620	100	527	50	mg/kg

Sample Description	CSS31 - 1 (35 - 0 cm)		CSS31 - 2 (0 - 18 cm)		CSS182 - 1 (15 - 0 cm)		CSS182 - 2(0 - 4 cm)		
Sample Date	10/15/2023 12:00 AM		10/15/2023 12:00 AM		10/14/2023 12:00 AM		10/14/2023 12:00 AM		
Lab ID	1948226		1948227		1948230		1948231		
General Chemistry (Soil)	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
Total Kjeldahl Nitrogen	7710	400	2820	100	6030	300	554 [480]	50	mg/kg

Sample Description	CSS168 - 2 (0 - 10 cm)		CSS168 - 3 (10 - 22 cm)		CSS168 - 4 (22 - 33 cm)		CSS168 - 5 (33 - 70 cm)		
Sample Date	10/16/2023 12:00 AM		10/16/2023 12:00 AM		10/16/2023 12:00 AM		10/16/2023 12:00 AM		
Lab ID	1948207		1948208		1948209		1948210		
Particle Size Analysis	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
Stone (4750 µm)	0	N/A	0	N/A	0	N/A	0	N/A	%(w/w)
Gravel (2000 µm)	0.5	N/A	0	N/A	0.5	N/A	0.8	N/A	%(w/w)

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Sample Description	CSS168 - 2 (0 - 10 cm)		CSS168 - 3 (10 - 22 cm)		CSS168 - 4 (22 - 33 cm)		CSS168 - 5 (33 - 70 cm)		
Sample Date	10/16/2023 12:00 AM		10/16/2023 12:00 AM		10/16/2023 12:00 AM		10/16/2023 12:00 AM		
Lab ID	1948207		1948208		1948209		1948210		
Particle Size Analysis	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
Very Coarse Sand (850 µm)	1.5	N/A	1.4	N/A	2.9	N/A	5	N/A	%(w/w)
Coarse Sand (500 µm)	13.9	N/A	17.6	N/A	17.3	N/A	21.4	N/A	%(w/w)
Medium Sand (250 µm)	36	N/A	48.7	N/A	39.6	N/A	33.9	N/A	%(w/w)
Fine Sand (106 µm)	21.4	N/A	20.8	N/A	29.5	N/A	15.6	N/A	%(w/w)
Very Fine Sand (75 µm)	1.5	N/A	1.2	N/A	1.1	N/A	1	N/A	%(w/w)
Silt (5-74 µm)	21	N/A	8.1	N/A	8.4	N/A	15.2	N/A	%(w/w)
Clay (<5 µm)	4.1	N/A	2.2	N/A	0.7	N/A	7.1	N/A	%(w/w)

Sample Description	CSS168 - 6 (70 - 110 cm)		CSS40 - 1 (150 - 180)		CSS91 - 2 (Bg)		CSS91 - 1 (Cg)		
Sample Date	10/16/2023 12:00 AM		10/13/2023 12:00 AM		10/12/2023 12:00 AM		10/12/2023 12:00 AM		
Lab ID	1948211		1948219		1948221		1948222		
Particle Size Analysis	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
Stone (4750 µm)	1.3	N/A	0	N/A	0	N/A	0	N/A	%(w/w)
Gravel (2000 µm)	0.2	N/A	0.5	N/A	0.3	N/A	0.5	N/A	%(w/w)
Very Coarse Sand (850 µm)	1	N/A	0.4	N/A	0.2	N/A	0.3	N/A	%(w/w)
Coarse Sand (500 µm)	4.2	N/A	0.7	N/A	0.6	N/A	1.1	N/A	%(w/w)
Medium Sand (250 µm)	6.3	N/A	1.1	N/A	1.3	N/A	1.2	N/A	%(w/w)
Fine Sand (106 µm)	6.1	N/A	1.6	N/A	1.8	N/A	1.7	N/A	%(w/w)
Very Fine Sand (75 µm)	1.2	N/A	0.5	N/A	0.5	N/A	0.5	N/A	%(w/w)
Silt (5-74 µm)	51.4	N/A	61.4	N/A	53.7	N/A	53.9	N/A	%(w/w)
Clay (<5 µm)	28.4	N/A	33.7	N/A	41.6	N/A	40.9	N/A	%(w/w)

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Sample Description	CSS198 - 2 (0 - 50 cm)		CSS198 - 3 (50 - 65 cm)		CSS31 - 2 (0 - 18 cm)		CSS31 - 3 (18 - 42 cm)		
Sample Date	[Not Provided]		[Not Provided]		10/15/2023 12:00 AM		10/15/2023 12:00 AM		
Lab ID	1948224		1948225		1948227		1948228		
Particle Size Analysis	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
Stone (4750 µm)	0	N/A	0	N/A	0	N/A	0	N/A	%(w/w)
Gravel (2000 µm)	0.3	N/A	0	N/A	0.4	N/A	0	N/A	%(w/w)
Very Coarse Sand (850 µm)	0	N/A	0.2	N/A	0.7	N/A	0.2	N/A	%(w/w)
Coarse Sand (500 µm)	0.8	N/A	0.8	N/A	2.8	N/A	0.2	N/A	%(w/w)
Medium Sand (250 µm)	1.1	N/A	1	N/A	3.2	N/A	0.6	N/A	%(w/w)
Fine Sand (106 µm)	2.2	N/A	1.8	N/A	3.9	N/A	0.2	N/A	%(w/w)
Very Fine Sand (75 µm)	0.8	N/A	0.6	N/A	1.3	N/A	0	N/A	%(w/w)
Silt (5-74 µm)	53.8	N/A	69.2	N/A	72	N/A	69.9	N/A	%(w/w)
Clay (<5 µm)	41	N/A	26.4	N/A	15.7	N/A	28.9	N/A	%(w/w)

Sample Description	CSS31 - 4 (50 - 65 cm)		CSS182 - 2(0 - 4 cm)		CSS182 - 3 (4 - 20 cm)		CSS182 - 4 (20 - 55 cm)		
Sample Date	10/15/2023 12:00 AM		10/14/2023 12:00 AM		10/14/2023 12:00 AM		10/14/2023 12:00 AM		
Lab ID	1948229		1948231		1948232		1948233		
Particle Size Analysis	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
Stone (4750 µm)	0	N/A	0	N/A	0	N/A	0	N/A	%(w/w)
Gravel (2000 µm)	0	N/A	0	N/A	0	N/A	0	N/A	%(w/w)
Very Coarse Sand (850 µm)	0.2	N/A	0.8	N/A	0.4	N/A	2	N/A	%(w/w)
Coarse Sand (500 µm)	0.4	N/A	3.2	N/A	0	N/A	3.7	N/A	%(w/w)
Medium Sand (250 µm)	0.6	N/A	4.7	N/A	2.6	N/A	3.7	N/A	%(w/w)
Fine Sand (106 µm)	0.6	N/A	8.8	N/A	5.1	N/A	6.9	N/A	%(w/w)
Very Fine Sand (75 µm)	0.2	N/A	3	N/A	1.4	N/A	2.4	N/A	%(w/w)
Silt (5-74 µm)	74.7	N/A	61.6	N/A	72	N/A	58	N/A	%(w/w)

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Sample Description	CSS31 - 4 (50 - 65 cm)		CSS182 - 2(0 - 4 cm)		CSS182 - 3 (4 - 20 cm)		CSS182 - 4 (20 - 55 cm)		
Sample Date	10/15/2023 12:00 AM		10/14/2023 12:00 AM		10/14/2023 12:00 AM		10/14/2023 12:00 AM		
Lab ID	1948229		1948231		1948232		1948233		
Particle Size Analysis	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Units
Clay (<5 µm)	23.4	N/A	17.9	N/A	18.5	N/A	23.2	N/A	%(w/w)

Sample Description	CSS182 - 5 (55 - 80 cm)		CSS182 - 6 (80 - 110 cm)		CSS198 - 4 (65 - 80 cm)		
Sample Date	10/14/2023 12:00 AM		10/14/2023 12:00 AM		[Not Provided]		
Lab ID	1948234		1948235		1948236		
Particle Size Analysis	Result	MDL	Result	MDL	Result	MDL	Units
Stone (4750 µm)	0	N/A	0	N/A	0	N/A	%(w/w)
Gravel (2000 µm)	0.8	N/A	0.7	N/A	0.9	N/A	%(w/w)
Very Coarse Sand (850 µm)	2.3	N/A	1.9	N/A	1.3	N/A	%(w/w)
Coarse Sand (500 µm)	3.3	N/A	3.1	N/A	2.2	N/A	%(w/w)
Medium Sand (250 µm)	3.6	N/A	3.1	N/A	2.1	N/A	%(w/w)
Fine Sand (106 µm)	6.9	N/A	6.3	N/A	4.1	N/A	%(w/w)
Very Fine Sand (75 µm)	2.3	N/A	2	N/A	1.5	N/A	%(w/w)
Silt (5-74 µm)	60.6	N/A	60.6	N/A	66	N/A	%(w/w)
Clay (<5 µm)	20.3	N/A	22.3	N/A	21.8	N/A	%(w/w)

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LEGEND

Dates: Dates are formatted as mm/dd/year throughout this report.

MDL: Method detection limit or minimum reporting limit.

[ ]: Results for laboratory replicates are shown in square brackets immediately below the associated sample result for ease of comparison.

Organic Soil Analysis: Data reported for organic analysis in soils samples are corrected for moisture content.

Quality Control: All associated Quality Control data is available on request.

Field Data: Reports containing Field Parameters represent data that has been collected and provided by the client. Testmark is not responsible for the validity of this data which may be used in subsequent calculations.

Sample Condition Deviations: A noted sample condition deviation may affect the validity of the result. Results apply to the sample(s) as received.

ICPMS Dustfall Insoluble: The ICPMS Dustfall Insoluble Portion method analyzes only the particulate matter from the Dustfall Sampler which is retained on the analysis filter during the Dustfall method.

Regulation Comparisons: Disclaimer: Please note that regulation criteria are provided for comparative purposes, however the onus on ensuring the validity of this comparison rests with the client.

pH Results: pH results are outside the standard calibration range of 4 to 10 pH units.

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