nwmo
NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

NWMO-FORM-IM-0004-R000

Contractor Document Approval Cover Sheet

File with Contractor Document. Security Class: Internal Use

Title: Nuclear Waste Management Organization Adaptive Phased Management Project - Wabigoon Lake Ojibway Nation-Ignace Area Biophysical Conceptual Site Model Update and Screening Level Change Assessment	External Document No.: Project No. 3260 August 2023	Revision: R000
Company Name: CanNorth – Canada North Environmental Services Limited Partnership		

NWMO Document No.: APM-REP-07000-0222	Revision: R000	NWMO P.O. No.: 2000317
Date Submitted: 2023/08/25		Page: Approval Cover Sheet

NWMO Document Title

Wabigoon Lake Ojibway Nation-Ignace Area Biophysical Conceptual Site Model Update and Screening Level Change Assessment

NWMO Authorization

Reviewed By: DocuSigned by: Michelle Nearing 4A0D53D76D2F4E9... Date: August 30, 2023

Name: Michelle Nearing
Title: Manager, Environment Program

Accepted by: DocuSigned by: Karine Glenn 9234662173B7452... Date: August 30, 2023

Name: Karine Glenn
Title: Director, Impact Assessment

Associated with NWMO-STD-IM-0001, Standards for Controlled Documents

Associated with NWMO-PROC-IM-0002, Controlled Document Management

CanNorth
Canada North Environmental Services Limited Partnership
A First Nation Environmental Services Company

NUCLEAR WASTE MANAGEMENT ORGANIZATION
ADAPTIVE PHASED MANAGEMENT PROJECT – WABIGOON LAKE OJIBWAY NATION-IGNACE AREA

BIOPHYSICAL CONCEPTUAL SITE MODEL UPDATE AND SCREENING LEVEL CHANGE ASSESSMENT

Final Report

Prepared by:
Canada North Environmental Services
Geosyntec Consultants International, Inc.
Independent Environmental Consultants
Zajdlik & Associates Inc.

Prepared for:
Nuclear Waste Management Organization

Project No. 3260

April 2023

Approvals

Assistant Project Manager	Leah Leon	April 6, 2023	
Title	**Name**	**Date**	**Signature**
Primary Project Manager	Stacey Fernandes	April 6, 2023	
Title	**Name**	**Date**	**Signature**
NWMO Lead	Michelle Nearing		
Title	**Name**	**Date**	**Signature**

Version	Date	Description of Revision	Prepared/Revised by
1.0	April 6, 2023	Initial issue	• Canada North Environmental Services • Geosyntec Consultants International Inc. • Independent Environmental Consultants • Zajdlik & Associates Inc.

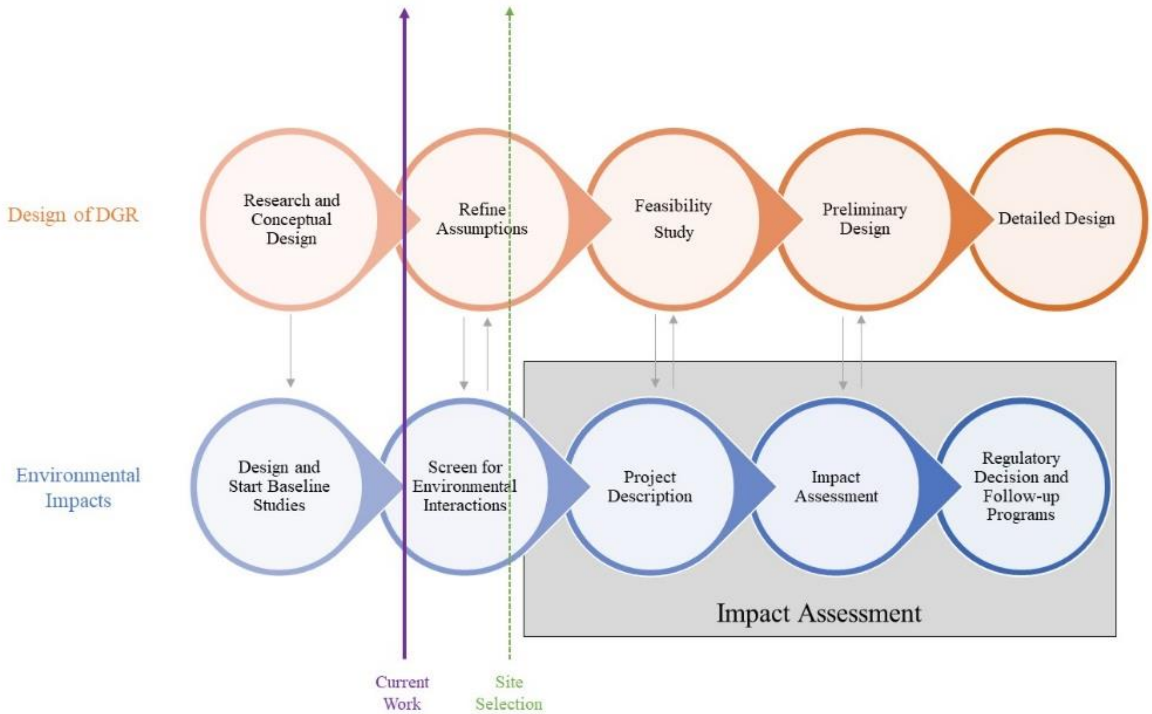
SUMMARY

INTRODUCTION

The Nuclear Waste Management Organization (NWMO) has undertaken a siting process for the safe, long-term management of used nuclear fuel. Canada's plan, which follows an approach known as Adaptive Phased Management (APM), would safely contain and isolate used nuclear fuel inside a deep geological repository (DGR) in a manner that protects people and the environment for generations to come. Throughout this document, the term Project is used to refer to the DGR and associated infrastructure.

There are two remaining sites being considered as informed and willing hosts for the Project. One of these sites is the Wabigoon Lake Ojibway Nation (WLON)-Ignace area, which is approximately 40 km west of Ignace. The nearest First Nation community to the potential site is WLON, but the area is also used by other Indigenous communities, including members of the Métis Nation of Ontario (MNO).

This document describes one of the first steps in the overall process of Project design and assessment of environmental impacts – examining how the Project may affect the environment and identifying technologies and systems that are commonly used to manage those changes. It also provides a high level description of the natural environment using existing information as site-specific baseline data are currently being collected. This screening level change assessment simply acknowledges when there may be a change to the environment because of the Project; it does not identify whether that change is important or significant. Additionally, this screening level change assessment focuses on the Project activities and not potential cumulative considerations of other activities in the area. These types of assessments will be done in detail within an Impact Assessment (IA), should the Project move forward at this site. The following diagram illustrates where this document fits into the process.



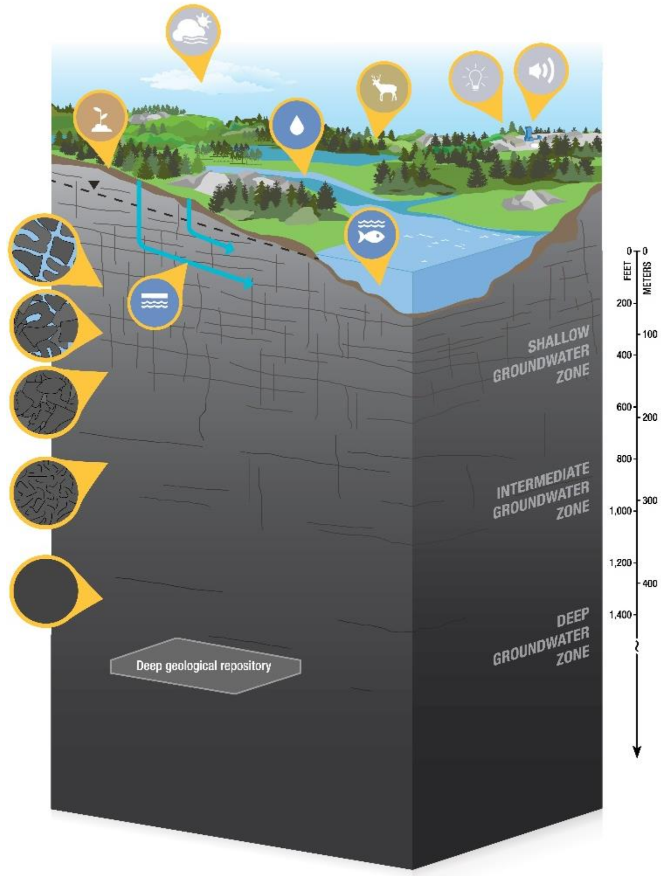
Incorporation of Indigneous and Local Community Voice

The NWMO is conducting its activities related to the Project in a manner that protects the public and the environment, promotes community understanding, and incorporates community, First Nation, Métis, and stakeholder needs. A collaborative process is used that that combines designers, users, rights holders, experts, citizens, knowledge holders, and regulators with the assumption that anybody is an expert regarding their own experience and draws on the diversity of one's practical and experiential knowledge to create a better design.

The NWMO has initiated engagement sessions and visioning workshops to contribute to a more detailed understanding of potential Project benefits, identify opportunities to work together, and determine how potential negative effects of the Project can be managed. Discussions are ongoing on various topics such as the basis for confidence in the safety of the Project, local land uses that need to be taken into account in planning field studies in the area, potential economic effects of the Project, and the long-term vision for the area held by local residents (NWMO 2017a). Throughout all phases of the Project, community input is being sought before finalizing the reports and workplans, including this document.

It needs to be emphasized that at this time the assessment has been conducted primarily through a Western Science approach. Additional discussion and input is required by rights-holders to reflect Indigenous Knowledge (IK) and a holistic view of the environment, within a harmonized approach.

CONCEPTUAL SITE MODEL



The biophysical environment includes living things (such as plants and animals), and non-living things (such as air, water, and soil). This document provides the current working Conceptual Site Model (CSM) for the biophysical environment. A description of the existing conditions has been provided; however, the CSM is based on a continuous learning model and will be updated as needed as the Project progresses and new information becomes available.

The proposed Project location, defined as the Area of Interest (AOI), is approximately 40 km west of the town of Ignace in Northwestern Ontario. It lies within the northern portion of the Revell Batholith within the Wabigoon Subprovince of the Superior Province in the Canadian Shield. The AOI is defined by an oval that is approximately 4.4 km by 8.7 km. Within the AOI are two primary roads (Dyment and Trapline roads), a network of operations roads and temporary access roads, and several small watercourses and wetlands. The land features consist mostly of forest, pasture, wetlands, and open land with man-made or recreational looking paths and trails. Forestry operations (cutting, milling, etc.) are widespread in the region, and there are several historic and current mining operations in the area including the proposed Treasury Metals, Goliath Gold, and Bending Lake Iron projects.

The northern portion of the area contains several small, connected waterbodies that collectively drain into Mennin Lake, which is located approximately 2 km southwest of the oval delineating the AOI. Mennin Lake flows north into the Mennin River, and then northwest into the Wabigoon River. This river drains northwest to Wabigoon Lake, which in turn, drains towards the Winnipeg River and the Nelson River, which outlets at Hudson Bay.

The bedrock geology of the AOI is defined by the Revell batholith, an elongate northwest-trending pluton estimated to be 40 km in length and 10 km to 15 km in thickness. In the vicinity of the site area, approximately 70% of the land surface consists of exposed bedrock or bedrock (Revell Lake batholith) covered by only a thin mantle of unconsolidated quaternary sediments (Golder 2013a; JDMA 2013a).

There are 120 water wells in the WLON-Ignace area, none of which are within the AOI. No published information is available on the deep bedrock hydrogeology at the typical repository depth of approximately 500 m; however, the NWMO has conducted a number of tests in the deep bedrock and is in the process of finalizing associated reports. Overburden aquifer wells ranged from 4.5 m to 42 m deep and shallow bedrock aquifer wells ranged from 5.5 m to 154 m deep.

The local atmospheric environment is characteristic of a northern Ontario air shed. The WLON-Ignace area has a primarily continental climate, with cold winters and mild summers. Most precipitation falls in the form of summer showers and thunderstorms. In winter, the region can experience prolonged periods of extreme cold. Major winter storms affect most parts of northern Ontario, including the WLON-Ignace area, at least once or twice per year. Climate change modelling suggests that the future is likely to be warmer and wetter, with an expected increase in winter and spring precipitation but drier summer months overall.

The majority of the area is comprised of undeveloped upland habitat that is almost exclusively dominated by mixes of black spruce and jack pine. Wetlands comprise 11% of the study area and are primarily black spruce dominated swamps. Hunting is common, with the most popular targets being moose, bear, deer, and small game such as grouse and snowshoe hare.

The First Nations and Métis people in the region both on and off reserve are still actively harvesting traditional foods and edible and medicinal plants. Stakeholders and First Nations’ rights-holders have expressed concern over potential Project impacts to hunting (including deer and moose), fishing, berry and mushroom picking, wild rice, birds, and insects. The NWMO is working to engage with local Indigenous Nations, governments, and communities to further identify and confirm species of interest.

COMMUNITY CONCERNS

NOTE TO READER:

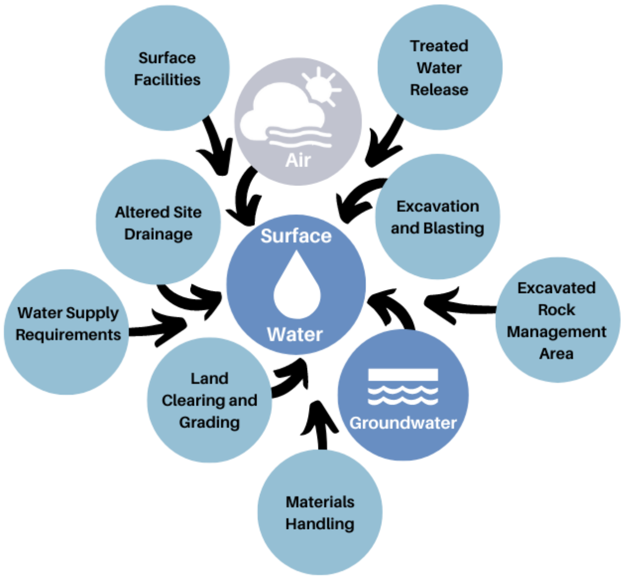
This document describes one of the first steps in examining how the Project may affect the environment, with consideration of concerns from community members from preliminary engagement sessions and workshops. The NWMO recognizes that engagement is an on-going collaborative process and additional concerns will be considered as the Project progresses.

Potential reasonable changes in the environment are identified, but it has not yet been determined whether these changes are important. For most of the changes identified, there are known, proven methods to reduce or eliminate the effect (mitigation measures). Some potential mitigation measures have been identified in this document.

Water Quality / Nibi / Where the Water Beings Live

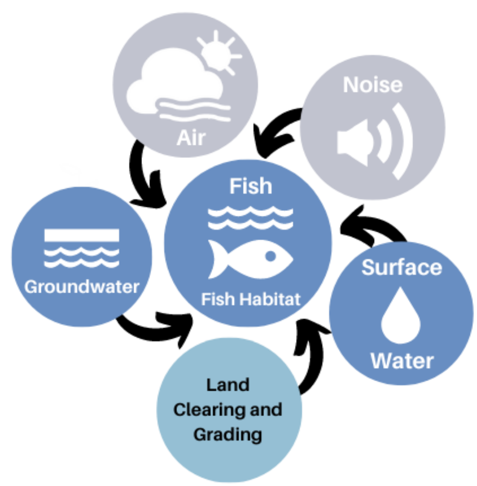
The protection of water quality is a high priority and many people have expressed how important it is to them. The Project may interact with surface water through the drawdown of groundwater from underground developments, release of water (treated or through run-off) to receiving waterbodies, or accidental release of contaminants to water from materials handling. Indirect interactions with surface water can also occur through airborne contaminants depositing into surface water or groundwater discharging into surface water.

Drawdown can occur when pumping water from underground. In some cases, it can affect surface water levels in nearby lakes, ponds, rivers, and wetlands. Changes in groundwater levels can also occur due to changes in the ground surface due to grading, paving, or diversion of surface water. To examine these possibilities, monitoring of groundwater and surface water levels will be conducted and these data will be used to develop, calibrate, and validate models before the project starts. This is common with mining projects. Information on the subsurface conditions (soil and rock types, groundwater flow patterns, groundwater quality) at different depths and locations will be needed to develop a robust and calibrated model.



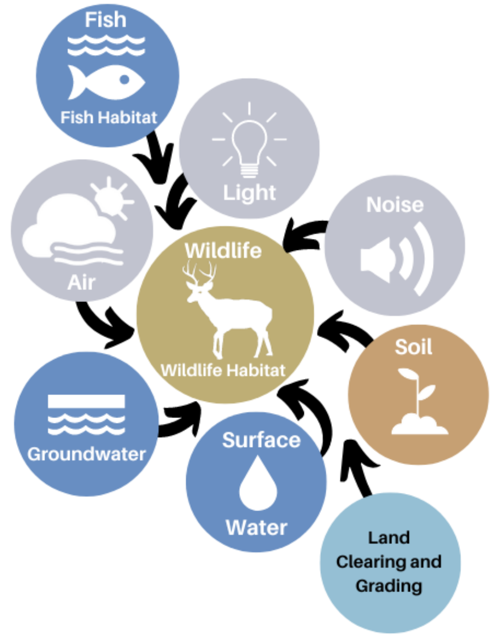
Water will be monitored and treated to meet applicable regulations before it is released. Both the quality and quantity of water released from the Project is important. It is expected that treated water released from the facility will be discharged to either the Revell River or the Mennin River. The Project will recycle and reuse service water to the extent practical to minimize the water needed. Design considerations such as limiting the Project footprint and paved areas to the extent practical will be included to minimize the water that needs treatment. For surface water run-off, proper handling and diversion will be important. Information is being collected now to help determine which locations would be the most suitable to take water from for use in the Project and then to release the treated water.

Fishing is an important part of life in this area, particularly walleye, lake trout, northern pike, lake whitefish, cisco, and white sucker. Fish can be affected by changes in water quality as well as physical changes in the environment where they live. Construction activities should also be timed to avoid disturbances during key periods, such as fish spawning periods. Additionally, regulatory guidance for protecting fish and fish habitat should be adhered to throughout construction activities.



Measures to protect fish and fish habitat through operations rely on ensuring water quality is protected. In all cases, a monitoring program will be designed with an understanding of the receiving environment built on the ongoing environmental baseline characterization program and will be in place to take samples of groundwater, surface water, sediment, and fish. Information on the current conditions is being collected to help understand conditions today. It is too early in the site characterization process to provide details on the program, but it will be designed to follow best practicies in terms of factors such as frequency, location, and number of samples. Trends will be examined and contingency measures can be set in place if the data show that the conditions are outside the expected range.

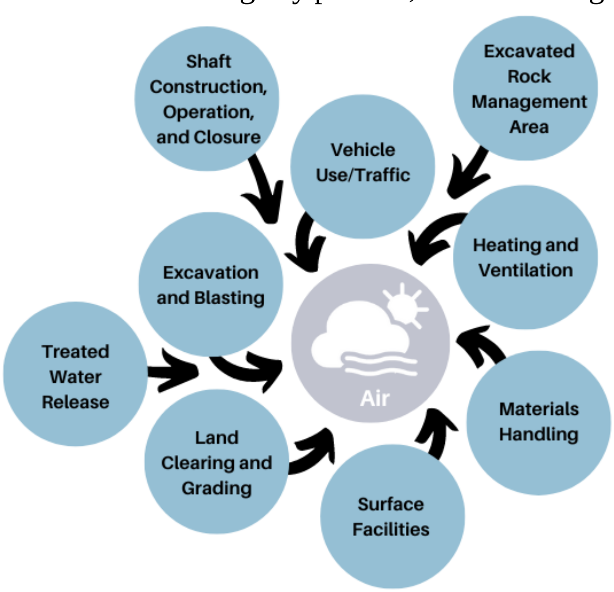
Protect and Enhance Natural Environment / Spirit of Everything (Aatsokewinan)



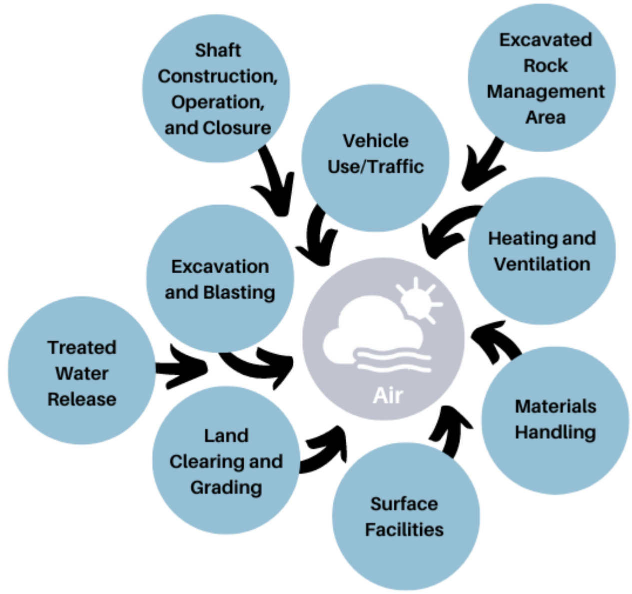
Protection of the natural environment - all living things and the habitats they need to be sustained - is very important to community members and the NWMO. Concern was expressed about wildlife (including birds such as Canadian Jays, deer and moose), fish, berries, mushrooms, wild rice, and insects. There are a number of activities that could affect the natural environment. There is a separate study for biodiversity that discusses this in further detail (Zoetica 2022); however, an assessment of how physical or chemical systems might interact with living things in their natural habitat was completed as part of this screening level review. Based on local Indigenous input, the importance of ceremony and the connection to the land and gifts from nature is recognized; incorporation of this will continue to be explored.

Project activities have the potential to interact with aquatic and terrestrial life through their changes to the physical environment including air, groundwater, soil, and surface water. Project activities also have the potential to result in the physical loss of available fish and wildlife habitat.

The facility should be positioned as much as possible to avoid ecologically sensitive areas, such as wetlands, and minimize water crossings. Construction activities should also be timed to avoid disturbances during key periods, such as during breeding bird nesting periods. Mitigation measures developed to reduce sensory disturbances (noise and light), protect air, water, and soil quality, and to ensure sufficient available water (both surface and groundwater) is available will also address potential interactions these components would otherwise have on aquatic and terrestrial life. Ultimately, as baseline data are collected and additional design information becomes known, the overall potential influence the Project may have on living things can be further assessed as part of the IA process. It will be important to incorporate IK into the assessment as well as conduct a holistic assessment.



Air, Noise and Light



During the engagement sessions, community members indicated that they were concerned about air quality and noise, particularly as it relates to increased traffic.

The Project will also have direct releases to the atmosphere during the site preparation and construction phases of the Project, from heavy equipment, land clearing and grading, excavation, drilling and blasting, materials handling and general construction activities. In addition, on-site operating facilities and infrastructure may have air and noise releases and vibration from sources like the main and ventilation shaft system, Used Fuel Packaging Plant (UFPP), compressor building, wastewater treatment facilities, surface fuel storage and dispensing facilities, concrete batch plant, and the excavated rock management facility. Mitigation measures, such as installation of air pollution control technology and barriers, can minimize releases. Temporary and permanent lighting systems employed during Project implementation are expected to generate light trespass/incidental light, glare and contribute to sky glow.

There are operational controls that can limit air, noise and vibration impacts from traffic such as enforcing speed limits, turning off vehicles when not in use, the use of dust suppressants on unpaved surfaces, using low-noise reverse alarms and controlling blast size and frequency. Electric vehicles can also be used to minimize releases of fuel combustion by-products and greenhouse gases. Similarly, lighting impacts can be mitigated through design measures that minimize light trespass and glare and through operational controls like switching and usage restrictions.

Excavated Rock Pile

The Excavated Rock Management Area (ERMA) is a Project activity that community members discussed. This is the rock that will be removed during the development of the DGR and placed on surface. Input was received that ceremony should be included for bringing rock up to surface that never should have seen light.

In addition, the ERMA has the potential to affect air quality (dust), soil, groundwater (leaching metals/minerals, salts, and residual explosives and change in the elevation), and surface water quality. This could then in turn affect wildlife and people. It also has the potential to change the appearance of the landscape.

The excavated rock pile will be placed in a location that facilitates construction and also minimizes the potential for impacts to waterbodies, streams, and wetlands. Leach testing of the rock will be done to understand the potential release of metals/minerals or salts from the exposed rock, which would influence the design of the rock pile, including whether a composite or multiple-layer liner system liner is required. The precipitation that falls on the pile will need to be managed and directed to a stormwater retention pond for treatment if it does not meet the appropriate guidelines before it is discharged to a natural water feature such as the Mennin or Revell rivers. Dust control measures can also be used to minimize the dust that would be generated from the rock. The rock pile can be built so that it fits into the natural topography (hills and valleys).

Cumulative Effects – Particularly Forestry

There was much discussion during the engagement sessions on the combined (cumulative) effect of the Project and forestry in the area. Baseline data are being collected now to help with this assessment, such as measuring baseline glyphosate levels in the environment. The full extent of the cumulative impact has not been explored in this document but will be completed as part of an IA if this site is selected for the location of the DGR. Baseline data are being collected now to help with this assessment, such as measuring baseline glyphosate levels in the environment. Design considerations, such as ensuring there is a buffer around the site to act as a fire break, will also be part of the planning for the Project.

Next Steps

The information contained within this report, including potential Project-environment interactions and mitigation measures, is being provided for community input. Feedback received through future engagement activities will help inform the CSM and future studies.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

Term	Description
ANSI	Area of Natural and Scientific Interest
AOI	Area of Interest
AMIS	Abandoned Mines Information System
APM	Adaptive Phased Management
BIS	Biodiversity Impact Studies
BMP	Best Management Practices
CNSC	Canadian Nuclear Safety Commission
CO	Carbon Monoxide
COPC	Contaminant(s) of Potential Concern
CSM	Conceptual Site Model
DFO	Department of Fisheries and Oceans Canada
DGR	Deep Geological Repository
DOC	Dissolved Organic Carbon
ECCC	Environment and Climate Change Canada
EEM	Environmental Effects Monitoring
EIS	Enviromental Impact Statement
EMBP	Environmental Media Baseline Program
EMP	Environmental Monitoring Program
ENRC	Environment and Natural Resources Canada
ERMA	Excavated Rock Management Area
GBIF	Global Biodiversity Information Facility
HHERA	Human Health and Ecological Risk Assessment
IA	Impact Assessment
IAIA	Impact Assessment Agency of Canada
IK	Indigenous Knowledge
m bgs	metres below ground surface
MECP	Ontario Ministry of the Environment, Conservation and Parks
MLAS	Mining Lands Administration System

MNO	Métis Nation of Ontario
MNRF	Ontario Ministry of Natural Resources and Forestry
NHIC	Natural Heritage Information Centre
NO	Nitrogen Monoxide
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NAG	Non-Acid Generating
NWMO	Nuclear Waste Management Organization
OPG	Ontario Power Generation
PAG	Potentially Acid Generating
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated Dibenzo-p-dioxins
PCDF	Polychlorinated Dibenzofurans
PHC	Petroleum Hydrocarbon Compound
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter with a diameter of 2.5 micrometers and smaller
PM_{10}	Particulate Matter with a diameter of 10 micrometers and smaller
SAR	Species at Risk
SO_2	Sulphur Dioxide
SWMP	Stormwater Management Pond
SVOC	Semivolatile organic compounds
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TSP	Total Suspended Particulate
UFPP	Used Fuel Packaging Plant
VOC	Volatile Organic Compound
WLON	Wabigoon Lake Ojibway Nation
WWIS	Water Well Information System

1.0 INTRODUCTION

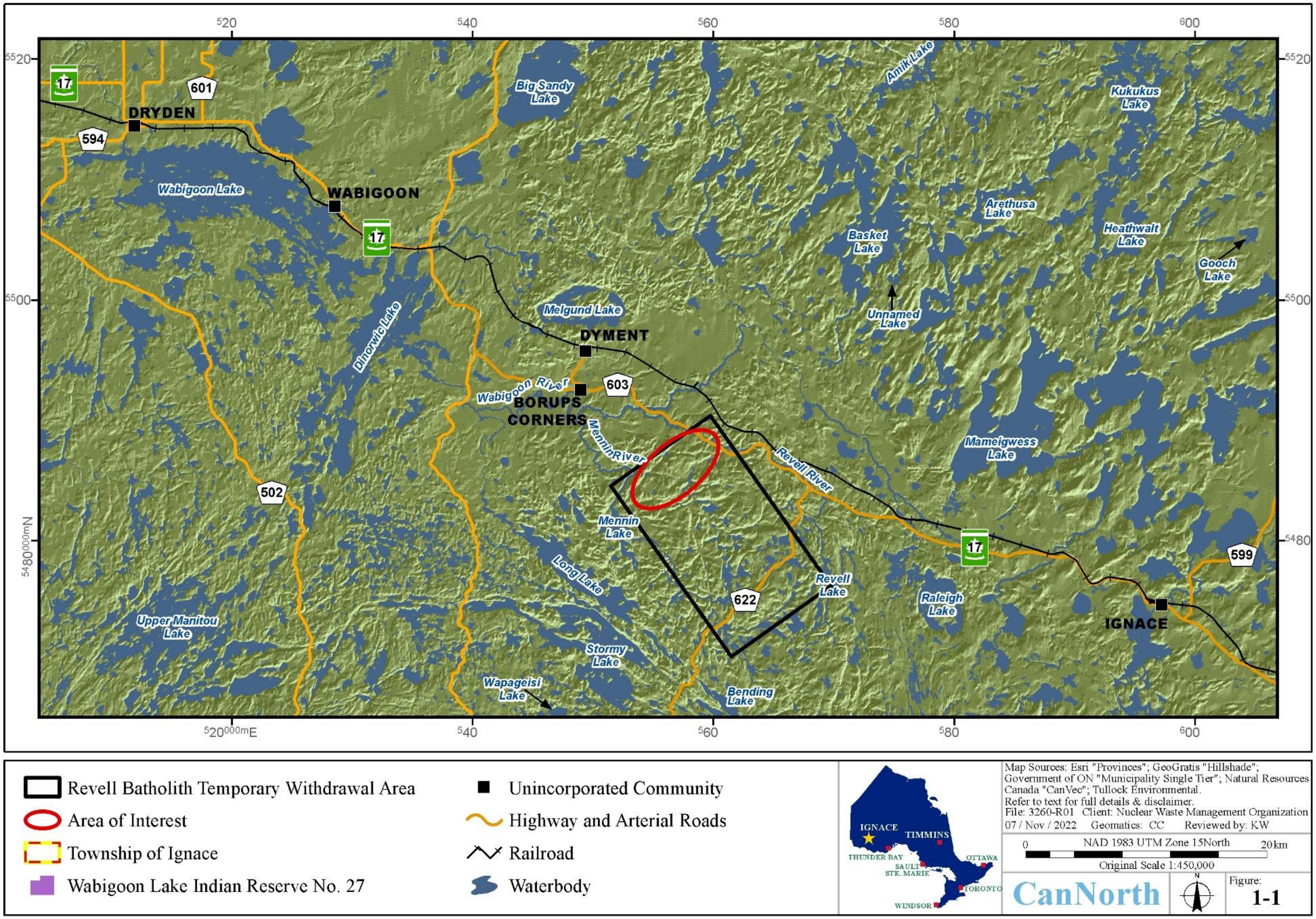
1.1 Background

The Nuclear Waste Management Organization (NWMO) was established in 2002 with the objective of developing and implementing a plan for the long-term management of Canada’s used nuclear fuel. The process has included the adoption of Adaptive Phased Management (APM), undertaking a siting process for the Deep Geological Repository (DGR) and associated infrastructure (hereinafter referred to as the Project), and conducting preliminary studies. From an initial list of 22 potential sites, 2 remain in the siting process as potential informed and willing hosts for the Project, including the Wabigoon Lake Ojibway Nation (WLON)-Ignace area in Northwestern Ontario, shown on Figure 1-1. The nearest First Nation is WLON. There are several neighbouring Indigenous communities in the area including the Métis Nation of Ontario (MNO). The NWMO is aiming to select a single preferred site in a suitable rock geosphere with informed and willing hosts by 2024.

The NWMO is actively engaging with local Indigenous Nations, governments, and communities throughout the site selection process to better understand the thoughts and concerns of people who wish to be engaged. From the results of the most recent (2021) Ignace community survey, Ignace residents indicated very high interest in the environment, including water, soil, wildlife, and air (CCI Research Inc. 2021). This *Conceptual Site Model and Screening Level Change Assessment* document is the first step in examining how the Project may affect the environment, and identifies technologies and systems that are commonly used to manage those potential environmental changes.

The purpose of this report is to share with local communities for input. It needs to be emphasized that at this time, the assessment has been conducted primarily through a Western Science approach. Additional discussion and input is required by rights-holders to reflect Indigenous Knowledge (IK) and a holistic view of the environment, within a harmonized approach.

Figure 1-1 Proposed location for DGR in Wabigoon Lake Ojibway Nation-Ignace area



1.2 Scope

This document provides the working Conceptual Site Model (CSM) for the biophysical environment that is being used to develop the baseline studies for the Project for the WLON-Ignace area. Biodiversity is an important part of the biophysical environment, information on this component has been included here; however a companion document has been prepared with additional detail (Zoetica 2022). Although interactions with socio-economic and human health have been identified at a high level, a CSM in support of these components will be developed separately.

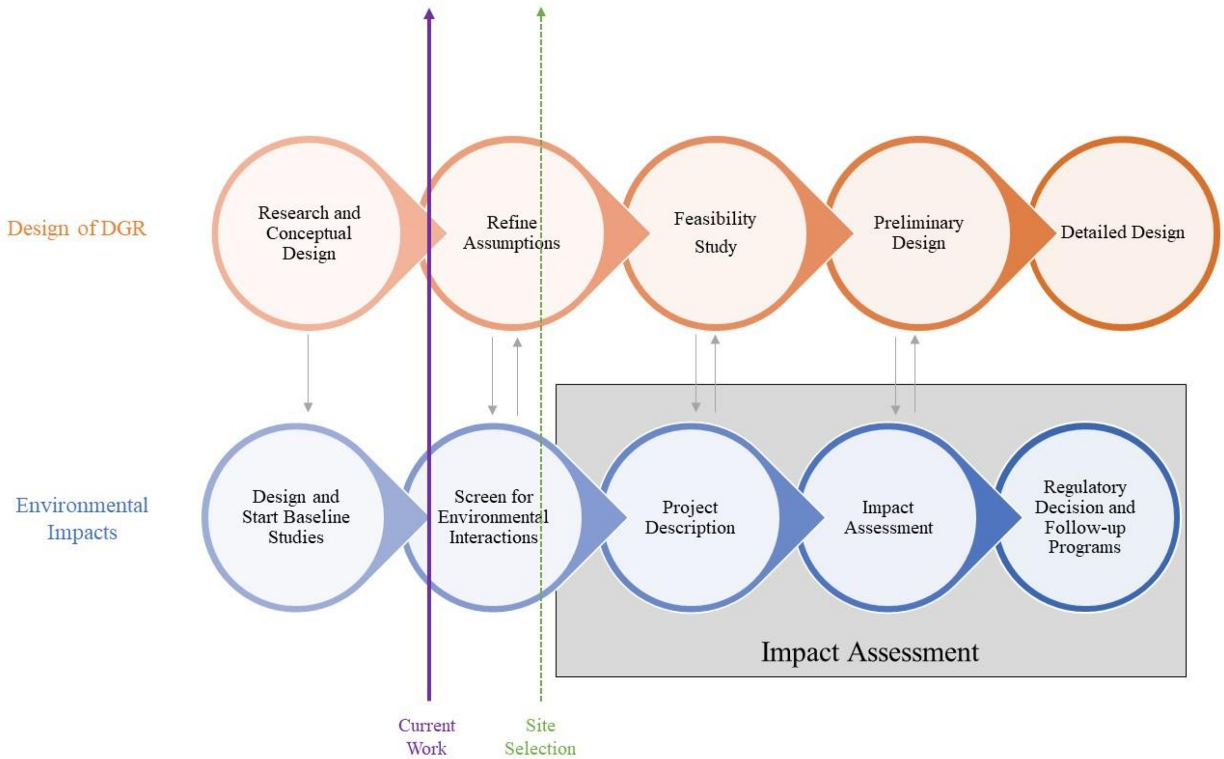
The information from the biophysical CSM and baseline studies will be used in the Impact Assessment (IA) if this site is selected for the location of the DGR. As the NWMO has yet to identify a preferred site, it is acknowledged that the IA process has not been initiated, and the Duty to Consult has not been triggered. The NWMO has been and will continue to engage with potentially impacted Indigenous peoples as the Impact Assessment Agency of Canada does not delegate its Duty to Consult.

This document also contains a screening level change assessment that examines the potential implications of the Project and incorporates comments and concerns that have been received by community members to date in the identification of potential changes. This screening level change assessment simply acknowledges when there may be a change to the environment because of the Project, it does not identify whether that change is important or significant. That information will ultimately be captured in a future iteration of the change assessment. Additionally, this screening level change assessment focuses on the Project activities and not potential cumulative considerations of other activities in the area. These types of assessments will be done in detail within an IA.

This document incorporates design considerations and identifies mitigation activities that can be considered to reduce or eliminate the likelihood of an effect. Additional information that would be required to assess effects has also been identified.

It is important to note that this work is not part of the IA process, as illustrated in Figure 1-2. It is part of the on-going development of the understanding of the community concerns, the environment, and the potential influence of the Project that NWMO needs to complete as part of its ongoing preparation.

Figure 1-2 Where initial screening stage falls within the biophysical environmental assessment process.



The scope of the CSM is specific to the normal Project activities on the Project footprint and does not consider transportation of materials to the Project site. The CSM integrates information from the various disciplines involved in the baseline programs to describe the local environment (i.e., the Environmental Media Baseline Program [EMBP] and Biodiversity Impact Studies [BIS]) and identifies how the various Project components interact with one another and the environment. It is intended to be based on Project- and site-specific information.

Development of the CSM for the original iteration of the EMBP involved a thorough review of documents provided by the NWMO prior to April 20th, 2019, related to the DGR in general and environmental work carried out in the region. It also required the application of numerous assumptions since the facility design and location had not been finalized. Any modifications to these assumptions based on updated design information are likely to impact the CSM. This current version of the CSM and screening level change assessment has been updated to include information from additional documents provided by NWMO prior to October 13th, 2022. See Section 1.4 for a list of documents consulted. The scope of this document has also been expanded beyond that of the CSM in the EMBP design to be inclusive of additional biophysical components, incorporate community input, and identify standard mitigation measures.

This CSM provides a narrative description of the study area and existing environment, identifies potential interactions between the Project and the environment, outlines the assumptions used in the development of the CSM, and compiles the information into a pictorial CSM. The CSM described herein is not a static document and will be updated as needed as the Project progresses and new information becomes available. This document identifies the possible Project interactions with the biophysical study components for Project activities at each of the five major stages of the Project (i.e., site preparation, construction, operation, extended monitoring, and decommissioning and closure) and includes a discussion of mitigation measures that could be used to reduce or remove the potential interaction. The document also identifies the data gaps and needed study plans for the potential interactions where there is not yet sufficient information to develop the needed mitigation measures.

1.3 Land Acknowledgement

It is acknowledged that the lands and communities discussed in this report are primarily situated on the Traditional Territory of the Anishinaabe people of Treaty 3 and the Métis Nation.

1.4 Documents Consulted

The following documents were reviewed for consideration in the CSM and screening level change assessment:

- AECOM. 2021. Preliminary flood hazard assessment at the Ignace study area. NWMO-TR-2021-26, December.
- Scatliff+Miller+Murray Inc. and InterGroup Consultants Ltd. (SMM and InterGroup) 2022. Ignace area community and culture study. Prepared for the Nuclear Waste Management Organization. October.
- Hatch & wsp Golder. 2020. Crystalline DGR facility construction plan. APM-TDM-04760-0201, Revision 1, December.
- Hatch & wsp Golder. 2019. NWMO conceptual design for Mark II underground repository in crystalline rock and sedimentary rock. APM-TDM-22100-0003, Revision 1, November.

- Hatch & wsp Golder. 2019. Excavated Rock Management Area study. APM-TDM-21110-0201, Revision 0, December.
- NWMO. 2022. Confidence in safety – Revell Site. NWMO-TR-2022-14, March.
- NWMO. 2021. Deep Geological Repository conceptual design report crystalline / sedimentary rock. Report number APM-REP-00440-0211-R000, September.
- NWMO. 2017. Postclosure safety assessment of a used fuel repository in crystalline rock. Report number TR-2017-02, Revision 000, December.
- Snowdon, A.P., S.D. Normani, and J.F. Sykes. 2021. Analysis of crystalline rock permeability versus depth in a Canadian precambrian rock setting. Journal of Geophysical Research: Solid Earth 126(5):e2020JB020998.

2.0 PROJECT INFORMATION

2.1 Description

The DGR will provide long-term containment and isolation of used nuclear fuel. Engineered and natural barriers will protect humans and the environment as radioactive decay occurs. The most recent design of the facility is presented in *Deep Geological Repository Conceptual Design Report Crystalline / Sedimentary Rock* (NWMO 2021).

The DGR will have facilities for operation, maintenance, and long-term monitoring. Certain areas of the surface facilities will have restricted access and will be located inside the Protected Area, which will include the Used Fuel Packaging Plant (UFPP), Main Shaft Complex, Service Shaft Complex, and Ventilation Shaft Complex. Surface facilities located outside the Protected Area include the Administration Building, Sealing Material Compaction Plant, and a Concrete Batch Plant. External facilities, located outside the DGR's perimeter fences, will include the Centre of Expertise, accommodation for construction personnel, and an Excavated Rock Management Area (ERMA) from the underground repository with associated stormwater management pond.

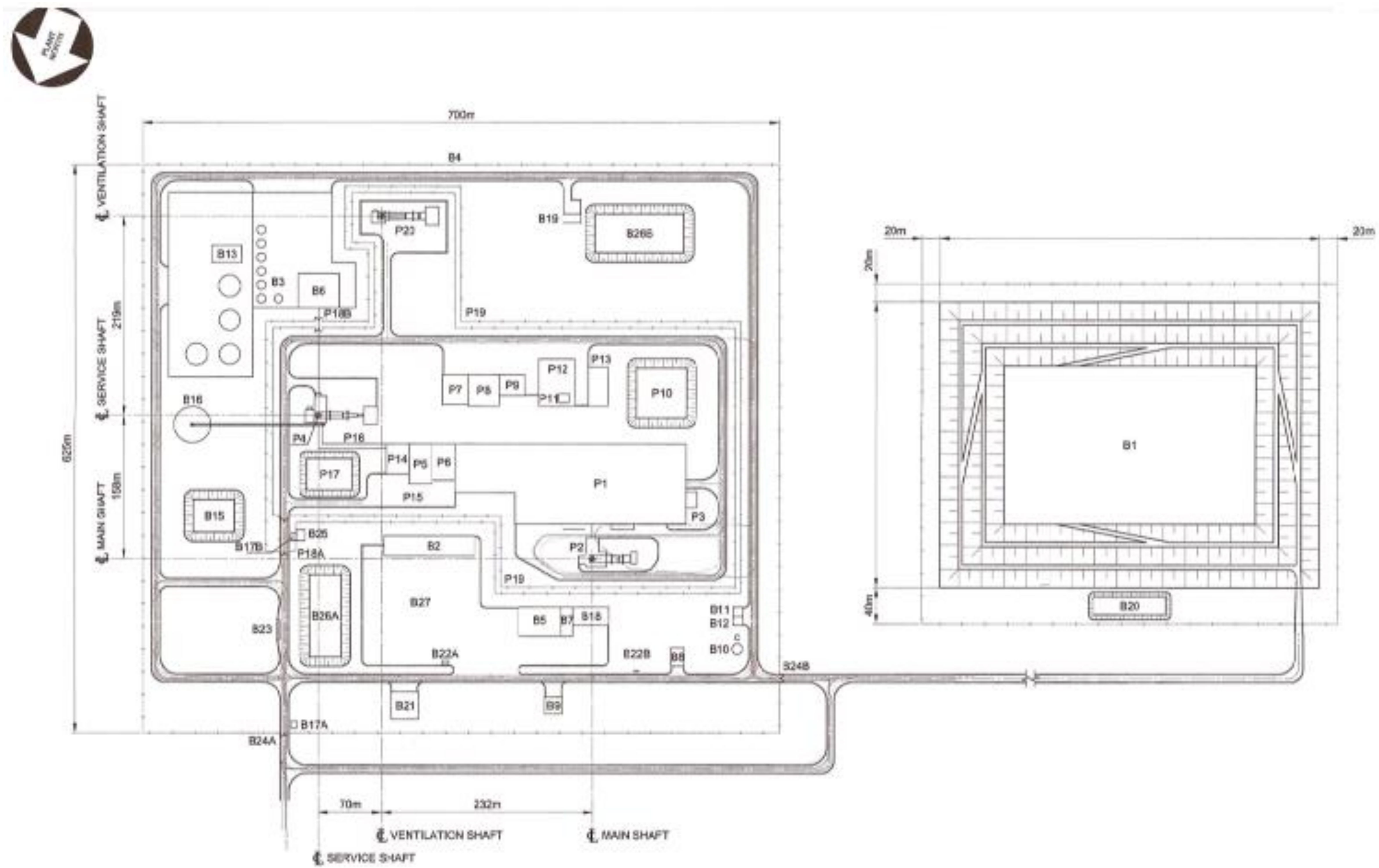
The current surface facilities layout is provided in Figure 2-1. A three-dimensional perspective of the surface facilities is provided in Figure 2-2. The land required to accommodate the Project will include an approximate footprint of 625 m x 700 m for the DGR surface facilities, and an approximate footprint of 500 m x 500 m for the ERMA (2.5 million m^3 stored in a pile with a maximum height of 15 m to 20 m). There is also likely to be a buffer that will be cleared beyond the fence boundary to serve as a fire break in the event of a forest fire in the future. Since the region is heavily forested, it is assumed there will be a 100-m fire break buffer for the DGR surface facilities and a 30-m buffer for the ERMA. Additional land will be required for access roads and potentially for a camp site. The location of the Project infrastructure is currently unknown. The Project will be accessible via the existing road network.

The CSM has been prepared with consideration of the following five major stages of the Project (NWMO 2021):

- Site Preparation: Site preparation includes obtaining the necessarily permits and licencing requirements. The site will be prepared for construction by clearing, site grading, installing fencing, installing temporary construction services, and establishing a storm water management system.

- Construction: The first phase of construction will be to excavate the shafts and an underground demonstration facility. The total site preparation and construction phase could be about 10 years.
- Operation: Operation will consist of receiving used nuclear fuel transported to the site, re-packaging the used fuel into long-lived containers, placing the used fuel containers in the repository, and continued underground development. These operational activities are expected to last about 50 years.
- Extended Monitoring: Following cessation of used-fuel placement activities, the placement rooms will be sealed and closed, but the access tunnels and shafts will remain open. A period of monitoring will continue for an extended period of time. For planning purposes, the period of extended monitoring is assumed to be up to 70 years. The preliminary decommissioning plan will be revised at the commencement of the extended monitoring period. Towards the end of the extended monitoring period, a detailed decommissioning plan will be prepared using information collected during the extended monitoring, and the detailed design of the shaft sealing system will be finalized.
- Decommissioning and Closure: The decommissioning of the facility will include sealing of access tunnels and shafts, and removal of surface facilities. The site will be restored to a defined end-state that will depend largely on future plans for the site (e.g., industrial, park). For planning purposes, a 10-year decommissioning period and 15-year closure period is assumed.

Figure 2-1 Surface facilities layout (generic)



Area	Protected Area
P1	Used Fuel Packaging Plant
P2	Main Shaft Complex
P3	Stack
P4	Service Shaft Complex
P5	Auxiliary Building
P6	Active Solid Waste Handling Facility
P7	Waste Management Area
P8	Active Liquid Waste Treatment
P9	Low-Level Liquid Waste Storage Area
P10	Stormwater Management Pond
P11	Switchyard
P12	Transformer Area
P13	Emergency Generators
P14	Quality Control Offices and Laboratory
P15	Parking
P16	Covered Corridor/PedestrianRoutes
P17	Mine De-watering Settling Pond
P18	Security Checkpoints
P19	Double Security Fence
P20	Ventilation Shaft Complex
B1	ExcavatedRock Management Area (ERMA)
B2	Administration Building including Firehall and Cafeteria
B3	Sealing Material Storage Bins
B4	Perimeter Fence
B5	Garage
B6	Sealing Material Compaction Plant
B7	Warehouseand Hazardous Materials Storage Building
B8	Air Compressor Building
B9	Fuel Storage Building
B10	Water Storage Tanks
B11	Water Treatment Plant
B12	Pump House
B13	Concrete Batch Plant
B14	Not Used
B15	ProcessWater Settling Pond
B16	Excavated Rock Stockpile (Working)
B17	Guardhouses (A, B)
B18	Storage Yard
B19	Sewage Treatment Plant
B20	ERMA - Stormwater Management
B21	Helicopter Pad
B22	Bus Shelters (A, B)
B23	Weigh Scale
B24	Security Checkpoints
B25	Security Monitoring Room
B26	Stormwater Management Ponds (A,
B27	Parking Area

Source: Modified from Figure 4, NWMO (2021)

Figure 2-2 Representation of DGR surface facilities

Source: Figure 5, NWMO (2021)

2.2 Project Assumptions

The current set of Project-related assumptions that have been made to develop the biophysical CSM and screening level change assessment are described below:

- The Project footprint will avoid as many waterbodies and wetlands as possible realizing that it will likely not be possible to entirely avoid wetlands given their abundance in the AOI.
- The above ground features of the facility will consist of five ponds that will be sized to accommodate a 1-in-500-year storm event and lined to prevent seepage to the groundwater.
  - There are two dewatering settling ponds and three stormwater management ponds to collect stormwater runoff for treatment. The five ponds will be designed with minimal potential for groundwater mounding and, under anticipated conditions, will not be likely to influence or adversely effect local shallow groundwater flow.
  - One service water settling pond.
  - One mine dewatering settling pond, which may contain sediments, nitrogen compounds, salinity, metallic elements or minerals and hydrocarbons.
- The above ground facility will be located at higher ground surface elevations in the local topography to be sufficiently above a 1-in-500-year flood event to the extent possible. Flood prevention and floodproofing mitigation measures will be designed and installed for the portion of the facility located within the 500-year floodplain.
- Service water will likely be sourced from a local waterbody.
- Potable water will be produced on site at the water treatment plant using the fresh/fire water tank as a supply source.
- Power will be supplied by the existing grid.
- Existing roads will be used, except for access road(s).
- Treated effluent(s) will be discharged during each of the Project phases.
  - During construction, dewatering water will be retained to reduce sediment before being released.
  - Water will be used for site facilities, such as the UFPP. This water would require treatment (e.g., radioactive particles) before release.
  - Sewage collected from the serviced buildings will be piped to an on-site sewage treatment plant for treatment to provincial standards prior to discharge with the other treated effluent streams.

  - The receiving waterbody is currently not known, nor is the quantity and quality of treated effluent(s); it is assumed that both discharges will occur to the Mennin River or Revell River, due to their larger size (solely based on size of river using aerial photography) and higher assimilative capacity (see Section 3.1.1).
- Excavated rock will be designed using best engineering practices which will include controls such a lining beneath the piles, water collection and management and dust controls. Under the anticipated Project conditions, excavated rock piles are not likely to influence and cause adverse effects on the local shallow groundwater flow.
- Dewatering rates utilized during the initial construction and operations will not significantly impact off-site and regional groundwater flow regimes or sensitive wetland areas. It is also assumed that the cone of depression will be minimized, for example by grouting in advance of sinking shafts to minimize inflow where needed.
- Appropriate operational protocols will be executed during the lifespan of the Project, and accidental surface releases of non-radiological chemicals and fuels will be prevented to the extent possible.

2.3 Public Concerns and Comments

The NWMO is conducting its activities related to the Project in a manner that protects the public and the environment, promotes community understanding, and incorporates community, First Nations, Métis, and stakeholder needs. The NWMO has initiated engagement sessions with rights-holders (e.g., WLON, Métis Nation of Ontario [MNO]) and stakeholders including municipal representatives, organizations and communities, key opinion leaders, community liaison committees, and citizens to better understand the thoughts and concerns of people who wish to be engaged. There will also be opportunities for other rights-holders to come on board and have their interests, values and concerns incorporated into the work. The activities are being carried out to contribute to a more detailed understanding of potential Project benefits, identify opportunities to work together, and determine how potential negative effects of the Project can be managed. Discussions are ongoing on various topics such as the basis for confidence in the safety of the Project, local land uses that need to be taken into account in planning field studies in the area, consideration of Spirit and ceremony, potential economic effects of the Project, and the long-term vision for the area held by local residents (NWMO 2017a).

Numerous open houses have been held in the area to support ongoing learning and engagement of people related to each major assessment and field activity (NWMO 2017a).

Representatives from the NWMO have also participated in many community and area events, and several opportunities have been provided for youth engagement to facilitate youth in learning more about the Project and to gain youth perspectives. One example is the engagement opportunities with the Toronto Zoo regarding their Bat Monitoring Programs.

Specific to the design of the EMBP, the NWMO held a series of workshops in 2018 and 2019 with stakeholders and rights-holders, including WLON and MNO, to provide direction to the EMBP design. During both rounds of workshops, participants repeatedly expressed concerns over cumulative effects of the Project. In other words, it was important to the stakeholders and rights-holders that the Project not be assessed in isolation, but rather in combination with the existing environment. It was also important to ensure protection of hunting and fishing resources and wildlife in general including deer and moose, fish, berries, mushrooms, wild rice, birds, and insects. The Project Participants also expressed concerns over the importance of inclusion of Spirit and ceremony, for example by making offerings of tobacco as a show of respect for the land, its inhabitants, and its history. The NWMO is committed to working with rights-holders to ensure that they can lead this aspect as desired.

When asked about questions/concerns that people had about the local environment, the most common responses related to water (lake, river, stream) and fish (pike, walleye), followed by animals/wildlife and the land. For the Project as a whole, community surveys have found that many of the residents in the area are neutral to positive, but are concerned about environmental impacts in particular:

- noise;
- dust;
- increased traffic on side roads;
- security of property; and
- access to existing trails for recreational use.

3.0 CONCEPTUAL SITE MODEL

The CSM summarizes information on the local environment that may be relevant to how the various Project components may interact with one another and the environment. Figure 3-1 provides a pictorial representation of the Project.

The focus of this CSM is on components of the biophysical environment that have the potential to be impacted by the Project which are directly related to land use in the area, the existing environment, and contaminants of potential concern (COPC). The original CSM was developed to support the EMBP design and has been expanded to be inclusive of additional biophysical components:

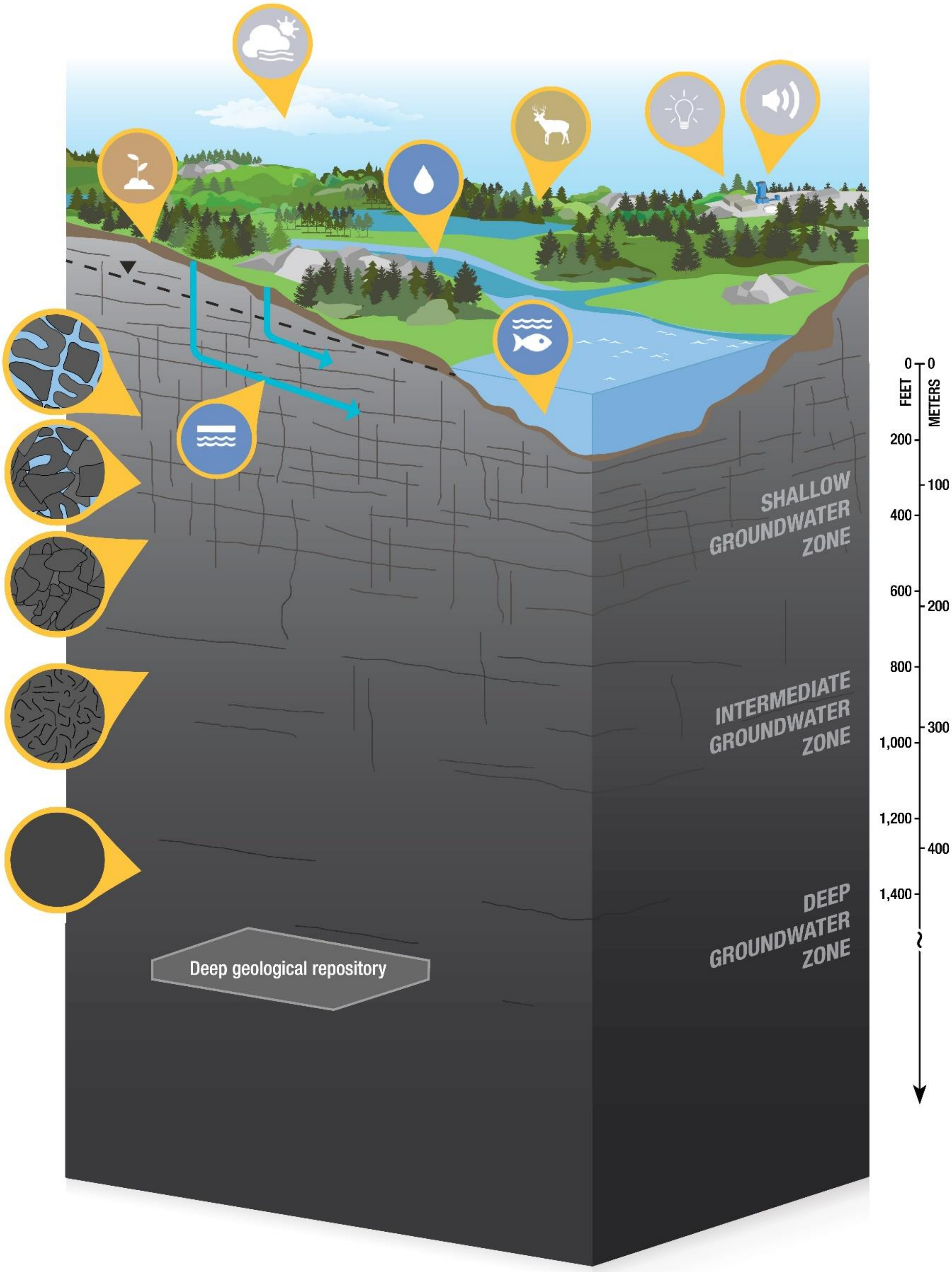
Physical Environment

- Air
- Noise
- Light
- Soil – subsurface soil and bedrock (to 100 m below ground surface)
- Shallow groundwater (focus is on groundwater in top 100 m below ground surface)
- Surface water

Biological Environment

- Fish and fish habitat
- Wildlife and wildlife habitat

Figure 3-1 Conceptual Site Model for the biophysical environment



Note: 1000 m reflects the extent of deep drilling being completed by the NWMO.

3.1 Study Area and Existing Environment

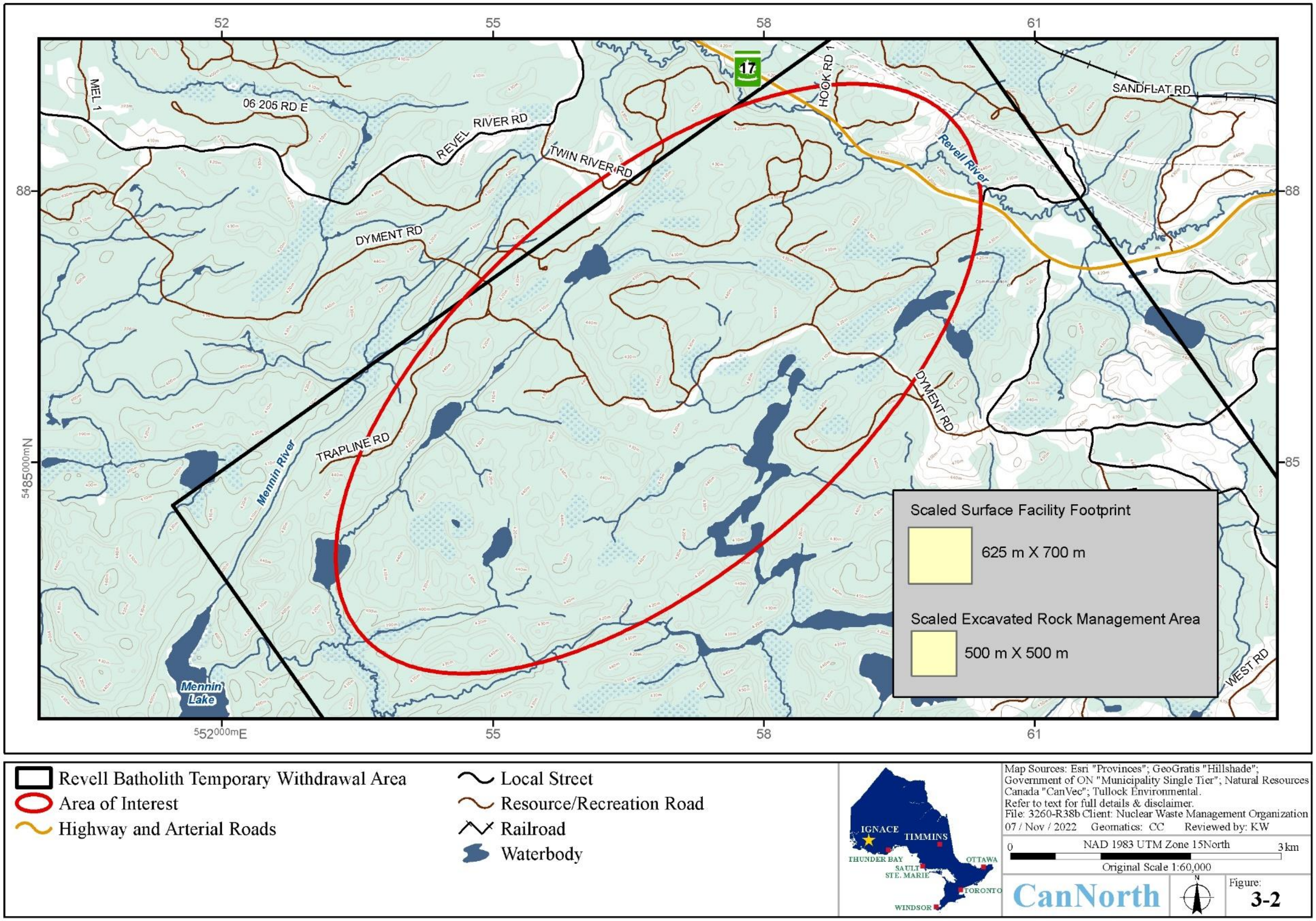
The NWMO has selected a potential geologically suitable area for the Project in Northwestern Ontario, located approximately 40 km west of the town of Ignace within the northern portion of the Revell Batholith within the Wabigoon Subprovince of the Superior Province in the Canadian Shield (Figure 1-1). The Wabigoon Subprovince is host to a series of granitic to granodioritic units that intrude metamorphosed volcanic and sedimentary rocks of greenstone belts. Granitic intrusive units in the area include the Revell, Indian Lake, White Otter Lake, and Basket Lake batholiths (Paterson Grant and Watson Limited 2013).

The potential geologically suitable area (Area of Interest, or AOI) is defined by an ellipse (oval) that is approximately 4.4 km by 8.7 km and extends from immediately north of Highway 17 in a southwest direction (Figure 3-2).

Within the AOI are two primary roads (Dyment and Trapline roads), a network of operations roads and temporary access roads constructed to support borehole drilling and logging, and several small watercourses and wetlands. Based on published maps and aerial photographs of the AOI, it is relatively flat (elevation range of ~30 m) and consists of several small lakes, streams, and wetlands; there are, however, several larger waterbodies in the area, such as Mennin Lake which is located approximately 2 km southwest of the outer extremity of the ellipse delineating the AOI, and Raleigh Lake which is approximately 20 km southeast of the AOI. Beyond the AOI, potential Project-environment interactions near to ground surface are also being evaluated with increasing distance from the Site (i.e., in the local and regional study areas).

Further refinement of the study areas may require engagement with Indigenous Nations, governments, and communities who may identify other areas of importance such as lands of cultural or recreational importance or those used for commercial purposes (e.g., forestry). The local and regional study areas that are being developed in support of the biophysical environment CSM may differ from those being developed in support of the social and human CSM.

Figure 3-2 Area of Interest



3.1.1 Surface Water

The AOI lies within the Wabigoon watershed, which drains from Raleigh Lake northwest to Wabigoon Lake. The region is drained by the English, Wabigoon, and Turtle rivers, which in turn make up part of the Nelson drainage system (Figure 3-3). The northern portion of the area contains several small, connected waterbodies that are currently unnamed. These unnamed waterbodies collectively drain into Mennin Lake, which is located approximately 2 km southwest of the outer extremity of the ellipse delineating the AOI. Mennin Lake flows north into the Mennin River, and then northwest into the Wabigoon River. Other streams in the area appear to be intermittent based on exhibited intermittent subterranean flow (Tulloch 2018a).

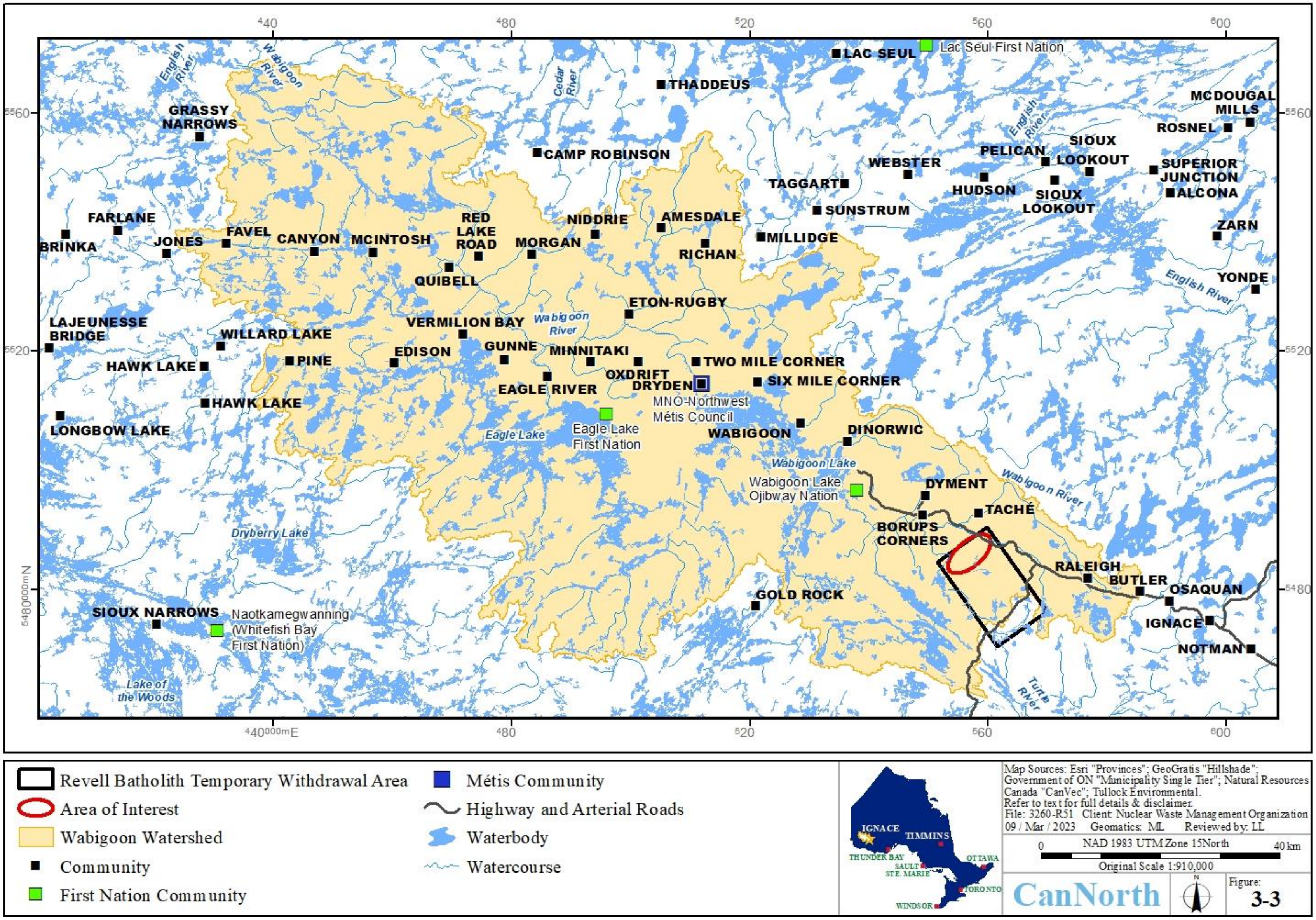
The Northwestern Ontario region contains many lakes of various sizes, 27 of which are larger than 10 km^2 and 10 of which are larger than 20 km^2, with about 18% (1,115 km^2) of the total surface area occupied by waterbodies (JDMA 2013b). The Revell Batholith contains no lakes larger than approximately 5 km^2; the largest lakes on this batholith are Revell Lake (5.1 km^2) and Mennin Lake (4.9 km^2) (JDMA 2013b). Mennin Lake is described by the Ontario Ministry of Natural Resources and Forestry (MNRF) Aquatic Resource Area data as a cool water thermal regime known to support 11 fish species (Tulloch 2018b).

Aerial photos indicate there has been logging in the northeast region of the AOI which may influence the local surface water flow, which would causing more runoff due to a decrease in interception and reduced infiltration. While there is a moderate change in elevation between the lowland areas with wetlands and watercourses, it is unclear whether local flooding occurs within the AOI. Hydrology studies completed as part of the EMBP may help to determine this.

Many of the waterbodies in the AOI are in headwater basins that contribute flow to Mennin Lake, with water flowing generally to the southwest. In addition, the northwest area of the AOI crosses with the ridge line between the Revell River and Mennin River basins, which both eventually go into Wabigoon Lake. Close to Mennin Lake, the surface topography appears to be very flat with multiple stream courses and wetlands criss-crossing the landscape. The largest rivers appear to be the Mennin River to the southwest of the AOI and the Revell River in the northeast section of the AOI. Given the larger flows in these two rivers, they are more likely candidates for water withdrawals and assimilating effluent discharges.

Given the topography, small drainage basins, and number of wetlands it will be important to understand the flow ranges in these streams, including whether some of them are intermittent, whether the wetland areas may be intermittent, and whether any seasonal flooding may occur. Understanding the flows will also inform the site design for water withdrawal needs and effluent discharge needs and how to effectively reduce water quality impacts. Given the location of watercourses and wetlands, there are areas within the AOI that may serve as good sites since they would not impinge upon watercourses or wetlands, although this is only one of factors for selecting the final site. This is being investigated further by NWMO and will also rely on information collected for the hydrology component of the EMBP. This information will be important for the construction, operations, and extended monitoring phases of the facility.

Figure 3-3 Overview of the Wabigoon watershed



3.1.1.1 Hydrology

Hydrology is the study of water in an environmental in regard to the way it moves, distributes, and is managed by naturally occurring and human influences. Hydrological condition is an important component of the site characterization of the baseline features of the Project as it supports many human and ecological components and has the ability to be aligned to serious affects from extreme weather events that need to be modeled and accounted for. The hydrology parameters component of the EMBP includes surface water features, meteorological, flow and velocity.

The Atikokan and Dryden meteorological stations are located approximately 140 km southeast and 65 km west from the AOI, respectively. The Northwestern Ontario region on average experiences 25 mm to 100 mm of precipitation per month and about 240 cm of snowfall per year, and therefore is unlikely to experience drought conditions that would affect local waterbodies. Local lakes and waterbodies are expected to freeze in the winter months (November to March).

More site-specific precipitation and meteorological data are required to better understand the hydrology in the AOI, especially with regards to seasonal weather patterns (rainfall and snowfall) and assess the potential for flooding and freezing near the facility. This information will also be important for stormwater and hydrology modelling to understand how much water is running off the surface facility and needs to be treated before discharge.

The Preliminary Flood Hazard Assessment for the WLON-Ignace area found that the AOI is mostly located near the headwater areas, which makes it less sensitive to extreme precipitation (AECOM 2021). However, a portion of the AOI is likely going to be within the floodplain. The selection of the exact location of the surface facilities proposed for the DGR, including the protected areas inside of the fences and the ERMA, should take into consideration the extent of the floodplain. If a portion of the surface facilities is located inside of the floodplain, appropriate mitigation measures should be designed and installed to minimize property damage and environmental impact caused by the potential flooding events. This assessment should also incorporate potential impact from climate change which may lead to more extreme rainfall events and changes in thawing season.

Waterbody maps have confirmed the presence of many wetlands within the AOI. Historic and more recent flow data are not available for the streams within the AOI. More detailed and site-specific information on flow, floods, and wetlands are proposed to be collected as part of the baseline monitoring program to better characterize the AOI and to better understand potential interactions between surface water features and the facility.

Outside of the AOI, downstream areas on the Revell River and below Mennin Lake on Mennin River downstream to the confluence with the Wabigoon River. The baseline conditions on both rivers are being studied as part of the baseline monitoring program to better understand the interactions that may occur from either a water withdrawal or effluent discharge, which are more likely to occur in these larger rivers than the small streams in the AOI.

3.1.1.2 Surface Water Parameters

The surface water parameters component includes parameters such as sediment quality, plankton, and benthic invertebrates. Surface water parameters are essential components when conducting site characterization of a DGR facility (CNSC 2018), as the Project has the potential of affecting aquatic environments through multiple pathways.

The area includes waterbodies with the potential of being impacted by the Project, as well as potential reference areas. An assumption is being made that treated effluent will be discharged through a single discharge point into either the Mennin River or the north part of the Revell River located downstream of the AOI. Furthermore, it is assumed that discharge will not occur upstream of Mennin Lake due to the small size and assimilative capacity of the upstream waterbodies located in the AOI.

There are lakes of significance to the communities within the regional area. The objective of sampling the regional waterbodies is to obtain baseline data on components of concern identified during various engagement workshops (such as water quality and invasive species) so that there are baseline data for comparison to long-term monitoring data collected during subsequent Project phases. Waterbodies near to Ignace that may be of fishing importance may include, among others, Agimak, Osaquan, Kekwanzik (Michel), and Indian lakes. Additionally, Kekwanzik Lake provides the source water for the Town of Ignace. None of these lakes are downstream of the AOI.

3.1.2 Geological and Hydrogeological Environment

The bedrock geology of the AOI is defined by the Revell batholith, an elongate northwest-trending pluton estimated to be 40 km in length and 10 km to 15 km in thickness. The 2.67 billion year old batholith is heterogeneous, ranging in composition from tonalitic (plagioclase- and hornblende-rich) to granitic (potassium feldspar-rich). Other mineralogical heterogeneity within the unit occurs in the form of pegmatitic dykes and increased potassium and aluminum-rich minerals (e.g., micas) in zones of weakness. Surficial lineament density in the Revell batholith is high, but it is uncertain if these represent real bedrock structures and how far they may extend to depth (Golder 2013a; JDMA 2013a).

Well records in the WLON-Ignace area only contain hydrogeological information on the overburden and shallow bedrock aquifers. From the Ontario Ministry of the Environment, Conservation and Parks (MECP) water well database, there are 120 water wells in the area, of which only 85 provide useful information regarding the aquifer, yields, and other hydrogeological parameters. None of the existing wells are within the AOI but some are within the larger study areas. No published information is available on the deep bedrock hydrogeology at the typical repository depth of approximately 500 m although the NWMO has conducted a significant number of tests in the deep bedrock and is finalizing reports of the data. Overburden aquifer wells ranged from 4.5 m to 42 m deep and shallow bedrock aquifer wells ranged from 5.5 m to 154 m deep. Aquifer tests conducted on these wells measured pumping rates of 4.5 L/min to 930 L/min for the overburden layer and 0 L/min to 206 L/min (typically 30 L/min to 40 L/min) for the shallow bedrock (Golder 2013a).

The regional groundwater flow of this area typically follows the topography. In the northwest portion of the WLON-Ignace area, regional flow can be assumed to be influenced by the Wabigoon River watershed in which the flow direction is towards the northwest (Golder 2013a). Limited information is available with regards to the hydrogeological properties of the deep bedrock in the WLON-Ignace area, although ongoing drilling and testing is providing the necessary data to evaluate this. Experience from other areas in the Canadian Shield has shown that groundwater flow in bedrock is generally confined to the shallow fractured bedrock systems. The low topographic relief of the Canadian Shield tends to result in low hydraulic gradients for groundwater movement in the shallow active region (Golder 2013a). Literature references from the Whiteshell Research Area, Atikokan, and East Bull Lake reported hydraulic conductivity values between 10^{-15} m/s and 10^{-10} m/s at typical repository depths (between 400 m to 500 m) and an average near-surface value of 10^{-8} m/s.

The fracture networks in the bedrock (shallow and deep) and the nature of the overburden layers are being evaluated to determine the site-specific hydrogeology. Hydrogeological parameters of interest include hydraulic conductivity, specific storage, primary/secondary porosity, horizontal/vertical hydraulic gradients, fracture aperture and spacing, and bulk density. The zone of influence of on-site dewatering activities should be determined in order to minimize/prevent alteration of the shallow and overall site groundwater flow regime.

3.1.3 Soil and Bedrock

Soil is the naturally occurring, unconsolidated mineral or organic material at least 10 cm in thickness that occurs at the earth's surface and is capable of supporting plant growth (Soil Classification Working Group 1998). Scientifically, the term "naturally occurring" for soils includes the disturbance of the surface horizons by human activities such as cultivation and logging, but not displaced materials such as stockpiled gravel or excavated rock. The definition of the soil medium for this baseline study is expanded to include soil and rock that is placed on surface as a result of excavation during construction activities (including consolidated and unconsolidated material).

Surficial soils in the study area are generally assumed to consist of the erosional-depositional products of quaternary glacial till. Quaternary units composed largely of glacial till deposits constitute the overburden material at the site area, which is estimated to be between 0 m and 30 m thick and may contain permeable and possibly unconsolidated material. In the vicinity of the site area, approximately 70% of the land surface consists of exposed bedrock or bedrock (Revell Lake batholith) covered by only a thin mantle of unconsolidated quaternary sediments (Golder 2013a; JDMA 2013a).

Environmental baseline characterization will be required to describe and characterize the distribution of existing surface terrain and associated soil quality and sensitivities within the local and regional soil study areas . Geochemical characterization will also be required to inform decisions on excavated rock and overburden placement within the AOI and ensure that storage of excavated materials is designed using best engineering practices. The soil study area includes the land beyond the AOI where there is the potential for effects to occur from the Project (e.g., through runoff, dewatering activities, etc.), and also extends beyond the local area to capture areas with support services and which may be affected by soil carried by prevailing winds.

3.1.4 Atmospheric Environment (Air Quality, Noise, and Light)

The local atmospheric environment is characteristic of a northern Ontario air shed, where local, regional, and national/international sources of COPC contribute to local air quality.

Within the WLON-Ignace area, there are several industrial sources that release COPC into the air shed, including the Domtar Inc. Dryden Mill, Resolute Forest Products, Ignace Sawmill, and TransCanada PipeLines Ltd.'s Station 58. These industries contribute to releases of fuel combustion by-products (i.e., CO, NO_X, SO_2, particulates) and in some cases, releases of volatile organic compounds VOCs), polycyclic aromatic hydrocarbons (PAHs), dioxins and furans, metals, chlorinated hydrocarbons, and sulphides. In addition, the intersecting rail corridor and Trans-Canada highway also contribute to releases of fugitive dust as well as fuel combustion by-products and noise. Diesel-fired power generators in remote First Nation communities also contribute to releases of fuel combustion by-products. Intermittent and seasonal sources (i.e., forest fires) will also effect existing and future air quality. In terms of light impacts, it is noted that there are limited sources in the area (i.e., intrinsically dark).

3.1.5 Biological Environment

The WLON-Ignace area lies in the Severn Uplands, featuring numerous lakes and the broadly rolling surfaces of Canadian Shield bedrock that occupies most of northwestern Ontario. It lies in a transition zone between the Boreal and the Great Lakes-St. Lawrence Forest, with the two major surface soil types (clay and sand) supporting conifer and mixed forest types with spruces, pines, cedar, tamarack, poplars, birch, and ashes. The region's forests provide habitat for wildlife, including game, fur-bearing mammals, and birds (NWMO 2013).

The community of Ignace website describes some of the most popular hunting targets as being moose, bear, deer, and small game such as grouse and snowshoe hare (https://www.ignace.ca). Recreational fishing is important in the region, with hundreds of lakes available for angling and nearby resorts providing fishing trips and excursions. The most popular species include walleye, northern pike (*Esox lucius*), lake trout (*Salvelinus namaycush*), brook trout (*Salvelinus fontinalis*), smallmouth bass (*Micropterus dolomieu*), lake whitefish (*Coregonus clupeaformis*), sauger (*Sander canadensis*), and yellow perch (*Perca flavescens*).

Information characterizing habitat types, vegetation, and wildlife in the AOI and surrounding area is being collected in the Biodiversity Baseline Study. The recent report (Zoetica 2022) provides more information on this topic.

3.1.5.1 Biodiversity

Biodiversity is defined as the variability among life, including within and between species, and among ecosystems. The variability in life and ecosystems forms the basis for ongoing evolution and is required for life to remain resilient. Biodiversity includes considerations of ecological functions that contribute to human well-being and spiritual well-being, which is integrated into the program as a study of ecosystem function and services.

The BIS follows a tiered approach where each successive tier involves the study of progressively more focused studies for selected biodiversity values. The study is currently in Tier 1 which focusses on the collation of existing data on species presence, known important habitats, and the collection of foundational habitat information through terrestrial ecosystem mapping, aquatic habitat mapping, and identification of candidate significant wildlife habitat foundational information on habitats and initial studies (e.g., eDNA metabarcoding studies) to document potential species presence. These studies will help to direct more specific Tier 2 studies.

Tier 1 studies have focussed on the collation of the following data:

1. Species of interest (species of special concern, species of interest to stakeholders and rightsholders, invasive species)
2. Important habitats (for supporting species of interest including critical habitat, significant or candidate significant wetland habitat, and important fish habitat)
3. Wetland and riparian habitats
4. Ecosystem functions and services including Ecosystem components that help to protect wildlife and or provide important ecosystem functions, and regulatory or provisioning services and cultural services within the context of biodiversity.

Biodiversity of the area is discussed in more detail elsewhere (Zoetica 2022).

3.1.5.2 Tissues

Obtaining and chemically analysing tissue samples is an important component of baseline studies as it provides data to be used in Human Health and Ecological Risk Assessments (HHERAs), the IA, and postclosure safety assessments. It also establishes baseline contaminant concentrations to which data from future monitoring programs can be compared.

The First Nations and Métis people in the region are still actively harvesting traditional foods and edible and medicinal plants. Results from the First Nations Food, Nutrition, and Environment Study (FNFNES) across Ontario in the same ecozone (Boreal Shield, Subarctic) indicated that approximately 80% of those interviewed consumed wild game and fish, 54% consumed wild birds, 63% wild berries and/or nuts, and 34% wild plants (Chan et al. 2014). Traditional foods including moose, fish species (especially walleye/yellow pickerel, lake whitefish, northern pike, lake trout, white sucker), and duck were important traditional foods in the region. The socio-economic baseline will collect information on the type, and general harvest locations of traditional foods consumed by local stakeholders/rights-holders close to the proposed Project area. This information would help to further define the study areas for the tissue sampling component of the baseline studies.

3.2 Land Use

A review was undertaken of historic and current land use in the area to help identify potential components that may have Project interactions and need consideration in the study design and future cumulative effects assessment. Being located in northwestern Ontario, there is a high likelihood that there are historic and/or current mining operations in the region. Forestry operations (cutting, milling, etc.) are also widespread in the region.

3.2.1 Historic Activities

Using the Abandoned Mines Information System (AMIS; Ministry of Mines 2019), no abandoned mines were found within the AOI or Revell Batholith Temporary Withdrawal Area, as shown in Figure 3-4; however, there are several abandoned mines in the region, including several that are in close proximity to the Mennin Lake drainage downstream of the AOI. According to AMIS, the abandoned mines contain a variety of hazardous features such as water-filled shafts, rotten tramway and mill foundations, leaching and tailing areas, and open cuts.

There are 45 known archaeological sites in the WLON-Ignace area, seven of which are found within the boundaries of the Township of Ignace. The potential for other archaeological and historical sites, particularly around Agimak Lake where others sites have been documented, is high. Sites identified at the periphery of the area include pictographs or rock paintings, pre-contact Aboriginal sites, and Euro-Canadian sites (NWMO 2013).

3.2.2 Current Activities

Current land use in the area is shown in Figure 3-4. The land features consist mostly of forest, pasture, wetlands, and open land with man-made or recreational looking paths and trails. There are limited transportation corridors and no discernable development in the immediate area.

There is recreational use of the area, including ATV trails that the Melgund Local Services Board (Dyment) has reported use of by community members and property owners along Long Lake (see Figure 3-5). The residents of Ignace and other local communities have strong connections to the surrounding natural environment. It is a source of pride and adds to their sense of place and quality of life. The natural setting provides various opportunities for fishing, forestry, hunting / trapping, and tourism (SMM and InterGroup 2022). Tourism is an important industry in the region, with the WLON-Ignace area containing numerous provincial parks, conservation reserves, and hunting and fishing lodges (SENES 2013).

The most active industry in the region is forestry. The AOI and immediately surrounding area is predominantly located within the Wabigoon Forest Management Unit (MU #130), within the Dryden District and the Northwest Region of the MNRF. Dryden Forest (MU #535) is to the north of the AOI. As per the Forest Management Plans for MU #130, the total planned harvest area was 70,946 hectares (ha) from 2008 to 2018, and 57,051 ha from 2019 to 2029 (MNRF 2019). Between 2008 and 2018, only 67% of the planned harvest area was in fact harvested because of the down turn in the forest economy (Domtar 2018). Current and planned forestry land uses for the region and AOI are described in the Forest Management Plans for MU #130 and MU # 535[1]. The spatial data underlying the maps in the plans were not available from the MNRF at the time of writing and, thus, forest land uses have not been included on Figure 3-4. Pesticide (VisionMAX™ Silviculture Herbicide # 27736 at a concentration of 356 grams of glyphosate per litre) is applied annually in MU #130 by aerial spraying over a two-month period, generally from August 1 through to September 30, for site preparation or vegetation management of regenerating areas.

There are no active mines within 25 km of the AOI; the nearest mines are Rainy River Gold Mine 165 km to the southwest and North American Palladium Ltd. (Platinum Group Metal Mine) approximately 190 km to east (Ontario Prospectors Association 2019). The

[1] The plans can be accessed at https://nrip.mnr.gov.on.ca/s/fmp-online?language=en_US.

Goliath Gold Project is a proposed open-pit and underground gold mine located approximately 35 km to the northwest of the AOI (see Figure 3-6). Treasury Metals recently completed its federal Environmental Assessment, receiving government approval in August 2019 to proceed with obtaining additional authorizations and permits. Treasury Metals also owns the nearby Goldlund Gold Project, which is in the exploration and development phase. The Bending Lake Iron Project, located approximately 20 km south of the AOI, is a proposed iron ore mine and on-site metal mill that is currently in the IA stage (see Figure 3-6). There are other mining projects in the exploration phase that are further afield and future iterations of the CSM will consider the applicability of these projects.

Other active operations in the area include hydro dams, with the nearest dam approximately 100 km northwest at Lac Seul. Ontario Power Generation (OPG) operates the Atikokan Generating Station, which was converted to operate on biomass in 2014, approximately 90 km southeast of the AOI. Since October 2018, the Independent Electricity System Operation (IESO) has advised Hydro One Inc. that a need for additional capacity will arise in the mid-2030s to accommodate energy needs of future mining projects proposed for the region. As a result, the Northest Bulk Transmission Line Project has been identified as a priority, which consists of a new double-circuit 230 kV line between Thunder Bay and Atikokan and a single-circuit 230 kV line from Atikokan to Dryden.

The International Institute For Sustainable Development (IISD) also has their Experimental Lakes Area, with 58 small lakes and their watersheds set aside for scientific research around the impacts of climate change, agricultural runoff, water management, contaminants such as mercury and organic pollutants, and a growing list of chemical substances. However, the nearest lake is over 100 km to the west of the AOI.

Figure 3-4 Land use map of the of the region

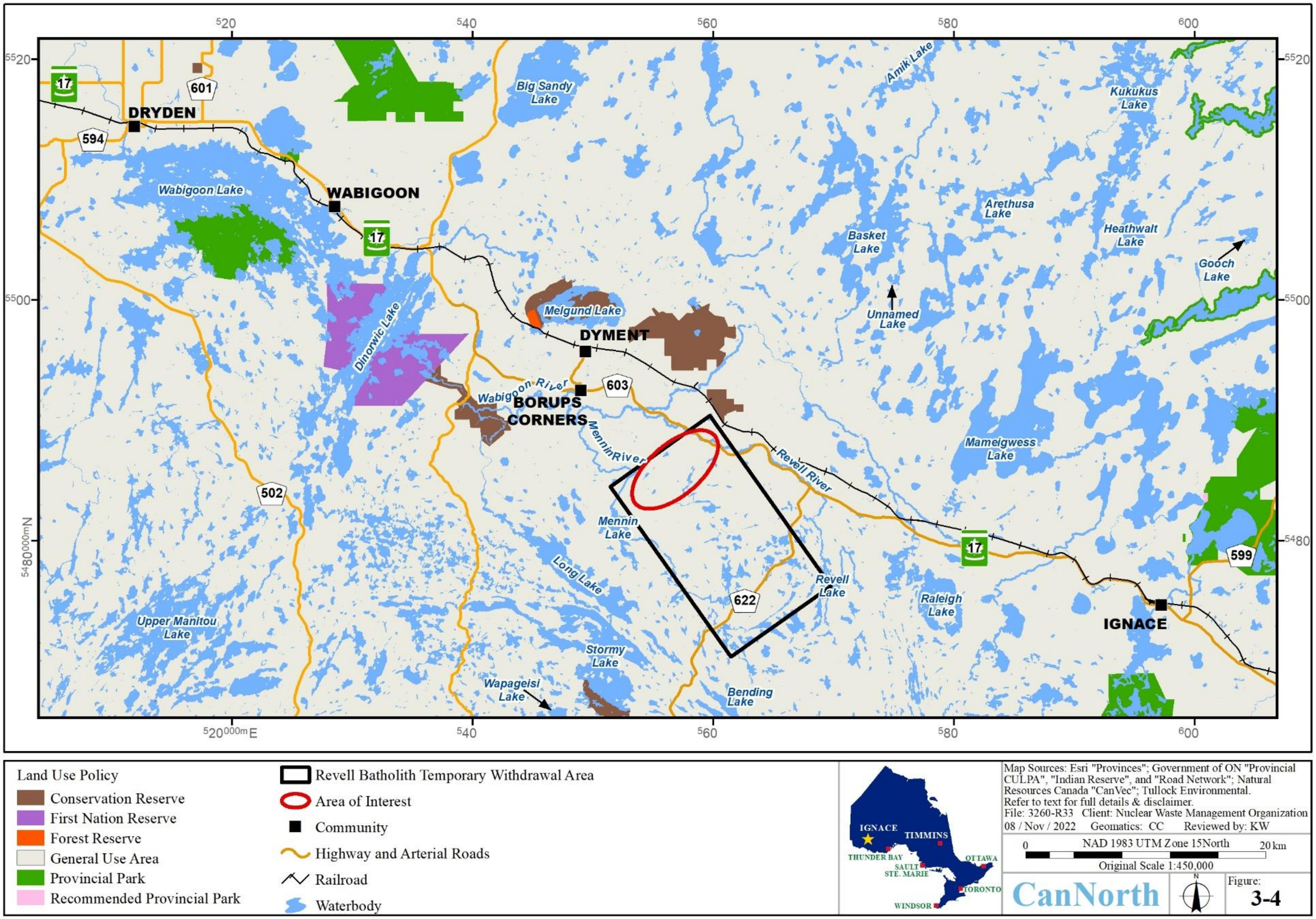


Figure 3-5 Recreational trails used by community members

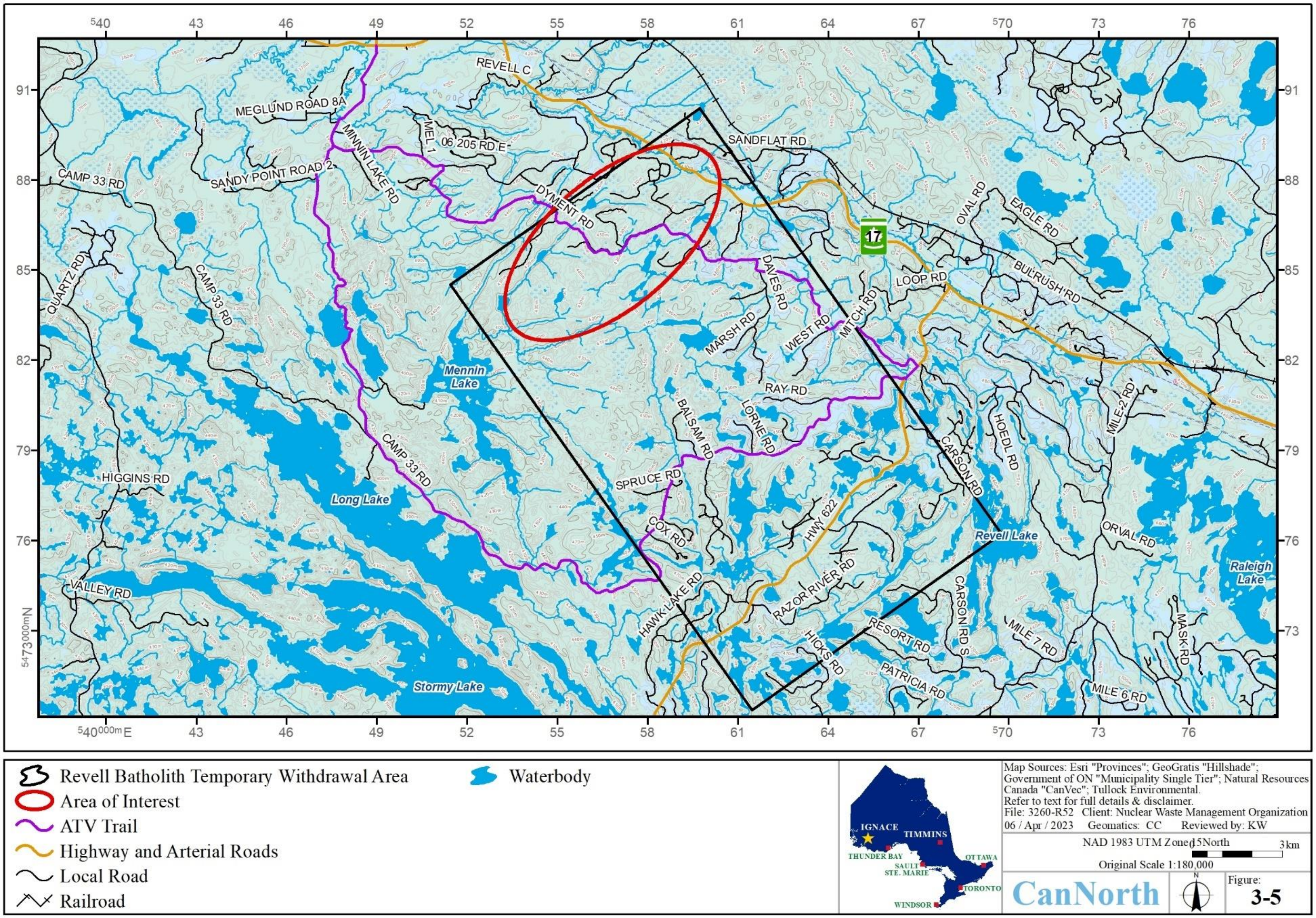
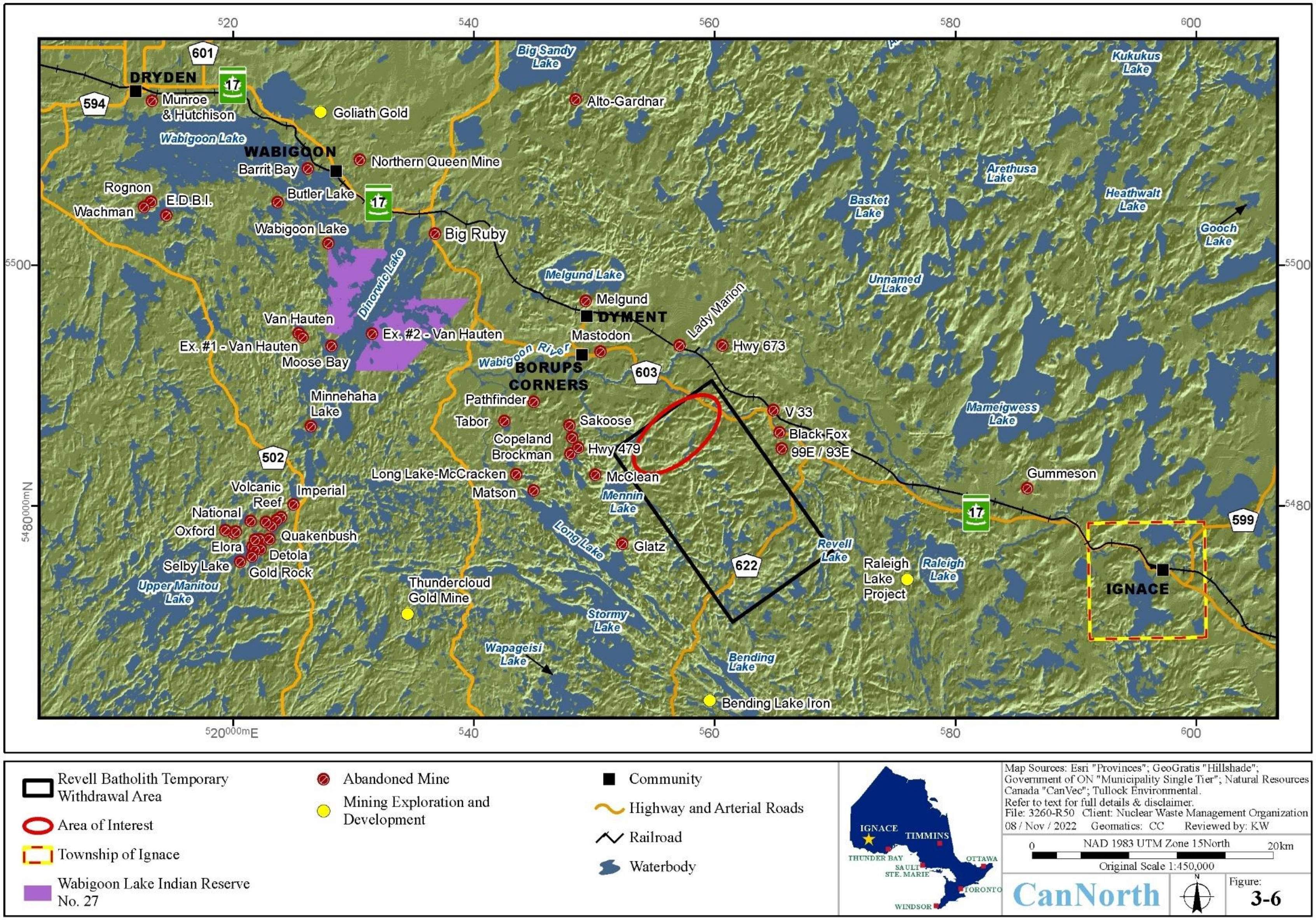


Figure 3-6 Mining activity in the region

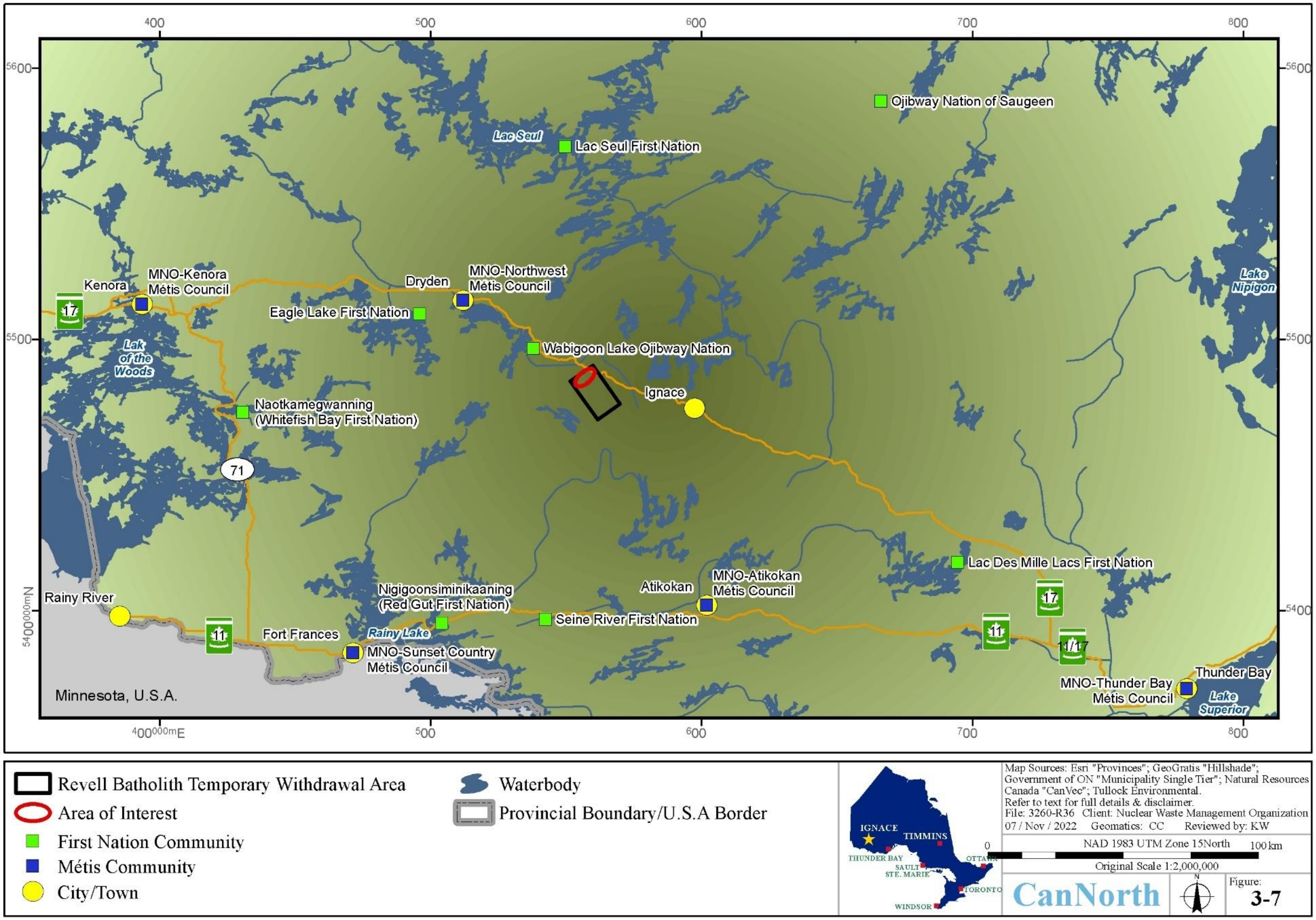


3.2.3 Indigenous Land Use

Throughout the process of site selection, NWMO staff and contractors have continued to meet with local Indigenous Nations, governments, and communities, including municipal representatives, First Nation and Métis leaders, organizations and communities, key opinion leaders, community liaison committees, and citizens to better understand the thoughts and concerns of people who wish to be engaged. Figure 3-7 shows the locations of the First Nation and Métis communities with whom the NWMO has entered into Learn More[2] agreements. Throughout various engagement activities, the First Nations' rights-holders have indicated that they use the area for hunting (including deer and moose), fishing, berry and mushroom picking, wild rice, birds, and insects.

[2] The NWMO's Learn More Program makes available resources (information and funding) to support participation in early steps of the site selection process.

Figure 3-7 Locations of communities in the WLON-Ignace area



3.3 Contaminants of Potential Concern

A comprehensive list of COPC is required to provide a complete picture of the existing conditions in the environment. In general, only those contaminants with the highest potential for having interactions with the Project have been identified as COPC; however, there are some exceptions (e.g., to allow for the assessment of cumulative effects) as discussed below.

The preliminary COPC list was developed in collaboration with the NWMO, with consideration of stakeholder and rights-holder concerns identified through preliminary engagement activities, and with consultation of numerous reports (Amiro 1992; Liberda et al. 2018; NWMO 2017b; Ontario Hydro Nuclear 1993; SENES 2012). The COPC list contains a wide suite of parameters, including numerous metals and radionuclides, as well as generic parameters routinely used to characterize components of the environment. The preliminary COPC list for the Northwest site is provided in Table 3-1; however, the list will be re-evaluated periodically to ensure it remains comprehensive and relevant. For example, additional future input from local Indigenous Nations, governments, and communities and data collected as part of the EMBP may influence this list. Community engagement workshops revealed that there is a high level of concern around the use of glyphosate and its environmental fate and, thus, it has been included as a COPC for those media identified as being of highest concern by community members (e.g., surface water, berries, etc.). The collection of information on levels of glyphosate in various environmental media may also provide valuable insight into aspects of the BIS.

For the radionuclides, different tiers were identified. The Tier 1 radionuclides are those that have been identified as being potentially present due to the Project (either construction, or operation). This includes tritium (H-3), carbon-14 (C-14), strontium-90 (Sr-90), iodine-129 (I-129), cesium-137 (Cs-137), as well as radon (Rn-222) and krypton-85 (Kr-85) for air only. In addition, gross-α, gross-β, and gross-γ levels are being measured to characterize the background values. There are two classes of Tier 2 radionuclides – artificial and natural. For the artificial Tier 2 radionuclides, a limited number of samples will be collected. For the natural Tier 2 radionuclides (uranium and thorium series radionuclides and potassium-40 [K-40]), information on background levels will be important to understand the typical levels and to understand measured gross-α and gross-β.

The COPC list also includes parameters such as petroleum hydrocarbon compounds (PHCs), polycyclic aromatic hydrocarbons (PAHs), and volatile organic compounds

(VOCs), which may be present at the site due to fuelling activities and gasoline emissions. Semivolatile organic compounds (SVOCs), such as phenols, will also be measured as these may be used in industrial processes or in explosives. Nitrogen compounds, including ammonia, are also included due to the use of explosives. Conventional air contaminants, for example carbon monoxide (CO), nitrogen oxides (NO_x), total suspended particulate (TSP), and particulate matter less than 2.5 µm ($PM_{2.5}$) and less than 10 µm (PM_{10}) in diameter are also included as COPC in air.

There are some cases where contaminants were included in the sample design due to a community concern and the potential for cumulative effects, such as polychlorinated biphenyls (PCBs), as well as polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs), which together can be referred to as dioxins and furans. These compounds are not related to the Project, but they are persistent and therefore may be present. Although not related to the Project, information on the presence of these compounds can inform the assessment of potential cumulative effects.

Table 3-1 Preliminary list of contaminants of potential concern

Category	Detailed List[1]
Radionuclides	Tier 1: H-3, C-14, Sr-90, I-129, Cs-137, gross-α, gross-β, γ, Rn-222 (air only), Kr-85 (air only)
	Tier 2 (Artificial) : Cl-36, Co-60, Se-79, Ru-106, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Cm-244, I-131
	Tier 2 (Natural): K-40, U-238, U-234, U-235, Th-228, Th-230, Th-232, Ra-226
Stable Elements (metals and metalloids)	Aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, bromine, cadmium, calcium, cesium, chromium, cobalt, copper, iron, lead, lithium, mercury, magnesium, manganese, molybdenum, nickel, phosphorus, potassium, rhodium, ruthenium, samarium, selenium, sodium, silver, strontium, thallium, tin, titanium, uranium, vanadium, zinc, zirconium
Nutrients and general chemistry – water	alkalinity, bicarbonate, bromide, calcium, carbonate, chloride, cyanide, fluoride, hydroxide, magnesium, pH, potassium, sodium, specific conductivity, sulphate, total dissolved solids (TDS), total hardness, total suspended solids (TSS), turbidity, ammonia (as nitrogen), nitrate + nitrite, nitrate (NO_3), total organic carbon (TOC), total inorganic carbon (TIC), dissolved organic carbon (DOC), phosphorus, total Kjeldahl nitrogen, chlorophyll-a, bod, total coliforms, e. coli
Nutrients and general – solids	% moisture, pH, total organic carbon (TOC), particle size (5 fraction EEM), ammonia as nitrogen, nitrate + nitrite, nitrate (NO_3), total phosphorus, total Kjeldahl nitrogen
Criteria Air Contaminants	Nitrogen oxides (NO_2/NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), suspended particulate matter (SPM), Particulate matter <10 microns (PM_{10}) and particulate matter <2.5 microns ($PM_{2.5}$)
Organics	Polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), petroleum hydrocarbon compounds (PHCs), dioxins and furans, polychlorinated biphenyls (PCBs)
Other	Cyanide
	Glyphosate

Note:[1] Not all COPC will be measured in all media.

3.4 Climate Change Considerations

The area has a primarily continental climate with cold winters and mild summers. Most precipitation falls in the form of summer showers and thunderstorms. In winter, the region can experience prolonged periods of extreme cold. Major winter storms affect most parts of northern Ontario, including the WLON-Ignace area, at least once or twice a year. (Golder 2013b)

The NWMO prepared a method development document in 2019 to anticipate the impacts of climate change on the DGR study sites (Roberts et al. 2019). Recent climate projections predict a 3°C to 4°C increase in temperature by the 2050s and an approximate increase of 6°C by the 2080s. In general, this increase in average temperatures is expected to be more substantial during winter months compared to summer months (approximately 1.8°C greater change in winter in the 2050s and 2°C greater change in the 2080s).

In the WLON-Ignace area, precipitation is expected to experience an increase of 50 mm/year to 75 mm/year by the 2050s and a 100 mm/year to 125 mm/year increase by the 2080s (Roberts et al. 2019). The projected increases in annual precipitation are mainly driven by an expected increase in winter and spring precipitation. Obtaining strategic baseline meteorology and hydrology data will aid in Project planning for water management in consideration of these predicted climate change effects.

Golder completed a climate change impact study to characterize the current and future climate conditions in the WLON-Ignace area (Golder 2020). Quantitative future climate conditions were projected to the year 2100; beyond 2100, a qualitative assessment was completed using projections available in literature. The study found that for the 2050s and 2080s, the future is likely to be wetter. The monthly total precipitation is projected to increase for all calendar months except July and August, with the greatest change estimated for December. There are expected to be more dry days with greater precipitation amounts on wet days. Shorter cold spells are expected with longer warm spells, longer growing season, more summer days and increasing extreme temperatures.

Based on the qualitative assessment, it was found that extreme precipitation statistics are likely to increase beyond the year 2100 and possibly well into the future. It was recommended that additional climate assessments be made throughout the life cycle of the DGR to update climate projections and reduce uncertainty. Obtaining strategic baseline meteorology and hydrology data will aid in Project planning for water management in consideration of these predicted climate change effects.

4.0 POTENTIAL PROJECT-ENVIRONMENT INTERACTIONS

For planning purposes, a preliminary description of the Project was developed by the NWMO that describes the works and activities likely to be associated with the site preparation, construction, operations, extended monitoring, and decommissioning and closure (see Section 2.1). The Project Team reviewed the preliminary Project description to consider where the Project was likely to interact with the biophysical components, which is a key component of an IA. The study components have been grouped as shown in Table 4-1. The EMBP has incorporated monitoring of these components into its design and data collection is currently underway[3]. These data will help further inform how potential interactions and associated risks can be designed out of the Project or mitigated. Standard mitigation practices for the various Project activities are outlined in Section 5.0.

Table 4-1 Study components for biophysical environment

Component	Includes
Air	Air quality Atmospheric environment [b]
Noise	Acoustic environment Vibration
Light	Lighting environment Visual
Soil	Surface soils and bedrock (to 100 m bgs) Soil quality for agriculture purposes
Groundwater[a]	Shallow groundwater (to 100 m bgs) Drinking water wells
Surface water	Surface water quality Hydrology (flow, volume, velocity) [b] Sediment quality Wetlands
Fish and Fish Habitat	Fish All aquatic biota (e.g., plankton, invertebrates) Aquatic species at risk Aquatic habitat including aquatic vegetation
Wildlife and Wildlife Habitat	Wildlife (mammal, birds, herptiles) Species at risk Vegetation and insects Edible wild products (berries, wild rice, medicinal plants) Wetlands

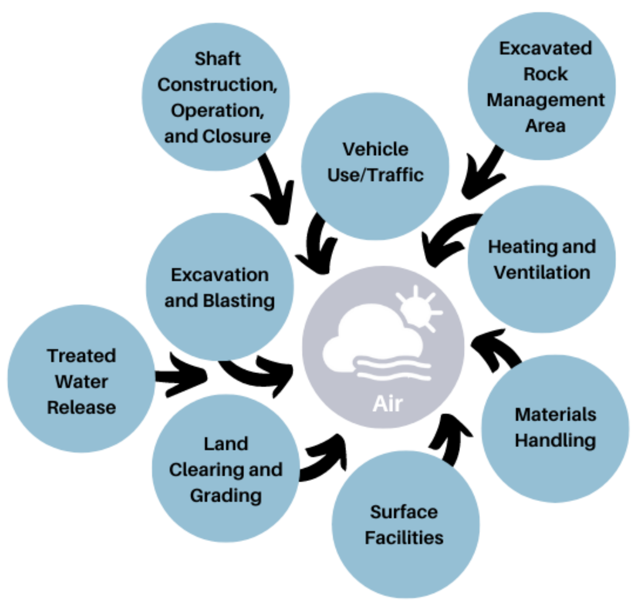
Note:
[a] Groundwater and bedrock below 100 m bgs is part of a different study and only discussed here as they may interact with the shallow groundwater and surface water.
[b] Meteorology is included within this component.

[3] Monitoring of some study components, such as fish and fish habitat and wildlife and wildlife habitat, is also being completed as part of the BIS.

The potential interactions are summarized in the following sections and described in more detail by Project activity in tabular format in Table 4-2 at the end of this section. The focus of the interactions table at this early stage in the Project is to identify potential Project-environment interactions and provide a high-level description of the design features and/or mitigation measures that will limit or block these potential interactions. Additionally, it provides a means to identify current data gaps that will need to be addressed as the Project advances. The focus is on the biophysical environment and on-site activities. Transportation to the site was not included in the interaction tables.

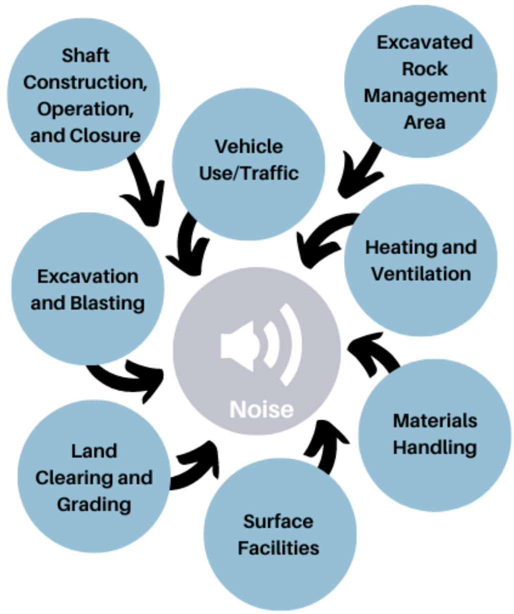
Additionally, study components for socio-economic conditions and human health will ultimately need to be included. These topics have been considered broadly here, though these are being assessed separately. Socio-economic includes social conditions (e.g., housing, community well-being, aesthetics) and economic conditions (e.g., jobs, training). Human health includes consideration of all social determinants of health. It is critical to identify and understand the potential impacts of the Project on Indigenous peoples, and to incorporate IK. This will form an essential part of each of these areas (biophysical, socio-economic, human health).

4.1 Air



Project activities can directly interact with air quality through releases to the atmosphere of COPC, from heavy equipment and vehicular usage/traffic, land clearing and grading, excavation, drilling and blasting, materials handling, and general construction activities. In addition, on-site operating facilities and infrastructure will have releases from sources like the main and ventilation shaft system, used fuel packaging plant, compressor building, wastewater treatment facilities, surface fuel storage and dispensing facilities, concrete batch plant, and the ERMA. These activities can affect wildlife and people (both socio-economic and human health components). There are operational controls that can limit air quality impacts such as enforcing speed limits, turning off vehicles when not in use, using dust suppressants on unpaved surfaces, and employing pollution control systems (i.e., HEPA filters). Electric vehicles can also be used to minimize releases of fuel combustion COPC and greenhouse gases.

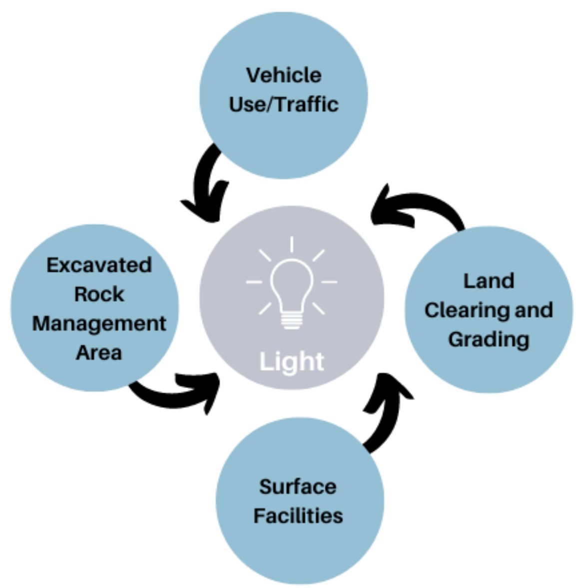
4.2 Noise



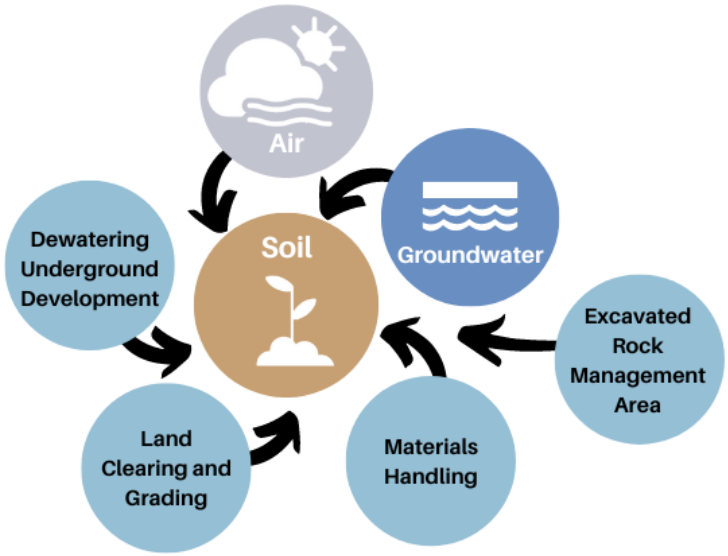
Project activities can directly interact with noise which can in turn affect wildlife and people (both socio-economic and human health components). Noise is a consideration in site preparation and construction activities such as land clearing, excavation and blasting, and materials handling as well as operations activities like the ventilation shaft system, UFPP, compressor building, and concrete batch plant. Operational and design measures can be put in place to mitigate noise effects.

4.3 Light

Project activities can have light impacts, which can in turn affect wildlife and people (both socio-economic and human health components). Temporary and permanent lighting systems employed during site preparation, construction, and operations are expected to generate light trespass/incidental light, glare, and contribute to sky glow. Lighting impacts can be mitigated through design measures that minimize light trespass and glare and through operational controls like switching and usage restrictions.



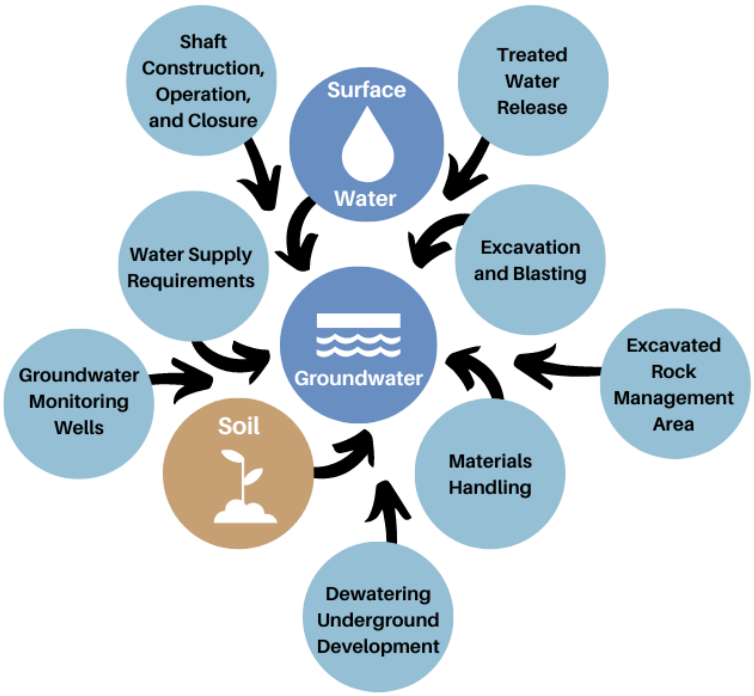
4.4 Soil and Bedrock



Project activities can directly interact with soil quality through the disturbance of soils (land clearing and grading or excavation), construction, or material handling resulting in fugitive dust release and deposition; increased erosion and sedimentation; and accidental release of contaminants to soil during facility construction or operation activities. Indirect interactions with soil can also occur through air or groundwater or surface water study components, such as deposition of contaminants from operations and by-product emissions from vehicle operation, power generation, or heating and ventilation; leaching of metals/minerals or soil chemistry changes associated with changes in groundwater table, or groundwater or surface water chemistry changes; or drainage from excavated rock storage. Project activities have the potential to interact with soil through many phases of the development and therefore careful consideration of design features and mitigation measures must be addressed early in the planning process to reduce the potential for interactions.

4.5 Groundwater

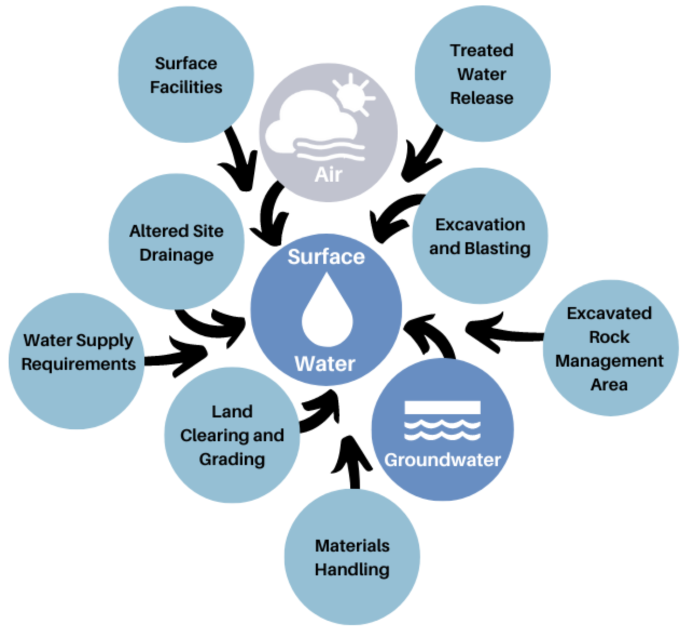
Project activities can directly interact with groundwater quantity through the disturbance of the subsurface (excavation, shaft construction and dewatering), changing groundwater flow paths, or dewatering for construction or operation activities. Indirect interactions with groundwater quantity or supply can also occur through changes to the ground surface which may change amounts or locations of recharge/discharge of precipitation, evapotranspiration due to plant loss/change, and surface water to groundwater interaction. Project activities can directly interact with groundwater quality through the disturbance of the surface and subsurface (land clearing and grading, excavation, dewatering), construction (e.g., shaft and repository), or material handling resulting in fugitive dust release and deposition, stormwater discharge or infiltration of drainage from excavated rock storage, and accidental release of contaminants during facility construction or operation activities. Indirect interactions with groundwater quality can also occur through air or soil or surface water study components, such as deposition of by-product emissions from vehicle operation, de-icing, or power generation or heating and ventilation; leaching of metals/minerals or soil chemistry changes associated with changes in groundwater table, groundwater or surface water chemistry changes. Impacts to the natural systems such as fish habitat and wetlands, from impacts to both groundwater quantity and quality include any function of the aquifers being impacted by the construction and operation activities to provide baseflow to streams, maintain water levels in wetlands, forests, or lakes, or provide recharge to other aquifers.



Project activities have the potential to interact with groundwater through many phases of the development and therefore careful consideration of design features and mitigation measures must be addressed early in the planning process to reduce the potential for interactions where possible.

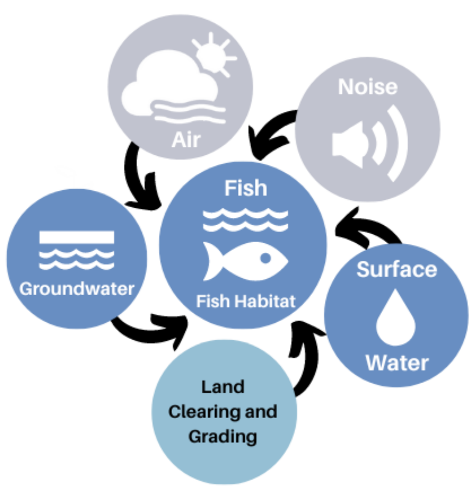
4.6 Surface Water

Project activities can directly interact with the quantity and movement of water through withdrawal or release of water at surface waterbodies. The change in surface water hydrology can also lead to change in groundwater water balance, erosion potential, and water quality parameters of the surface water body.



There is potential of drawdown of water from underground developments, obtaining service water, release of treated water, or accidental release of contaminants to water from materials handling to have an effect on the baseline surface water conditions. The addition of impervious surfaces resulting from the Project can also increase the volume and flowrate of stormwater runoff from the site. Indirect interactions with surface water can also occur through air or groundwater study components. Project activities have the potential to interact with surface water quality and quantity through many phases of the development. Therefore, careful considerations throughout the preliminary and detailed design process, and within the IA process, are needed to ensure that potential impacts to surface water are eliminated where possible, mitigated and/or compensated for within the proper process. Additionally, the connection of surface water components to other critical components of the Project like social and economic factors such as Indigenous traditions and culture should be considered through the planning and design process.

4.7 Fish and Fish Habitat



Project activities have the potential to interact with Fish and Fish Habitat (aquatic life) through their interaction with physical environmental features including air quality, groundwater quality and quantity, and surface water quality and quantity. Additionally, if the Project cannot avoid disturbing aquatic habitat, the Project activities have the potential to result in the physical loss of available aquatic habitat or the degradation of quality habitat. Mitigation measures developed to address potential interactions with these components help protect the receptors of potential effects (i.e., fish and fish habitat).

4.8 Wildlife and Wildlife Habitat

Project activities have the potential to interact with Wildlife and Wildlife Habitat (terrestrial life) through their interaction with physical environmental features including background noise and light conditions, air quality, groundwater quality and quantity, surface water quality and quantity, soil quality, and fish and fish habitat. Additionally, if the Project cannot avoid disturbing terrestrial habitat, the Project activities have the potential to result in the physical loss of available wildlife habitat. Mitigation measures developed to address potential interactions with these components help protect the receptors of potential effects (i.e., wildlife and wildlife habitat).

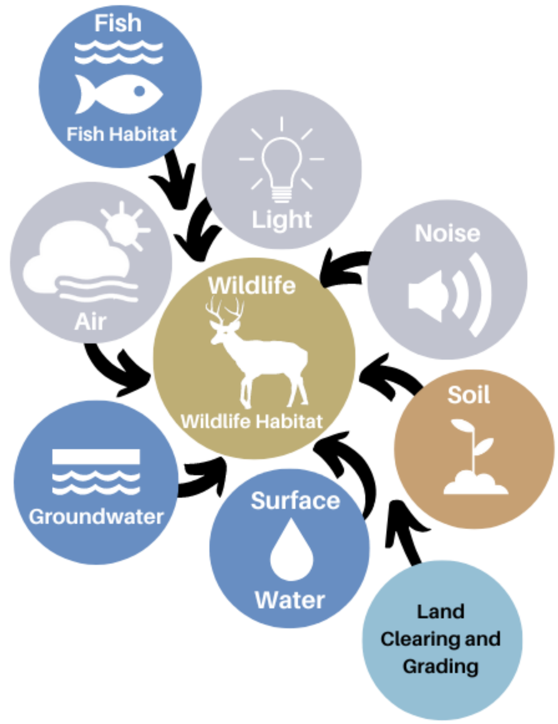


Table 4-2 Potential Project-environment interactions during the major stages of the Project

Land Clearing and Grading

Stage	Environment Interaction	Biophysical Study Components								Socio-economic Components	Human Health Study Components
		Air	Noise	Light	Soil	Groundwater	Surface Water	Fish and Fish Habitat	Wildlife and Wildlife Habitat		
Land clearing and grading activities will be completed as part of the following Project phases: • Site preparation, including consideration of fire break buffer • Construction • Decommissioning	Increased release / deposition of COPC could alter air, soil, and surface water quality, which in turn could affect aquatic, terrestrial and human receptors and shallow groundwater quality.	x			x	x	x	x	x		x
	Removing vegetation and altering the natural grading and compaction of the site will alter surface water drainage (hydrology) and infiltration on the site, increasing the potential for erosion and sedimentation and in turn potential affecting soil quality (loss of topsoil and/or nutrients in soil), surface water and groundwater quality, and aquatic and terrestrial receptors.				x	x	x	x	x		
	Increased activity on the Project site because of land clearing and grading could increase the background light conditions and affect wildlife and human receptors.			x					x	x	
	Increased activity on the Project site because of land clearing and grading could increase background noise conditions and affect wildlife and human receptors.		x						x	x	x
	The land clearing and grading of the Project site will result in a loss of habitat within the Project footprint affecting terrestrial receptors and potentially affecting aquatic receptors if aquatic habitat cannot be avoided.							x	x	x	
	Depending on the placement of the Project within the AOI, there could be a loss of recreational trails									x	

See Section 5.1 for design features and/or mitigation measures.

Excavation and Blasting

Stage	Environment Interaction	Biophysical Study Components								Socio-economic Components	Human Health Study Components
		Air	Noise	Light	Soil	Groundwater	Surface Water	Fish and Fish Habitat	Wildlife and Wildlife Habitat		
Excavation of the underground facilities will be completed with controlled drill and blast methods as part of the following Project phases: • Construction • Operations (due to continued underground development)	Increased release of COPC could affect air, soil, and surface water quality and shallow groundwater quality, which in turn could affect groundwater, aquatic, terrestrial, and human receptors.	x			x	x	x	x	x	x	x
	Use of explosives could release by-product components and increase nutrients (nitrogen and ammonia compounds) in site contact water which could affect surface water and groundwater quality and aquatic, terrestrial and human receptors.					x	x	x	x		x
	Increased activity on the Project site from excavation and blasting activities could increase background noise conditions and affect wildlife and human receptors.		x						x	x	x
	Detonation of explosives near water may result in overpressure and increased particle velocity, adversely effecting fish and fish habitat. Noise of detonation also has the potential to adversely effect wildlife and wildlife and human receptors.		x					x	x	x	x
	Disturbance of rock formation may increase the weathering potential of the shallow bedrock and the connection between overburden, shallow and deep bedrock in the vicinity of the shafts.					x	x				

See Section 5.2 for design features and/or mitigation measures.

Increase in Vehicle Traffic

Stage	Environment Interaction	Biophysical Study Components								Socio-economic Components	Human Health Study Components
		Air	Noise	Light	Soil	Groundwater	Surface Water	Fish and Fish Habitat	Wildlife and Wildlife Habitat		
Increased vehicle traffic on site will occur during the following Project phases: • Site Preparation • Construction • Operation • Decommissioning and Closure	Increased release of combustion by-product emissions could alter air and soil quality and subsequently groundwater and surface water quality.	x			x	x	x				x
	Increased release of suspended particulate matter (dust) and radon could affect air, soil, and groundwater and surface water quality and in turn affect aquatic, terrestrial, and human receptors.	x				x	x	x	x	x	x
	Increased vehicle traffic on site could increase the amount of pollutants in stormwater runoff which could affect groundwater and surface water quality and associated aquatic, terrestrial, and human receptors.					x	x	x	x	x	x
	Increased activity on the Project site could increase the background light conditions and affect wildlife and human receptors.			x					x	x	
	Increased activity on the Project could increase background noise conditions and affect wildlife and human receptors.		x						x	x	x
	Increased activity on the Project site can have direct effects on wildlife (collisions).								x		
	Increased use of road salts for vehicle safety. These could affect soil, groundwater and surface water quality and in turn affect aquatic and terrestrial receptors.				x	x	x	x	x		

See Section 5.3 for design features and/or mitigation measures.

Water Supply Requirements

Stage	Environment Interaction	Biophysical Study Components								Socio-economic Components	Human Health Study Components
		Air	Noise	Light	Soil	Groundwater	Surface Water	Fish and Fish Habitat	Wildlife and Wildlife Habitat		
The Project will require a freshwater water supply during the following Project phases: • Construction • Operation • Decommissioning • Extended monitoring	The water supply requirements could affect the surface water levels (assuming surface water source) which in turn could affect aquatic, terrestrial, and human receptors.						x	x	x	x	
	The construction of a water intake within a fish bearing waterbody could adversely effect fish and fish habitat through physical disturbance and/or release of sediment.					x	x	x			
	If not properly designed and screened, the operation of water intake in a fish bearing waterbody could result in the entrainment or impingement of fish.							x			
	Lowered water table from groundwater extraction during construction and operation may affect surface features through drawdown (soil moisture, wetlands), which can in turn affect aquatic or terrestrial biota (plants, wildlife).				x	x	x	x	x	x	

See Section 5.4 for design features and/or mitigation measures.

Altered Site Drainage and Surface Water Runoff

Stage	Environment Interaction	Biophysical Study Components								Socio-economic Components	Human Health Study Components
		Air	Noise	Light	Soil	Groundwater	Surface Water	Fish and Fish Habitat	Wildlife and Wildlife Habitat		
The surface drainage of the Project footprint will be altered during the following phases: • Construction • Operation • Extended monitoring	The Project footprint construction will result in an altered site drainage which could affect downgradient water levels and flow which in turn could affect aquatic and terrestrial receptors.					x	x	x	x	x	
	The installation of stormwater management ponds may alter the groundwater-surface water interaction if a pond with no hydraulic barriers between the ponding water and underlying soil layer is selected (infiltration pond etc.).				x	x	x				
	Storing water in stormwater management ponds may increase the temperature of runoff compared to runoff discharged into the receiving water body and groundwater in short period of time. This could impact the aquatic environment and fish habitat.					x	x	x			

See Section 5.5 for design features and/or mitigation measures.

Excavated Rock Management Area (ERMA)

Stage	Environment Interaction	Biophysical Study Components								Socio-economic Components	Human Health Study Components
		Air	Noise	Light	Soil	Groundwater	Surface Water	Fish and Fish Habitat	Wildlife and Wildlife Habitat		
Excavated rock from the development of the underground facilities will be stored in the ERMA during the following Project phases: • Construction • Operation • Extended monitoring • Decommissioning and closure	Above ground storage of excavated rock could result in the generation of COPC that could affect air, soil, and groundwater and surface water quality and in turn affect aquatic, terrestrial, and human receptors.	x			x	x	x	x	x	x	x
	Above ground storage of excavated rock from underground operations could leach metals/minerals and residual explosives into the downgradient environment affecting aquatic, terrestrial, and human receptors.				x	x	x	x	x	x	x
	Above ground storage of excavated rock from underground operations could produce acid rock drainage due to the sulfide content of the rock resulting in downgradient impacts to soil, groundwater, and surface water quality.				x	x	x	x	x	x	x
	Increased activity on the Project site could increase the background light conditions and affect wildlife and human receptors.			x					x	x	x
	Increased activity on the Project site could increase background noise conditions and affect wildlife and human receptors.		x						x	x	x
	Above ground storage of excavated rock from underground operations could lead to potentiometric surface mounding beneath.					x					

See Section 5.6 for design features and/or mitigation measures.

Surface Facilities

Stage	Environment Interaction	Biophysical Study Components								Socio-economic Components	Human Health Study Components
		Air	Noise	Light	Soil	Groundwater	Surface Water	Fish and Fish Habitat	Wildlife and Wildlife Habitat		
The development and operation of surface facilities (e.g., concrete batch plant, air compressor building, used fuel packaging plant) will occur in the following Project phases: • Construction • Operation • Extended monitoring • Decommissioning and closure	Release of COPC to air could affect air, soil, and surface water quality and in turn affect aquatic, terrestrial, and human receptors.	x			x	x	x	x	x	x	x
	Increased activity on the Project site could increase the background light conditions and affect wildlife and human receptors.			x					x	x	
	Increased activity on the Project site activities could increase background noise conditions and affect wildlife and human receptors.		x						x	x	x
	Surface water quality could be affected from contact with surface facilities and transport of suspended particulates which in turn could affect aquatic and terrestrial receptors.					x	x	x	x		
	Surface water and groundwater quantity and quality could be affected from additional impervious surfaces from the surface facilities which in turn could affect aquatic and terrestrial receptors.					x	x	x	x		

See Section o for design features and/or mitigation measures.

Dewatering

Stage	Environment Interaction	Biophysical Study Components: Air	Noise	Light	Soil	Groundwater	Surface Water	Fish and Fish Habitat	Wildlife and Wildlife Habitat	Socio-economic Components	Human Health Study Components
Dewatering of underground development will occur in the following Project phases: • Construction • Operation • Extended monitoring	Dewatering during construction could impact shallow groundwater, surface and wildlife habitat and terrestrial receptors and human receptors. The nature and magnitude of dewatering during construction is expected to be very different than during operations. In addition, potential mitigation measures will be different.				x	x	x	x	x	x	x
	Dewatering of underground facilities could lower groundwater levels causing surface water drawdown, subsequent water level alterations, and change to soil moisture.				x	x	x	x	x		
	Dewatering of underground facilities could disturb sediment and lead to changes in geochemical conditions resulting in the mobilization of minerals and contaminants which in turn would affect surface water quality and aquatic, terrestrial, and human receptors.				x	x	x	x	x	x	x
	Deep groundwater release at surface could impact shallow groundwater and/or soil chemistry and in turn affect wildlife habitat and terrestrial receptors and human receptors.				x	x	x	x	x		x
	Depending on the repository depth, dewatering for repository construction may result in groundwater with geochemical signature requiring proper disposal if/when transmissive fracture zones are encountered during excavation.				x	x	x	x	x		x

See Section 5.8 for design features and/or mitigation measures.

Treated Water Discharge

Stage	Environment Interaction	Biophysical Study Components								Socio-economic Components	Human Health Study Components
		Air	Noise	Light	Soil	Groundwater	Surface Water	Fish and Fish Habitat	Wildlife and Wildlife Habitat		
Discharge of treated water (dewatering water, site facilities, site contact water, and sewage) will occur in the following Project phases: • Construction • Operation • Extended monitoring • Decommissioning and closure	Discharge of treated water from site facilities (e.g., UFPP) could affect surface water quality and aquatic, terrestrial, and human receptors						x	x	x	x	x
	Discharge of treated site contact water could increase the temperature of the water in the receiving surface waterbody and impact the aquatic habitat.						x	x			
	Discharge of treated dewatering water to the downstream receiving waterbody could affect groundwater, surface water quality, and aquatic, terrestrial, and human receptors					x	x	x	x	x	x
	Discharge of treated sewage water to downstream receiving waterbody could affect groundwater, surface water quality, and aquatic and terrestrial receptors						x	x	x	x	x

See Section 5.9 for design features and/or mitigation measures.

Groundwater Monitoring Wells

Stage	Environment Interaction	Biophysical Study Components								Socio-economic Components	Human Health Study Components
		Air	Noise	Light	Soil	Groundwater	Surface Water	Fish and Fish Habitat	Wildlife and Wildlife Habitat		
Groundwater monitoring will occur during the following Project phases: • Construction • Operation • Extended monitoring • Decommissioning and closure	Failure of seals in groundwater monitoring wells or abandoned wells that are no longer needed could lead to surface impacts to shallow groundwater, or mixing of groundwater types which could affect human receptors.					x	x			x	x

See Section 5.10 for design features and/or mitigation measures.

Shaft Construction, Operation, and Closure

Stage	Environment Interaction	Biophysical Study Components								Socio-economic Components	Human Health Study Components
		Air	Noise	Light	Soil	Groundwater	Surface Water	Fish and Fish Habitat	Wildlife and Wildlife Habitat		
Shafts: • Construction • Operation • Extended monitoring • Decommissioning and closure	Construction and operations emissions (combustion products, radon) could affect air, noise, soil, and surface water quality and in turn affect aquatic, terrestrial, and human receptors.	x	x		x		x	x	x	x	x
	Failure of seals in shaft during construction, operation, or during decommissioning and closure could lead to mixing of groundwater types or surface water impacts to shallow groundwater which could affect aquatic, terrestrial, and human receptors.					x	x	x	x	x	x

See Section 5.11 for design features and/or mitigation measures.

Heating and Ventilation of the Project Facility

Stage	Environment Interaction	Biophysical Study Components								Socio-economic Components	Human Health Study Components
		Air	Noise	Light	Soil	Groundwater	Surface Water	Fish and Fish Habitat	Wildlife and Wildlife Habitat		
Heating and ventilation of the Project facilities will occur during the following phases: • Construction • Operation • Extended monitoring • Decommissioning and closure	Increased release of combustion by-product emissions could alter air, noise, soil and surface water quality.	x	x		x		x	x		x	x
	Emergency stand-by generators can result in the release of combustion by-product emissions could alter air, soil, surface water, and eventually groundwater quality as well as noise impacts.	x	x		x	x	x				

See Section 5.12 for design features and/or mitigation measures.

Materials Handling

Stage	Environment Interaction	Biophysical Study Components								Socio-economic Components	Human Health Study Components
		Air	Noise	Light	Soil	Groundwater	Surface Water	Fish and Fish Habitat	Wildlife and Wildlife Habitat		
Materials handling (placement of material in stockpiles, waste and fuel handling) will occur through the following Project Phases: • Construction • Operation • Extended monitoring • Decommissioning and closure	Increased release of COPC could affect air, soil, groundwater and surface water quality and in turn affect aquatic, terrestrial and human receptors.	x			x	x	x	x	x		
	Increased activity on the Project site activities could increase background noise conditions and affect wildlife and human receptors.		x						x	x	x
	Fuel storage tanks and fueling can result in fugitive releases and noise.	x	x			x	x				x
	Accidental release of hazardous materials on site or use of fire suppressants if needed could affect aquatic, terrestrial, and human receptors.	x			x	x	x	x	x	x	x
	Risk of exposure to external radiation from used fuel bundles being present in the UFPP could affect wildlife and human receptors.								x	x	x

See Section 5.13 for design features and/or mitigation measures.

5.0 MITIGATION MEASURES

As the Project develops, consideration of Project design features and potential mitigation measures to limit the potential Project-environment interactions will be developed. At a high-level, an initial list of potential mitigation measures and standard best management practices being used in Canada for the main Project activities is included here. The specific mitigation measures to be implemented will need to be consistent with the applicable municipal, provincial, and/or federal standard and well as those that apply to the nuclear industry, mining, and other applicable industries (e.g., concrete batch plant). It will be important to consider where there are current standards and effective mitigation measures applicable to the Project during the various phases and schedules throughout the site development process. These standards and effective mitigations may then need to be modified for site specific conditions and when the IA process is undertaken the last resort would be assessing if compensation is required.

In the future, detailed mitigation measures and their implementation sequence will be specified for each environmental receptor/pathway using site-specific information obtained through baseline data collections. Project design, technologies employed, and mitigation measures will utilize information collected through monitoring and will be adapted as needed throughout the life of the Project. Examples include the selection of construction technologies or the selection of discharge locations for treated water.

Once additional information is available, the interactions and design of mitigation measures can be compiled in order to judge the likelihood of an effect occurring and the magnitude of impacts. This would result in a refined list of Project activities and impacts that require further consideration. The ultimate goal is to logically, and in a transparent manner, determine which project activities require a detailed evaluation and to minimize all potential impacts to the extent possible. This process will be completed as part of the IA if the site is selected to move forward.

Best management practices (BMP) are developed by different industries and agencies to summarize proven, effective measures that are commonly applied to mitigate environmental effects. The British Columbia Ministry of Environment and Climate Change Strategy[4] explains BMPs as *legislation might dictate that projects cannot harm a stream,*

[4] https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/laws-policies-standards-guidance/best-management-practices

while best management practices provide practical methods to avoid harming a stream. Some examples include:

- Department of Fisheries and Ocean (DFO) provides a document *Measures to Protect Fish and Fish Habitat* https://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures-eng.html
- Federal government provides guidelines to avoid harm to migratory birds https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/reduce-risk-migratory-birds.html
- Ontario provides requirements and best management practices for test holes and dewatering wells https://www.ontario.ca/document/test-holes-and-dewatering-wells-requirements-and-best-management-practices
- Federal government provides a code of practice for the environmental management of road salts to minimize the impact from winter maintenance https://www.canada.ca/en/environment-climate-change/services/pollutants/road-salts/code-practice-environmental-management.html

It is expected that further in the process, detailed Management Plans for the protection of each component will be developed that include, but are not limited to, key commitments, obligations and regulatory requirements, roles and responsibilities, COPC, mitigation, monitoring, and reporting requirements.

Standard mitigation measures have been identified below and have been organized according to the Project activities discussed in Section 4.0. A list of some of the BMPs that may be considered within the IA is provided in Appendix A.

5.1 Land Clearing and Grading

Land clearing and grading activities will be completed as part of the site preparation, construction, and decommissioning phases of the Project.

Mitigation measures for land clearing and grading activities begin with selecting an appropriate location. Biodiversity is an important consideration with respect to selecting an appropriate location. A separate study is currently underway examining mitigation measures specific for biodiversity. One of the key mitigation measures is avoidance (e.g., avoiding sensitive areas where feasible for siting). Other mitigation measures include minimizing, deterrents, and off-setting. These mitigation measures have not been discussed in this document and the separate report should be consulted (Zoetica 2022) .

Additional mitigation measures for consideration when completing siting and land clearing and grading activities include:

- Identify potentially contaminated footprints and mitigate these prior to activities.
- Limit the facility footprint to the extent practical and minimize areas of vegetation clearing and soil disturbance.
- Minimize timeframes for site clearing and activities that expose soils to the extent practical.
- Minimize construction activities in areas of medium to high index of aquifer vulnerability to the extent practical.
- Minimize water crossing and avoid potentially sensitive habitats to the extent practical.
- Avoid or minimize disturbance to existing recreational trails; create alternate trails in the event that disturbance is unavoidable. Path of alternate trails should be determined in consultation with local users.
- Incorporate recommended stormwater management practices into the design package.
- Operational controls, including but not limited to, the following:
  - Optimize equipment and minimize travel distances, where possible.
  - Employ standard operating procedures for the use of equipment and machinery, including maintenance requirements.
  - Turn off equipment when not in use.
  - Apply water and/or other dust suppressants on unpaved or disturbed surfaces.
  - Stabilize exposed surfaces where possible (e.g., compacting, temporary re-vegetation or application of mulch, stone, geotextiles, etc.).
  - Utilize enclosures/coverings for storage piles (i.e., three-sided bunker, tarpaulin) and maintain appropriate shape (no steep sides or faces).
  - Employ standard operating procedures for the use of equipment and machinery, including maintenance requirements.
  - Limit work to daytime hours where practical and minimize any required night-time work to the extent possible.
  - Schedule work in sensitive areas to avoid periods that may result in high flow volumes and/or increased erosion and sedimentation.
  - Schedule in-water work outside of DFO Restricted Activity Periods.

  - Apply best management practices for work near species of conservation concern as required during site preparation, construction, operation, and decommissioning activities. For example:
    - schedule work in sensitive areas to avoid environmentally sensitive periods such as bird nesting season, generally mid-May through mid-July.
    - Schedule the sequence and timing arrangement of construction activities to maximize erosion protection, such as timing to establish vegetation to address spring run-off.
  - Install appropriate erosion and sediment control measures.
  - Stockpile removed topsoil for future use in reclamation; the pile should be covered or retained in a covered facility to prevent or limit erosion and introduction of noxious weeds and invasive species.
  - Apply best management practices to minimize water quality impacts to groundwater recharge areas.
  - Establish on-site vehicle restrictions, including restrictions on tailgate banging during offloading and restricting the use of engine brakes.
  - Use low-noise/white noise/broadband reverse alarms for mobile equipment as opposed to beepers.
  - Use timers or motion sensors for exterior lighting at site office and other stationary facilities.
  - Ensure any temporary lighting (e.g., floodlights) are set up in such a way as to eliminate or minimize off-site light trespass, avoiding over-design of temporary lighting systems.
  - Minimize cut and fill to the extent practical.
- Design controls, including but not limited to, the following:
  - Use wind fencing and wind breaks and berms.
  - Maximize the distance between equipment staging areas and sensitive locations.
  - Avoid sensitive locations when orienting directional lights.
  - Minimize steepness and length of slopes.
  - Apply DFO’s Codes of Practice, where relevant.
  - Apply DFO’s *Measures to Protect Fish and Fish Habitat* (DFO 2019).
  - Reclaim and revegetate areas where non-permanent facilities have been decommissioned.

  - Construct laydown areas where topography is naturally flat and well draining to the extent practical; terrace site where possible.
  - Fill and contour the site to blend with natural surrounding topography, to the extent practical.
  - Consider tiling of soil in non-vegetated areas prior to restoration to re-establish infiltration along access roads, storage areas, or other well travelled areas where soil compaction has occurred.
  - Rehabilitate disturbed areas that intercept existing groundwater flow with porous granular material to maintain existing groundwater linkage particularly at river/wetland intersection.

See Section 5.13 for mitigation measures from material handling.

5.2 Excavation and Blasting

Excavation of the underground facilities will be completed with controlled drill and blast methods and will occur during construction and operations (due to continued underground development).

One key mitigation measure for excavation and blasting activities is to develop a Blast Management Plan that includes details of the planned blasting program, such as inventory of explosive material, schedule/frequency of blasts, charge mass per delay. Mitigation measures can then be considered based on the predicted air, noise and ground-borne vibration.

- Follow best management practices for use of explosives near Canadian fisheries waters (e.g., Wright and Hopky 1998).
- Schedule blasting near Canadian fisheries waters to occur outside of restricted activity timing windows.
- Collect, store, and divert contact water (surface and groundwater) to water treatment plant (see Section 5.9).
- Minimize excavation activities in areas of medium to high index of aquifer vulnerability to the extent practical.
- Implement site-specific procedures to ensure that overburden and organic soils excavated from the site during construction are preserved and stockpiled for future reuse in site reclamation; the pile should be covered or retained in a covered facility to prevent or limit erosion and introduction of noxious weeds and invasive species.

- Identify groundwater wells of high potential for impacts due to the proposed design and establish baseline conditions, mitigation steps, and triggers for follow on activities (e.g., increased monitoring frequency, change in activities, alternate supply, etc.).
- Employ a blasting plan that provides information concerning blasting procedures, including the safe use and storage of explosives, and the measures and best management practices that will be implemented to prevent potential adverse impacts to human health, safety, and the environment.
- Provide notice and warning to communities when near-surface blasting will occur.

5.3 Vehicle Traffic

An increase in vehicle traffic may occur on site during site preparation, construction, operation, and decommissioning and closure. Mitigation measures related to vehicle traffic include but are not limited to the following:

- Establish and enforce speed limits of less than 25 km/hr on unpaved roads to control dust emissions and reduce collisions with wildlife. Implement signage throughout the site clearly stating the speed limit.
- Plan on-site truck routes to minimize travel distances where possible.
- Maintain the unpaved roads via grading or other maintenance practices to reduce the amount of fine particles available for dispersion.
- Maintain the unpaved roads such that they are free of ruts and potholes to avoid excessive noise and vibration from vehicles travelling on uneven surfaces.
- Avoid unnecessary use of engine brakes, horns and high beams.
- Turn vehicles off when not in use.
- Turn off headlights when vehicles are parked.
- Control mud and dirt adhering to the wheels, tires, roof, undercarriage, and other exterior surfaces prior to leaving the site, to the extent possible (e.g., employ mud mats, shaker grates, wheel wash)
- Control traffic through use of proper signage plan including regulatory signs, barricades, gates, warning signs, and guidance signs.
- Provide spill response training and place spill kits strategically throughout the site and/or in vehicles.
- Use electric vehicles, where possible.

5.4 Water Supply Requirements

The Project will require a freshwater supply during construction, operation, and extended monitoring. Based on current information available from the WLON-Ignace area it is assumed that the water supply will be sourced from a surface waterbody.

- Recycle and reuse service water to the extent practical to reduce the Project's water use footprint.
- Select water intake location to provide adequate separation from industrial activities, minimize susceptibility to flooding and erosion, and minimize adverse environmental impact both during construction and operation of the facility.
- Design the water intake structure in accordance with DFO's Measures to Protect Fish and Fish Habitat and available code of practice for preventing entrainment and impingement of fish.
- Use an appropriately sized intake screen to reduce impingement and entrainment of aquatic biota, particularly fishes.

5.5 Altered Site Drainage and Surface Water Runoff

The surface drainage of the Project footprint has the potential to be impacted during site preparation, construction, operation, and extended monitoring. Mitigation measures include:

- Limit the Project footprint and additional impervious areas to the extent practical
- Design and install appropriate site drainage and water containment and conveyance structures to divert contact water for treatment.
- Design and install appropriate distributed stormwater management best management practice devices for pollutant control before stormwater reaches the stormwater management ponds (catch basin inserts, downspout filtration boxes, vegetated swales etc.).
- Identify locations for the disposal of snow so that it is not disposed of directly into lakes and streams or onto any ice-covered water body and is not stockpiled upgradient of environmentally sensitive areas.
- Stabilization of environmentally sensitive areas should be conducted prior to freeze-up; maintenance if required and reinforcement should be completed in anticipation of snow melt events.

- Design and install appropriate flood prevention measures based on the outcome of the flood assessment of the site if necessary, including dry-floodproofing (e.g., columns and extended foundation, fill pads, berms and walls, etc.) and wet-floodproof for non-habitable structures such as storage rooms and sheds. Consider cut/fill balance for any proposed floodplain capacity losses as well as future changes to flood hazard limits associated with climate change.
- Provide adequate contact water storage capacity to manage runoff and seepage from the surface facilities.
- Perform routine inspection and maintenance of water containment structures, conveyance structures, floodproofing structures and the stormwater quality management facilities (distributed devices and Stormwater Management Ponds [SWMPs]).
- Apply DFO's *Measures to Protect Fish and Fish Habitat.*
- Limit steepness and length of slopes in disturbed areas and stockpiled soils.
- Avoid placing soil stockpiles near waterbodies.
- Use appropriate erosion control measures.
- Reclaim and revegetate areas where non-permanent facilities have been decommissioned.
- Monitor water flows in downstream aquatic environment and apply adaptive management if changes in flow are affecting fish habitat or erosional processes.
- Apply best management practices to minimize water quality impacts to groundwater recharge areas.
- Rehabilitate disturbed areas that intercept existing groundwater flow with porous granular material to maintain existing groundwater linkage particularly at river/wetland intersection.
- Implement a Project-specific Environmental Monitoring Plan and site contact water management procedures under an Environmental Protection Program.
- Implement a detailed Decommissioning and Reclamation Plan.
- Implement measures to prevent contamination of waterbodies by runoff from snow disposal areas, such as by directing runoff to settling ponds prior to discharge.

Specific to stormwater management, measures are required to mitigate the effects of urbanization in the hydrological cycle including increased runoff and decreased infiltration of rain and snowmelt:

- Design SWMPs and settling ponds in accordance with the Ontario Ministry of Environment Conservation and Parks design manual (MOE 2003).
- Line stormwater ponds, as required, over their base and embankments for protection and to prevent water infiltration back into the ground.
- Collect flows and monitor for quality; treat if required before being directed to any downstream uses (e.g., landscape irrigation) or discharged off the site.
- Design and install appropriate outlet structure(s) from the SWMPs to the receiving waterbody to minimize the peak discharge difference between pre and post development condition of the receiving waterbody. This approach to reducing hydromodification will need to be considered in the design process.
- Avoid groundwater recharge areas, wetlands and areas with sensitive vegetation.

5.6 Excavated Rock Management Area (ERMA)

Excavated rock from the development of underground facilities will be stored in the ERMA during construction, operation, extended monitoring, and decommissioning and closure. At present it is the NWMO's plan to store all excavated rock material on site. Possible mitigation measures include:

- Locate the ERMA in an area to avoid streams and wetlands, to the extent possible.
- Maintain appropriate slopes of the stockpiles.
- Employ appropriate erosion, sediment, and dust control measures.
- Geochemical characterization of drill core from the WLON-Ignace area is ongoing and to date supports that the rock is expected to be Non-Acid Generating (NAG); regardless, the NWMO is advancing the ERMA design that takes Potentially Acid Generating (PAG) excavated rock into consideration.
    - Design the testing program to meet site-specific needs, using a combination of static and kinetic test methods, as appropriate. Consult the following documents in designing, implementing and interpreting the results of the prediction program:
        - William A. Price (1997). Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia. British Columbia Ministry of Employment and Investment.
        - MEND. 2009. Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. MEND Report 1.20.1. December 2009.

    - If the rock at the site is determined to be acid generating, then the ERMA will be designed to limit the amount of leachate that can seep into underlying groundwater contained in the soil and rock by using a composite or multiple-layer liner system in the main rock pile area, perimeter ditches, and a stormwater management pond (NWMO 2021).
- Treat water conveyed to stormwater management pond according to applicable regulations prior to discharge to the environment.
- After excavated rock placement has ended, design the ERMA to be contoured to blend with the surrounding terrain, capped to control infiltration, and re-vegetated with native plant species.
- Develop site-specific programs for the prediction of leachate and stormwater quality.
- Develop site-specific programs for the prediction of wastewater quality to include:
    - The identification and description of all geological materials (including rock as well as overburden) to be excavated, exposed, or otherwise disturbed by excavation.
    - The prediction of the metal leaching and acidic drainage potential of all geological materials, including the timing and conditions during which metal leaching and acidic drainage are expected to occur.
    - The prediction of other potentially harmful components in water from the ERMA, including processing reagents, ammonia, algae-promoting substances, thiosalts, chlorides, and elevated pH.

5.7 Surface Facilities

Surface facilities, such as the concrete bath plant, air compressor building, UFPP, etc., will be developed and operated during construction, operation, extended monitoring, and decommissioning and closure. Mitigation measures include:

- Grout ground formations to reduce seepage, increase soil stability, and reinforce structures.
- Assess and minimize the effect of foundations on shallow groundwater.
- Apply best management practices to minimize water quality impacts to groundwater recharge areas such as reduced infiltration along access roads, storage areas, or other well travelled areas where soil compaction may occur.
- Install appropriate air pollution control technology (e.g., HEPA filters).

- Assess noise control measures for stationary sources (e.g., acoustic enclosures, noise barriers) on an as-needed basis.
- Assess lighting control measures (e.g., siting, task lighting, shielding, output distribution) on an as-needed basis.
- While it is recognized that construction and operations at the facility will continue on a 24-hour basis, avoid working during the night-time hours to minimize use of artificial light and noise impacts.
- Use timers or motion sensors for lighting at stationary structures (e.g., batch plant), within the constraints of security lighting requirements.
- Avoid pointing stationary light sources (e.g., floodlights) directly at sensitive locations.

5.8 Dewatering

During the construction and operation phases, there will be pressure changes in the open shafts and repository. These pressure changes may result in changes the groundwater flow paths. The size and extent of the pressure changes and its possible effects on surrounding groundwater and surface water systems need to be quantified.

The issues related to the effects of the open repository during construction and operation phases concern both the conditions in the repository (groundwater flow and hydrochemical conditions) and in the surrounding environment (groundwater levels, surface water levels, and hydrochemical conditions).

Modeling results will inform the potential impacts and mitigation steps needed to address impacts to groundwater quantity and quality and, due to the groundwater-surface water interactions, mitigate impacts to vulnerable surface waterbodies and wetlands. Information needed to support the identification of mitigation measures is provided in Section 6.2.

5.9 Treated Water Discharge

It is expected that treated water will ultimately discharge to the Mennin River or Revell River. Depending on the release point, engineered wetlands may be considered.

5.9.1 Treated Effluent

- Locate proposed treated effluent diffuser away from sensitive or unique fish habitats (e.g., critical spawning habitat), to the extent practical.

- Install and operate appropriate effluent treatment system to reduce the release of COPC to the downstream environment:
  - Recycle and reuse service water to the extent practical.
  - Incorporate effluent treatment methods (physical, chemical, and or biological treatment processes) to minimize release of COPC.
  - Design the treated effluent diffuser to provide effective mixing and assimilation of effluent to limit the area of the receiving environment effected by the discharge.
  - Release strategy considering seasonal variations (consider erosion control under high flow, reduced assimilative capacity under low flow).
- Monitor treated effluent flow and quality and ensure discharge water meets water quality criteria appropriate for release. Set conservative operational and action limits to guide discharge strategy and trigger additional mitigation prior to exceeding regulatory limits.
- Implement a surface water monitoring program to monitor for potential accumulation of COPC in the downstream environment (see Section 5.9.3).
- Implement a sediment quality monitoring program to monitor for potential accumulation of COPC in the downstream environment.
- Implement monitoring of aquatic biota to assess for potential effects related to treated effluent discharge.
- Implement monitoring of biota tissues in downstream environment for potential COPC uptake.
- Implement an effluent monitoring plan, waste management program, and environmental protection program.
- Develop and implement a detailed decommissioning and reclamation plan.

5.9.2 Treated Sewage

- Design treated sewage outfall to provide effective mixing and dilution of effluent.
- Design discharge such that flow does not interact with sediment.
- Treat sewage to appropriate release limits (minimum secondary treatment) in accordance with provincial standards and licence/permit conditions. Tertiary treatment would be the most comprehensive, consisting of secondary treatment (removing organic matter, suspended solids, secondary settlement) and the removal of specific substances of concern (e.g., solids, nutrients, and/or contaminants) using a combination physical, chemical and biological treatment processes.

- Monitor treated sewage quantity and quality to ensure discharge water quality meets criteria appropriate for release. Set conservative operational and action limits to guide discharge strategy and trigger additional mitigation.
- Implement an effluent monitoring plan and environmental protection program; the design of the monitoring program will depend on the type of wastewater system (intermittent or continuous) and the level of treatment (secondary or tertiary).
- Implement a surface water monitoring program (see Section 5.9.3).

5.9.3 Surface Water Monitoring

- Follow best practice in the development surface water monitoring program as part of an overall environmental protection program for the Project through all phases.
- The design should have clear data quality objectives that match the need for the data depending on the phase of the Project. The overall objective of the monitoring program is to measure the potential effects of COPC on the receiving environment. Project phase specific ERAs should be used to design the monitoring program such that the data can be used to determine whether measurable effects are within acceptable limits.
- The surface water quality monitoring program should be designed in accordance with CSA N288.4 and other BMP guiding documents described in Appendix A.

5.10 Groundwater Monitoring Wells

Groundwater monitoring will occur during construction, operation, extended monitoring, and decommissioning and closure. Monitoring will:

- Follow best management practices for drilling, installation, maintenance, and abandonment of wells to minimize risk of surface impacts to groundwater and mixing of groundwater from different aquifers during drilling, monitoring, and after well abandonment phases. For example, those identified in:
    - Water Supply Wells - Requirements and Best Management Practices Manual: https://www.ontario.ca/document/water-supply-wells-requirements - and-best-practices
    - Test Holes and Dewatering Wells - Requirements and Best Management Practices Manual: https://www.ontario.ca/document/test-holes-and-dewatering-wells - requirements-and-best-management-practices

5.11 Shaft Construction, Operation, and Closure

During shaft construction, operation, and closure, mitigation measures will include:

- Follow best management practices for excavation, blasting, maintenance, and closure of shafts to minimize mixing of groundwater from different aquifers during drilling, monitoring and after closure phases (e.g., Environment Canada Environmental Code of Practice for Metals Mines 2009).
- Follow best management practices for excavation, blasting, maintenance, and closure of shafts to minimize creating fractures or preferential flow paths along the shafts that could result in changes to groundwater flow patterns.
- Mitigation measures as identified in ONTARIO REGULATION 240/00 - Advanced exploration, mine development and closure.
- Maximize the stability of underground workings so that there is no surface expression of underground failure.
- Prevent collapse, stress transfer and flooding of adjacent opening.
- Seal all drill holes and other surface openings, especially those connecting the underground workings to the surface.
- Secure underground shaft or vent raise openings using concrete or other appropriate materials to ensure permanent closure.
- Ensure that underground workings do not become a source of contamination to the surface environment or groundwater. Minimize potential for contamination and, if required, collect, and treat.
- Resurface, re-slope and contour as required to blend with surrounding topography or desired end land-use targets.

See Section 5.2 for mitigation measures for excavation and blasting.

5.12 Heating and Ventilation of the Project Facility

- Air pollution control technology.
  - High Efficiency Particulate Air (HEPA) filtration systems will be available where underground air exhausts to surface.
- Locate stand-by generators in a location that minimizes impacts on receptors (air quality and noise).
- Assess need for noise control measures (e.g., acoustic enclosures, noise barriers) on an as-needed basis.

5.13 Materials Handling

Materials handling (e.g., placement of material in stockpiles, waste and fuel handling, etc.) will occur through all phases of the Project. Mitigation measures will include:

- Minimize speed of descent and drop heights during truck loading/unloading and material handling.
- Where possible, trucks will maintain an adequate freeboard, so that no part of the load comes within a safe distance of the top of any sideboard, side panel or tail gate, and the load will be covered during transport.
- Where possible, loading and unloading activities will be conducted when the wind speed is low (<18 km/hr) in order to minimize fugitive dust emissions and dispersal off-site. In very high wind conditions, these activities will be suspended, where practical.
- Apply dust control to working areas (e.g., surface watering, chemical dust suppressants) during dry and windy conditions.
- Stabilize surfaces in inactive areas and at completed works.
- Maximize the distance between the truck loading areas and sensitive receptors.
- Complete regular inspections to ensure that equipment and sound muffling devices are in good working order.
- Prohibit tailgate banging during unloading.
- While it is recognized that construction and operations at the facility will continue on a 24-hour basis, including rock hauling to the ERMA, work during nighttime hours will be minimized to the extent practical to minimize use of artificial light and noise impacts.
- Eliminate or minimize light trespass for any required lighting at truck loading areas.
- Equipment will be maintained and regularly checked for leaks.
- Secondary containment to be used during servicing and re-fueling.
- Double containment of fuel storage tanks.
- All hazardous substances will be stored and handled on site in accordance with applicable regulations.
- Implement a Hazardous Materials Spill Response Plan and Waste Management Plan.
- Follow any additional best management practices for nuisance impacts (e.g., dust, odours, noise) related to material handling (Appendix A).

6.0 DATA GAPS

As illustrated in Figure 1-2, the Project remains within the data gathering stage of development (concept design and baseline data collection). At this early stage of development, there are still many design decisions, unconfirmed assumptions, site specific environmental conditions and data, and community inputs that could influence the potential Project-environment interactions and corresponding mitigation measures. Future Project-environment interactions and corresponding mitigation measures will benefit greatly from further engagement and input from community members, in particular WLON, neighbouring First Nations, and MNO on their connection and use of the land.

6.1 Data Assumptions and Requirements

The specific design details and data that are needed to support the CSM and current assumptions, when possible, are summarized in Table 6-1. Some parameters could be estimated from literature or proxy location through openly accessed environmental databases (e.g., ECCC, MNRF, etc.); however, site-specific data are preferable if available. Much of the site-specific data will be collected from various programs, such as the EMBP and BIS, during the next few years. The EMBP will also gather data on the existing biophysical environment over the next few years, and these data will be used to define baseline conditions as part of the IA if the Project moves forward at this site.

Table 6-1 Data assumptions and requirements

Type	Data Requirement	Current Value, Assumption, or Stage	Reference Number	Notes/Details
Design, data	Receiving waterbody for treated effluent discharges	Mennin River or north part of Revell River (owing to its larger flow in comparison to smaller streams)	1	• There will be two treated discharge streams discharging through a single point: one from the ERMA, and one for all other sources (on-site treated effluent, treated sewage, treated stormwater runoff, UFPP) • Discharge will not occur upstream of Mennin Lake due to the small size and assimilative capacity of the upstream waterbodies located in the AOI • Data from the EMBP (hydrology) will assist with determining the selected river
Design	**Effluent discharge quantity (m^3/s)**			
	Dewatering water	Planned	2a	• During construction, will be retained to reduce sediment before release
	Treated sewage	Planned	2b	• To be estimated during Pre-Feasibility level site specific design
	Treated effluent	Planned	2c	
Design	Treated effluent discharge quality (concentration)	Planned	3	• To be estimated during Pre-Feasibility level site specific design
Design	Stormwater runoff (m^3/s)	Planned	4	• From all paved surfaces, roof water • Note that Golder (2012) assumed a storm rate of 25 mm over 6 hours • Integrating forecasted climate change related precipitation changes to assess future flood hazard limit changes and how those amended limits would interact with the site
Design	Added impervious surface by proposed site (m^2)	Planned	5	• Infiltration, runoff evaluation – surface water and groundwater implications
Design	Service water supply source	Surface waterbody	6	• Waterbody needs to be able to support water use without impacts to the aquatic environment • Need to be mindful of distance/cost for pumping
Design	**Required service water supply (m^3/d)**			
	Total average for surface and underground facilities (operations)	134 to 189	7a	• 33.5 to 47.3 million L/yr assuming 250 operating days • To be estimated and updated during Pre-Feasibility level site specific design
	Surface facilities	97 to 134	7b	• To be updated during Pre-Feasibility level site specific design
	Underground (construction)	102 to 190	7c	
	Underground (operations)	33 to 51	7d	

Type	Data Requirement	Current Value, Assumption, or Stage	Reference Number	Notes/Details
Design, data	Extent and orientation of air shed that could be impacted from ventilation system discharges	In Progress/Planned	8	• Air dispersion modelling
Data	Digital elevation or Lidar data for the AOI	In Progress	9	• To inform future air dispersion, noise, and light modelling • Any changes to during site preparation and construction should be well characterized • NWMO indicates this is available
Data	**Surface water and groundwater interactions**			
	Groundwater/surface water elevations on-site and in the regional watershed (m from a reference datum)	In Progress/Planned	10	• EMBP groundwater and surface water data will be used to inform modelling • Any changes to during site preparation and construction should be well characterized
Data	Groundwater – background groundwater data (physical and chemical)	Recommended	11	• To provide data for modeling and calibration of model • To understand inputs into the AOI
Data	Groundwater flow direction, vertical and horizontal gradients, and other hydrogeologic properties of all aquifers encountered from ground surface to depth of repository in the vicinity of the AOI	In Progress/Planned	12	• To provide data for modeling and calibration of model
Data	Soil types, chemical composition, and geotechnical properties of soil and rock in the AOI and surrounding area	In Progress	13	• Soil, overburden, and bedrock investigation included in EMBP, with field implementation started in 2022 • Geochemical characterization will also be required to inform decisions on locating the ERMA within the AOI
Data	Characteristics of the soil and the water quality from erosion due to exposure to wind, rainfall, and snow	In Progress	14	• To provide data for modeling and calibration of model
Design	**Site layout**			
	Surface facilities footprint (m x m)	625 x 700	15a	• This number is based on the generic surface facilities design and will be updated once the surface facilities design for the WLON-Ignace area is completed
	Size and locations of the facility structures, roadways, laydown areas	Planned	15b	• Need to consider distance to adjacent waterways (unnamed streams, rivers, wetlands, and lakes in the AOI)
Data	Abundance and likelihood of occurrence of plant, fish, and wildlife species in the AOI and surrounding region	On-going	16	• Investigations included in EMBP and Biodiversity studies, with field implementation started in 2022
Design	Finalization/update of COPC list	In Progress	17	• Especially herbicides and insecticides

Type	Data Requirement	Current Value, Assumption, or Stage	Reference Number	Notes/Details
Data	**Meteorological data within the AOI**			
	Total precipitation (mm) *Snow depth (mm)* *Ambient air temperature (°C)* *Atmospheric pressure (kPa)* *Soil moisture (%)* *Solar radiation (kWh/m²)* *Wind speed (km/hr)* *Wind direction* *Potential evapotranspiration (mm/d)*	In Progress	18	• At the AOI
Data	**Characterization of overburden units**			
	Thickness (m) *Horizontal K (m/s)* *Vertical K (m/s)* *Specific storage (1/m)* *Porosity (--)* *Lithologic description (--)*	In Progress	19	• Minimal overburden in the AOI • Need to characterize the subsurface sufficiently to understand groundwater surface water interactions, modeling inputs and calibration, and protection of current shallow groundwater users (potable, irrigation, other)
Data	**Characterization of shallow bedrock units**			
	Equivalent K horizontal (m/s) *Equivalent K vertical (m/s)* *Specific storage (1/m)* *Matrix porosity (--)* *Mean discontinuity or major flow zone spacing (m)*	In Progress	20	• Data is needed for design and safety case • Need to characterize the subsurface and groundwater flow sufficiently to understand groundwater flow, design of short- and long-term monitoring networks, modeling inputs and calibration
Data	**Characterization of deep bedrock units**			
	Equivalent K horizontal (m/s) *Equivalent K vertical (m/s)* *Specific storage (1/m)* *Matrix porosity (--)*	In Progress	21	• Data is needed for design and safety case • Need to characterize the subsurface and groundwater flow sufficiently to understand groundwater flow, design of short- and long-term monitoring networks, modeling inputs and calibration
Data, design	**Excavated rock**			
	Geochemistry of excavated rock	In Progress/Planned	22a	• Ensure the piles will not influence or cause adverse effects on local shallow groundwater flow • Determine geochemistry such as metal and salt leaching and acid rock drainage potential of excavated rock to inform ERMA design and develop inputs to site water quality models

Type	Data Requirement	Current Value, Assumption, or Stage	Reference Number	Notes/Details
				• Work is currently underway, initial round of results expected in 2023 • Need complementary analytical suites for leach tests / SW/GW • Determine metals content to inform air quality dispersion modelling and treatment needs for any leachate
	Estimation of rock extracted through construction and development (m^3)	2.5 million	22b	• Based on NWMO (2021)
	ERMA Footprint (m x m)	500 x 500	22c	• Location within AOI unknown
Data	Environmental baseline data	Various	23	• EMBP: Surface water quantity and quality, sediment quality, soil quality, groundwater quality and quantity, air quality, and tissues chemistry • BIS: Fish and fish habitat, wildlife and wildlife habitat, and species at risk
Data	Hydraulic conductivity of crystalline rock (m/s)	1.00E-11 or less	24	• Based on NWMO (2022)
Data	Hydraulic conductivity near surface and variability in the hydrostratigraphic units	Recommended/Planned	25	• Need to characterize the subsurface sufficiently to understand groundwater surface water interactions, design of short- and long-term monitoring networks, modeling inputs and calibration, and protection of current groundwater users (potable, irrigation, other)
Data	Site-scale hydraulic gradients with depth	In Progress	26	• Need to characterize the subsurface and groundwater flow sufficiently to understand groundwater surface water interactions, design of short- and long-term monitoring networks, modeling inputs and calibration, and protection of current groundwater users (potable, irrigation, other)
Data	Regional-scale hydraulic gradients with depth	Recommended	27	• Need to characterize the subsurface and groundwater flow sufficiently to understand groundwater surface water interactions, design of short- and long-term monitoring networks, modeling inputs and calibration, and protection of current groundwater users (potable, irrigation, other)
Data	Recharge/discharge locations (local)	In Progress	28	• Need to characterize the subsurface and groundwater flow sufficiently to understand groundwater surface water interactions, design of short- and long-term monitoring networks, modeling inputs and calibration, and protection of current groundwater users (potable, irrigation, other)

Type	Data Requirement	Current Value, Assumption, or Stage	Reference Number	Notes/Details
Data	Recharge/discharge locations (regional)	Recommended	29	• Need to characterize the subsurface and groundwater flow sufficiently to understand groundwater surface water interactions, design of short- and long-term monitoring networks, modeling inputs and calibration, and protection of current groundwater users (potable, irrigation, other)
Design	**Groundwater extraction rate (m^3/d)**			
	Construction (shallow)	Planned	30a	• Water pumped to surface from underground and includes consumed service water (not groundwater extraction) • Current values based on NWMO (2021) • Conservative and not site-specific; will be estimated during the PFS level design. • Does not include considerations for recycling of underground service water which is currently being considered in the design
	Construction (deep)	Up to 350	30b	
	Operations (deep)	Up to 180	30c	
Data	Site-specific average (seasonal) and peak stream flow rates (m^3/s)	In Progress	31	• Data being collected as part of the hydrology component of the EMBP
Data	**Soil characterization**			
	Site-specific soil infiltration rate (mm/hr)	In Progress	32a	• To inform air dispersion modelling (fugitive dust releases) from disturbed areas within the Project footprint • To determine baseline conditions
	Soil classification	In Progress	32b	
	Silt content	Recommended	32c	
	Moisture content (%)	Recommended	32d	
	Particle size distribution	Recommended	32e	
	Metals content	In Progress	32f	
Data	Engagement with rights-holders	In Progress	33	• Indigenous Knowledge on quantity, type, and general harvest locations of traditional foods will help refine the study areas and species of interest for the EMBP
Data	**Characterization of traditional and non-traditional foods sourced from the area**			
	Type Quantity General harvest locations	Recommended	34	• This information will help document potential VCs for the IA • This information will help bridge the gap between the tissue media baseline data and the human health risk assessment for the IA • Data would be collected through a community dietary survey
Data	Salinity of deeper aquifers in the area	In Progress	35	

Type	Data Requirement	Current Value, Assumption, or Stage	Reference Number	Notes/Details
Data	**Characterization of waterbodies within and adjacent to the AOI**			
	Stage (m; vertical datum: NAVD 88)	In Progress	36a	• Continuous stream gauges – Mennin and Revell rivers
	Flow rate (m^3/s)	In Progress	36b	• Continuous stream gauges – Mennin and Revell rivers
	Bathymetry	In Progress	36d	• Small lakes within the AOI, Mennin Lake and reference lakes
	Stage (m; vertical datum: NAVD 88)	In Progress	36d	• Staff gauges (discrete): Small unnamed streams and small lakes within the AOI, Mennin Lake, Revell Lake
Data	Visual / aesthetics / light	Recommended	37	• Visual landscape inventory to define existing landform (terrain slope, height, topographic variety), land cover (type, diversity), representative viewpoints (community, rights-holders), and photo records • Lighting design information
Study	Human health and ecological risk assessment	Recommended	38	• Would use information from baseline, engagement, and socio-economic studies (e.g., dietary study)

Table 6-2 provides a summary of the required information identified in Table 6-1.

Table 6-2 List of required information

Document/Study	Reference Number [a]	Due Date
Pre-Feasibility Design	2(a-c), 3, 5, 6, 7(a-d), 15(a-b)	Complete by Q4 2024
Preliminary Design	2(a-c), 3, 5, 6, 7(a-d), 15(a-c)	Complete by Q2 2026
ERMA Design	9, 22(b,c)	Complete by Q4 2024
Safety Case	17	Complete by Q2 2025
Community Engagement	33, 34	Ongoing, key dates: VCs by Q4 2024 Dietary studies Q4 2024 All IA inputs required by Q2 2026
EMBP	11, 13, 18, 31, 32(a-f), 36(a-f)	Q4 2025
BIS	16	Q4 2025
Air Dispersion and Noise Impact Assessment / Modelling	8, 9, 18, 22, 23, 32(c-f)	Q4 2026 – Q2 2027
Light and Visual Impact Assessment/ Modelling	9, 37	Q4 2026 – Q2 2027
Groundwater Characterization and Modelling	10, 12, 19, 20, 21, 23, 24, 25, 26, 27, 28, 29, 35	Q1 2025 – Q3 2026
Groundwater Extraction Rate (m^3/d)	30(a-c)	Q4 2024
Geochemical Testing of Rock	14, 22a	Q2 2023 - Q3 2025
Geotechnical Properties of Soil	13	Q1 2026
Flood Assessment	4	Q4 2025 - Q3 2026
Site Water Balance	2(a-c),	Q4 2025 - Q3 2026
Water Quality Modelling	1	Q4 2026 - Q2 2027
Human Health and Ecological Risk Assessment	38 (needs information from 33 and 34)	Q1 2026 - Q4 2027

Note:

[a] Reference number assigned in Table 6-1.

6.2 Supporting Information Required for Mitigation Measures

Mitigation measures for the potential Project-environment interactions were discussed in Section 5.0. To support and confirm these measures, the following supporting information is required:

- Studies to support the selection of the source water and discharge receiving waterbody
  - Hydrology data collected through the EMBP
  - Groundwater characterization
- Determination of whether or not water supply requirements will cause lowered water levels in source waterbody or other sensitive receptors

    - Groundwater surface water evaluation which can in part be done by identifying areas of groundwater discharge and recharge, gaining and losing river stretches through field monitoring and providing data to refine and calibrate the groundwater model
    - Evaluation of baseline data and additional detailed studies (geochemistry, tracer studies, groundwater elevation data over time, to refine/calibrate modeling) to determine areas of groundwater surface water interaction, vulnerabilities of wetlands and other surface water bodies to dewatering, sensitivities and vulnerabilities of water supply wells to dewatering activities
- New information on the chemistry of the excavated rock (e.g., sulfide content of excavated rock) or other analyses to incorporate, particularly around whether or not the excavated rock is PAG
    - Need to implement geochemical testing program
    - Geochemical baseline program to determine the acid rock drainage and metal leaching potential (ARD/ML), including oxidation of primary sulphides and secondary soluble sulphate minerals; additional objectives are to determine the anticipated quality of the water that may come in contact with the excavated rock and potential air quality impacts from dust generated from the excavated rock pile
    - Gap analysis and preliminary design of the geochemical evaluation
    - Rock and overburden sample collection
    - Testing including static testing, short-term and long-term leach testing and mineralogical analysis, post kinetic test analysis
- Detailed information on discharge location(s) and methods (i.e., engineered wetlands, diffuser)
- Liquid effluent treatment plant design
    - Volumes
    - COPC including metals (geochemistry) and blasting agent residue (e.g., ammonia)
    - Expected removal efficiencies
    - Modelling of surface water quality can help define exposure-based release limits
- Airborne effluent design
    - Ventilation exhaust (volumetric flowrate, exit velocity)
    - COPC

    - HEPA filter operating efficiency
- Stormwater management details
    - COPC concentrations in runoff from outside the rock piles pre- and post-construction
    - Predicted reduction in COPC levels in the settling pond either by treatment or settling
- Data to support dewatering mitigation
    - Baseline groundwater monitoring (quality and elevation/pressure) before and during production activity to provide the data to evaluate environmental impacts
    - Development of a predicted zone of influence for each aquifer that will be withdrawn
    - Development of the minimum and maximum rates and duration for dewatering
    - Establishment of clear detailed mitigation, monitoring, and contingency plans, and provides a detailed plan for reporting and communications for implementing the plan based on adaptive management principles
    - Establish action levels with respect to water levels/pressures and key water quality parameters (e.g., dissolved oxygen, pH, dissolved solids, metals etc.) for each of the aquifers encountered in the dewater activities; identify what action levels trigger what actions for the various monitoring locations and parameters

6.3 Other

Transportation of material to the site was not included in the interactions table. It is acknowledged that this is high concern to community members.

6.4 Schedule

In the event that the Project does move forward at the proposed Site, an IA would need to be completed, which would require the completion of numerous supporting studies. Related to the biophysical environment, the Impact Assessment Agency of Canada (IAAC 2020) requires the following information be contained within an IA:

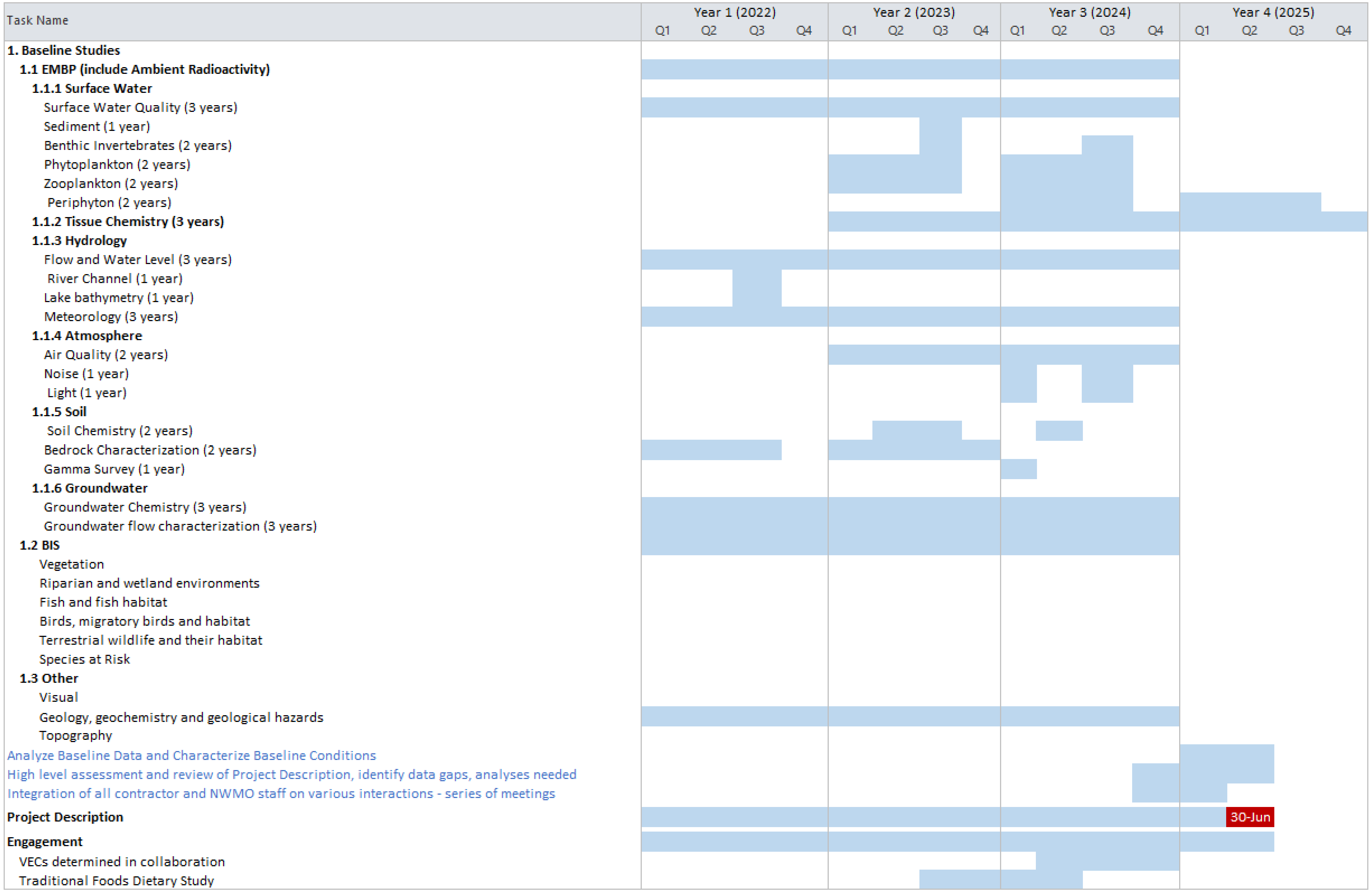
- Baseline conditions – biophysical environment
    - Atmospheric, acoustic, and visual environment

    - Meteorological environment
    - Geology, geochemistry and geological hazards
    - Topography, soil and sediment
    - Riparian and wetland environments
    - Groundwater and surface water
    - Vegetation
    - Fish and fish habitat
    - Birds, migratory birds and their habitat
    - Terrestrial wildlife and their habitat
    - Species at Risk
    - Ambient radioactivity
- Predicted changes to the physical environment
    - Changes to the atmospheric, acoustic, and visual environment
    - Changes to groundwater and surface water
    - Changes to riparian, wetland and terrestrial environments
    - Radiological conditions
    - Electromagnetism and corona discharge
- Effects to valued components - environment
    - Fish and fish habitat
    - Birds, migratory birds and their habitat
    - Terrestrial wildlife and their habitat
    - Species at risk
    - Climate change

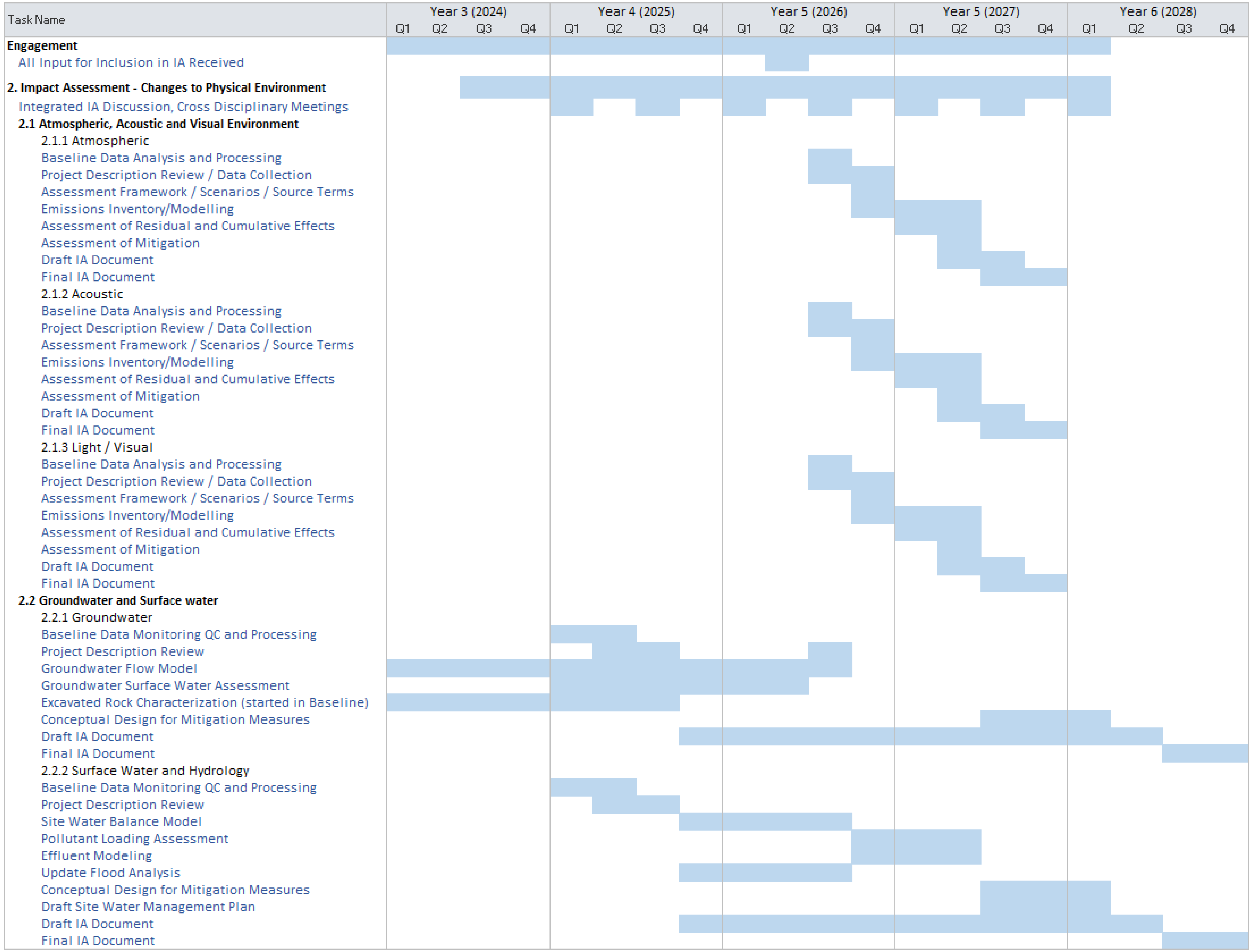
Prior to an IA, the NWMO would need to file an initial Project Description. Based on an assumed filing date of June 30, 2025, followed by filing of the IA document by May 31, 2028, a general schedule of the supporting studies that must be completed is provided in Figure 6-1.

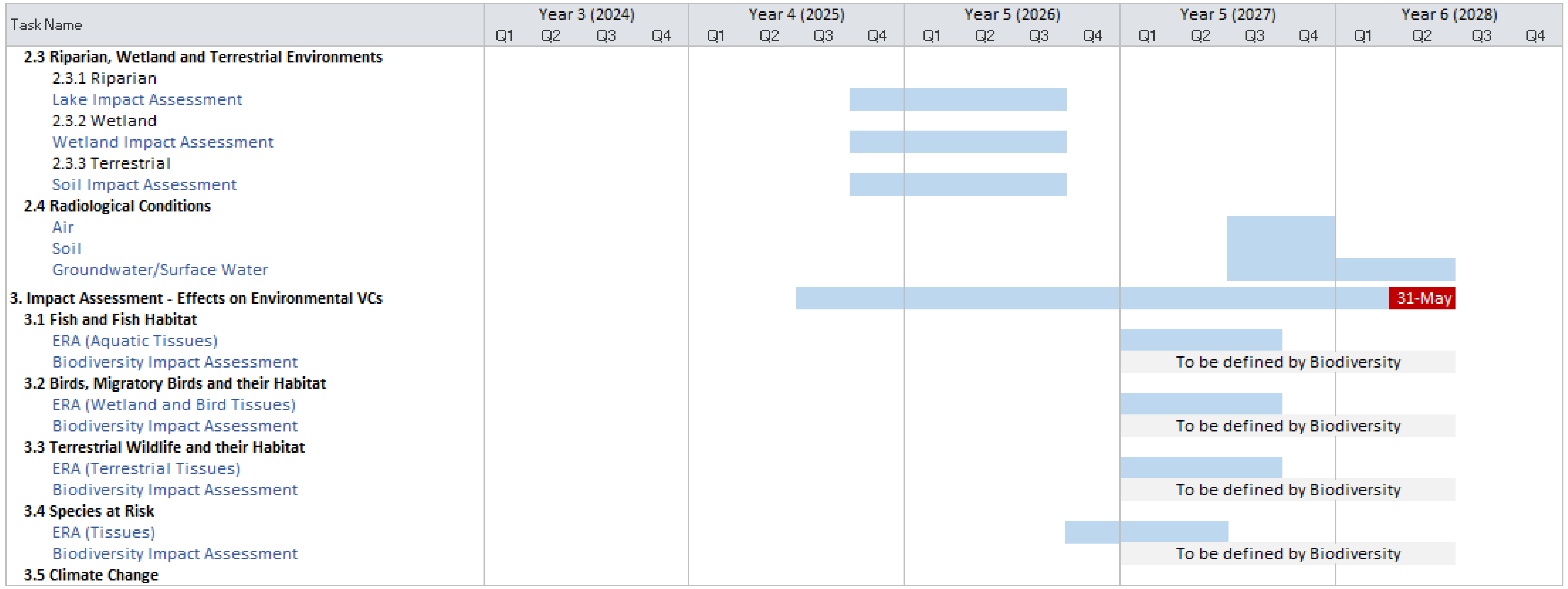
Figure 6-1 Schedule of studies in support of the Impact Assessment

a) Baseline Studies



b) Impact Assessment




Task Name
Year 3 (2024)
Year 4 (2025)
Year 5 (2026)
Year 5 (2027)
Year 6 (2028)
Q1 Q2 Q3 Q4
2.3 Riparian, Wetland and Terrestrial Environments
2.3.1 Riparian
Lake Impact Assessment
2.3.2 Wetland
Wetland Impact Assessment
2.3.3 Terrestrial
Soil Impact Assessment
2.4 Radiological Conditions
Air
Soil
Groundwater/Surface Water
3. Impact Assessment - Effects on Environmental VCs
31-May
3.1 Fish and Fish Habitat
ERA (Aquatic Tissues)
Biodiversity Impact Assessment
To be defined by Biodiversity
3.2 Birds, Migratory Birds and their Habitat
ERA (Wetland and Bird Tissues)
Biodiversity Impact Assessment
To be defined by Biodiversity
3.3 Terrestrial Wildlife and their Habitat
ERA (Terrestrial Tissues)
Biodiversity Impact Assessment
To be defined by Biodiversity
3.4 Species at Risk
ERA (Tissues)
Biodiversity Impact Assessment
To be defined by Biodiversity
3.5 Climate Change

7.0 MAP SOURCES AND DISCLAIMERS

CanNorth has exercised all reasonable care in the compilation, interpretation, and production of the map figures contained in this document. However, it is not possible to warrant or guarantee the accuracy, precision, currency, suitability, or reliability of any of the displayed or underlying data contained in the figures. Therefore, these are presented for reference and/or illustrative purposes; they are neither intended for legal delineation of any geographic feature nor for navigational use. The user must accept the data “as is" and CanNorth assumes no responsibility for loss or damage incurred as a result of any user reliance on this data.

Map figures produced using ESRI ArcGIS 10.7.1.11595

Aquatic Resources Areas Summary. Ontario Ministry of Natural Resources and Forestry. 2015. “Aquatic Resource Area Polygon Segment”, “Non_Sensitive.gdb\ ARA_ WATER_POLY_SEGMENT”. Contains information licensed under the Open Government Licence – Ontario, https://www.ontario.ca/ page/open-government-licence-ontario.

Area of interest. Tulloch Engineering. 2017. “Ignace_OvalA.shp.”

Cities, Towns, and Communities. ©Department of Natural Resources Canada. 2019. 1:50,000 “CanVec – 50K – ON – Toponymy.” http://ftp.maps.canada.ca/pub/nrcan_rncan/vector/canvec/shp/Toponymy/. Contains information licensed under the Open Government License – Canada https://open.canada.ca/en/open-government-licence-canada

Digital topographic raster background images. ©Department of Natural Resources Canada. 2020. 1:50,000. “Toporama Web Mapping Service of the Earth Sciences Sector.” WMS Server: http://wms.ess-ws.nrcan.gc.ca/wms/toporama_en. Contains information licensed under the Open Government License – Canada http://open.canada.ca/en/open-government-licence-canada.

Esri World Imagery. ESRI, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, Aero GRID, IGN and the GIS User Community. 2020. ArcGIS Online http://www.esri.com/software/arcgis/arcgisonline.

First Nation reserves. Natural Resources Canada, Earth Sciences Sector, Surveyor General Branch, Cadastral Information Service. 2015. “Aboriginal Lands – ONTARIO”. Contains information licensed under the Open Government License – Canada https://open.canada.ca/en/open-government-licence-canada.

Forest harvest in the AOI. 2019. Geosyntec.

Land Use. Ontario Ministry of Natural Resources and Forestry. 2019. “Crown land use policy area”, “Non_Sensitive.gdb\CLUPA_PROVINCIAL”. Contains information licensed under the Open Government Licence – Ontario, https://www.ontario.ca/ page/open-government-licence-ontario.

Provincial Boundaries. ©Department of Natural Resources Canada. 2020. “Administrative Boundaries in Canada – CanVec Series – Administrative Features.” https://open.canada.ca/data/en/dataset/306e5004-534b-4110-9feb-58e3a5c3fd97. Contains information licensed under the Open Government License – Canada https://open.canada.ca/en/open-government-licence-canada.

Railroads. ©Department of Natural Resources Canada. 2017. 1:50,000. “CanVec ON Transport.” http://ftp.maps.canada.ca/pub/nrcan_rncan/vector/canvec/shp/ Transport/. Contains information licensed under the Open Government License - Canada https://open.canada.ca/en/open-government-licence-canada

Revel Batholith Temporary Withdrawal Area. 2018. “Ignace_WithdrawalArea Revell.shp”.

Rivers. ©Department of Natural Resources Canada. 2017. “North American Atlas – Hydrography.” 1:10,000,000. Contains information licensed under the Open Government License – Canada http://open.canada.ca/en/open-government-license-canada.

Roads. ©Department of Natural Resources Canada. 2017. 1:50,000. “CanVec ON Transport.” http://ftp.maps.canada.ca/pub/nrcan_rncan/vector/canvec/shp/Transpo rt/. Contains information licensed under the Open Government License - Canada https://open.canada.ca/en/open-government-licence-canada

Township of Ignace. Land Information Ontario. 2012. “\MUNICIPAL_BOUNDARY_ LOWER_AND_SINGLE_TIER.shp”. Contains information licensed under the Open Government Licence – Ontario, https://www.ontario.ca/page/open-government-licence-ontario.

United States of America Boundary. National Atlas of the United States. 2012. 1:1,000,000. “State Boundaries of the United States.” http://nationalatlas.gov/mld/1statep.html

Wabigoon Watershed. Land Information Ontario. 2012. “WATERSHED_TERTIARY”. Contains information licensed under the Open Government Licence – Ontario, https://www.ontario.ca/page/open-government-licence-ontario.

Waterbodies. ©Department of Natural Resources Canada.2017. “North American Atlas – Hydrography.” 1:10,000,000. Contains information licensed under the Open Government License – Canada http://open.canada.ca/en/open-government-license-canada.

8.0 LITERATURE CITED

AECOM. 2021. Preliminary flood hazard assessment at South Bruce study area. NWMO-TR-2022-xx DRAFT, June.

Amiro, B.D. 1992. Baseline concentrations of nuclear fuel waste nuclides in the environment. Atomic Energy of Canada Limited, AECL (Report).

CCI Research Inc. 2021. Nuclear Waste Management Organization and Township of Ignace - Community survey report. https://www.nwmo.ca/~/media/Site/Files/PDFs/2021/06/02/15/40/NWMO-Community-Results--Ignace-v300.ashx?la=en.

Chan, L., O. Receveur, M. Batal, W. David, H. Schwartz, A. Ing, K. Fediuk, A. Black, and C. Tikhonov. 2014. First Nations Food, Nutrition and Environment Study (FNFNES). Results from Ontario 2011-2012. Ottawa, ON: University of Ottawa.

CNSC (Canadian Nuclear Safety Commission). 2018. Class IB facilities guidance on Deep Geological Repository site characterization. Regulatory document REGDOC-1.2.1, Draft, October.

DFO (Department of Fisheries and Oceans Canada). 2019. Measures to protect fish and fish habitat. https://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures-eng.html.

Domtar. 2018. 2017-2018 Annual Report Wabigoon Forest SFL #541953.

Golder (Golder Associates Ltd.). 2012. OPG'S deep geologic repository for low & intermediate level waste. Work package 2-12: Water quality modelling results for the stormwater management pond (SWMP). DGR-TM-01130-29954.

Golder (Golder Associates Ltd.). 2013a. Phase 1 desktop geoscientific preliminary assessment of potential suitability for siting a Deep Geological Repository for Canada's used nuclear fuel – Township of Ignace, Ontario. NWMO Report number APM-REP-06144-0011.

Golder (Golder Associates Ltd.). 2013b. Phase 1 desktop assessment: Environment report – Township of Ignace, Ontario. APM-REP-06144-0010, November.

Golder (Golder Associates Ltd.). 2020. Climate change impacts on climate variables for a deep geological repository (Ignace study area). NWMO-TR-2020-04, December.

IAAC (Impact Assessment Agency of Canada). 2020. Tailored impact statement guidelines template for designated projects subject to the Impact Assessment Act. https://www.canada.ca/en/impact-assessment-agency/services/policy-guidance/practitioners-guide-impact-assessment-act/tailored-impact-statement-guidelines-projects-impact-assessment-nuclear-safety-act.html.

JDMA (JD Mollard and Associates Limited). 2013a. Phase 1 geoscientific desktop preliminary assessment, lineament interpretation – Township of Ignace, Ontario. Prepared for Golder Associates Ltd. and the Nuclear Waste Management Organization (NWMO), November.

JDMA (JD Mollard and Associates Limited). 2013b. Phase 1 geoscientific desktop preliminary assessment, terrain and remote sensing study - Township of Ignace, Ontario. Prepared for Golder Associates Ltd. and the Nuclear Waste Management Organization (NWMO), November.

Liberda, K., H. Leung, and NWMO. 2018. Preliminary Preclosure Accident Consequence Analysis for the APM Conceptual Design - 18090. WM2018 Conference, March 18-22, 2018, Phoenix, Arizona, USA.

Ministry of Mines. 2019. Abandoned Mines Information System. https://www.mndm.gov.on.ca/en/mines-and-minerals/applications/ogsearth/abandoned-mines (accessed May 22, 2019).

MNRF (Ontario Ministry of Natural Resources and Forestry). 2019. Forest Management Plan Summary: 2019-2029 Wabigoon Forest Management Plan.

MOE (Ontario Ministry of the Environment). 2003. Stormwater management planning and design manual. Ontario Ministry of the Environment, Conservation, and Parks. Ontario, Canada.

NWMO (Nuclear Waste Management Organization). 2013. Preliminary assessment for siting a deep geological repository for Canada's used nuclear fuel: Findings from Phase One studies, the Corporation of the Township of Ignace, Ontario. Report number APM-REP-06144-0009, November.

NWMO (Nuclear Waste Management Organization). 2017a. Technical report: Engagement activities, 2014 to 2016. March.

NWMO (Nuclear Waste Management Organization). 2017b. Post closure safety assessment of a used fuel repository in crystalline rock. Report number TR-2017-02, Revision 000, December.

NWMO (Nuclear Waste Management Organization). 2021. Deep geological repository conceptual design report crystalline / sedimentary rock. Report APM-REP-00440-0211-R000. September.

NWMO. 2022. Confidence in safety - Revell site. NWMO-TR-2022-14, March.

Ontario Hydro Nuclear. 1993. Derivation of the source term for chronic radioactive emissions from the used fuel disposal centre during the preclosure phase. N-03784-939973 (UFMED), December.

Ontario Prospectors Association. 2019. Ontario mining & exploration: Directory and resource guide 2019.

Paterson Grant and Watson Limited. 2013. Phase 1 desktop geoscientific preliminary assessment, processing and interpretation of geophysical data - Township of Ignace, Ontario. November.

Roberts, J., T. Hauser, and E. Fausto. 2019. Climate change impacts review and method development. NWMO-TR-2019-05, R000, March.

SENES (SENES Consultants Ltd.). 2012. APM site boundary assessment. APM-TM-03630-31475, January. Prepared for Nuclear Waste Management Organization.

SENES (SENES Consultants Ltd.). 2013. Draft community profile – Township of Ignace, Ontario. NWMO report number APM-REP-06144-0015, July.

Soil Classification Working Group. 1998. The Canadian system of soil classification. Ottawa: Agriculture and Agri-Food Canada Publication 1646 (Revised).

Tulloch (Tulloch Engineering Inc.). 2018a. Adaptive phased management - Phase 2 environmental work, technical memorandum 3, Ignace, ON. Report number APM-REP-07000-0206, Version 2.1, May 25.

Tulloch (Tulloch Engineering Inc.). 2018b. Adaptive phased management - Phase 2 environmental work, technical memorandum 1, Ignace, ON. Version 3.2, February 28.

Wright, D.G., and G.E. Hopky. 1998. Guidelines for the use of explosives in or near Canadian fisheries waters. Can. Tech. Rep. Fish. Aquat. Sci. 2107:IV + 24 p.

Zoetica. 2022. Biodiversity impact studies – Northwestern Ontario region: 2022 change assessment memorandum. Draft. Prepared for the Nuclear Waste Management Organization, Toronto, ON.

APPENDICES

LIST OF APPENDICES

APPENDIX A

BEST MANAGEMENT PRACTICES

TABLE OF CONTENTS

A.0 BEST MANAGEMENT PRACTICES

A.1 INTRODUCTION

The main document discussed the implementation of best management practices (BMP) to mitigate environmental impacts. This appendix provides a more detailed list of some of the BMPs that may be considered within the IA.

A.2 General

These BMPs have been developed for a range of activities as well as general frameworks. BMPs developed for the mining sector will generally apply to the activities associated with this project.

- Environmental Code of Practice for Metal Mines: https://www.ec.gc.ca/lcpe-cepa/documents/codes/mm/mm-eng.pdf
- Incorporating climate change into the mining sector: https://mining.ca/wp-content/uploads/2021/10/MAC-Climate-Change-Guide-June-2021.pdf
- Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities. Mining Associate of Canada. 2011. https://mining.ca/resources/guides-manuals/developing-an-operation-maintenance-and-surveillance-manual-for-tailings-and-water-management-facilities/
- Canadian National Master Construction Specification https://nrc.canada.ca/en/certifications-evaluations-standards/canadian-national-master-construction-specification

A.3 BMPs by Project Activity

A list of common BMPs have been compiled and organized by project activity. It is recognized that many of the BMPs would be applicable to multiple activities.

A.3.1 Land Clearing and Grading

Land clearing and grading activities commonly occur as part of various project activities. As such, a number of published BMPs are available for mitigating potential effects on the biophysical environment. These BMPs include government guidance documents as well as industry specific guidance that can be applied to various project types. The following documents can be used as guidance for developing specific mitigation practices for the South Bruce Project:

- Ontario species at risk guides and resources: Best management practices https://www.ontario.ca/page/species-risk-guides-and-resources#section-3
- DFO's *Measures to Protect Fish and Fish Habitat* (DFO 2019) https://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures-eng.html
- DFO's Codes of Practice https://www.dfo-mpo.gc.ca/pnw-ppe/practice-practique-eng.html
- In-water Work Timing Window Guidelines (OMNR 2013) https://www.ontario.ca/document/water-work-timing-window-guidelines
- Guidelines to avoid harm to migratory birds https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/reduce-risk-migratory-birds.html
- Canadian National Master Construction Specifications https://nrc.canada.ca/en/certifications-evaluations-standards/canadian-national-master-construction-specification/
- Ontario Provincial Standards (2022) https://www.roadauthority.com/Standards/?id=4cd60a04-a9fe-4a31-9df3-6fa41bb60e65
- Ontario's Environmental guidelines for access roads and water crossings (2019) https://www.ontario.ca/page/environmental-guidelines-access-roads-and-water-crossings
- Ontario Provincial Standards Specification OPSS.PROV 201, APRIL 2019, https://www.roadauthority.com/Standards/Home/FileDownload?standardFileId=8c90c949-0a83-4dc7-bdf5-72d19633431f
- Although not located in Toronto, the TRCA has management plans for activities such as underground infrastructure and dewatering that may be useful: https://trca.ca/planning-permits/projects-that-require-a-permit/infrastructure-planning/

BMPs for nuisance impacts (e.g., dust, odours) from land clearing and grading activity presented in Attachment A should also be consulted. Mitigation practices to limit the potential effects of land clearing and grading on the biophysical environment tend to focus on avoiding sensitive timing windows (i.e., fish spawning periods or bird nesting periods), minimizing the overall project footprint, minimizing areas of vegetation clearing and soil disturbance, minimizing water crossings, and implementing design and operation controls should also be observed. Zoetica (2022) should be consulted for BMPs for Biodiversity.

A.3.2 Excavation and Blasting

Mitigation measures for excavation and blasting activities will be informed by the following guidance documents and BMPs:

- Guidelines for the Use of Explosives in or near Canadian Fisheries Waters. https://publications.gc.ca/site/archivee-archived.html?url=https://publications.gc.ca/collections/Collection/Fs97-6-2107E.pdf
- Ontario Provincial Standards Specification OPSS.MUNI 120 https://www.roadauthority.com/Standards/Home/FileDownload?standardFileId=956fb3a9-5044-4b9c-9c2e-c3b4eb78b75a
- Ontario Provincial Standards Specification OPSS.MUNI 201 https://www.roadauthority.com/Standards/Home/FileDownload?standardFileId=0efb6ac7-06ea-4296-b311-9089883c55df
- Ontario Provincial Standards Specification OPSS.MUNI 202 https://www.roadauthority.com/Standards/Home/FileDownload?standardFileId=c8a94aa7-aa8b-4782-991b-7287294bb56f
- Ontario Ministry of Agriculture, Food, and Rural Affairs Best Management Practices Series http://www.omafra.gov.on.ca/english/environment/bmp/series.htm
- Ontario Excess Soil: Best management practices https://www.ontario.ca/page/management-excess-soil-guide-best-management-

In addition, BMPs for nuisance impacts (e.g. dust, odours) presented in Attachment A

A.3.3 Vehicle Traffic

Many of the BMP for traffic have been included in other sections (e.g. land clearing and grading). In particular the BMPs for nuisance impacts presented in Attachment A provide guidance for traffic. Some additional BMPs include:

- Environmental Guide for Noise, Ministry of Transportation https://prod-environmental-registry.s3.amazonaws.com/2022-03/Environmental%20Guide%20for%20Noise%20(2022)_1.pdf

- Code of practice for the environmental management of road salts https://www.canada.ca/en/environment-climate-change/services/pollutants/road-salts/code-practice-environmental-management.html
- Good Practices for Winter Maintenance in Salt Vulnerable Areas https://conservationontario.ca/fileadmin/pdf/conservation_authorities_section/SWP_Good_Practices_Salt_Vulnerable_Areas_2018.pdf

A.3.4 Water Supply Requirements

- Water management: policies, guidelines, provincial water quality objectives | ontario.ca

- End-of-pipe fish protection screens for small water intakes in freshwater (DFO 2020) https://www.dfo-mpo.gc.ca/pnw-ppe/codes/screen-ecran-eng.html

A.3.5 Altered Site Drainage and Surface Water Runoff

A.3.5.1Stormwater Management

Ontario's Stormwater Management Planning and Design Manual described stormwater management plan as a requirement to mitigate the effects of urbanization on the hydrologic cycle including increased runoff and decreased infiltration of rain and snowmelt. These stormwater management practices (SWMPs) or alternatively, stormwater best management practices (Stormwater BMPs), should be sized and designed to ensure that:

- Groundwater and baseflow characteristics of are preserved;
- Water quality will be protected;
- The watercourse will not undergo undesirable and costly geomorphic change;
- There will not be any increase in flood damage potential;
- An appropriate diversity of aquatic life and opportunities for human uses will be maintained.

The design manual categorized the SWMPs into two categories based on the locations of the proposed SWMP. Some examples practices under the two categories are listed below:

- Lot level and conveyance controls:
    - Storage controls: rooftop, parking lot and pipe storage etc.

  - Infiltration-based controls: downspout disconnection, infiltration trenches, perforated pipes etc.

- End-of-pipe Controls:
  - Wet Ponds
  - Wetlands
  - Dry Ponds
  - Infiltration Basins

In addition to these BMPs listed in the Design Manual, other types of structural Stormwater BMPs should also be considered and sized for the mitigation measures of the Project. Examples of these structural BMPs include catchbasin inserts, rain gardens (lot level and conveyance) and specialized filtration basins to provide treatment for COPCs (end-of-pipe).

Besides implementing the appropriate permanent structural stormwater BMPs during the operational phase of the Project, temporary stormwater BMPs should be implemented during the construction phase of the Project, in order to control COPCs commonly associated with construction sites (sediment, oil and crease, concrete truck washout etc.). Examples of these construction-phase stormwater BMPs include erosion and sediment controls and timely stabilization of disturbed areas (US EPA 2022).

- Ontario's Stormwater Management Planning and Design Manual: https://www.ontario.ca/document/stormwater-management-planning-and-design-manual-0
- The US EPA (2022) provides a list of BMPs that are representative of the types of practices that can successfully achieve the minimum control measures: https://www.epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater
- ITRC guidance on post construction BMP lifecycle processes including contracting, cost considerations, installation factors including construction challenges, inspection checklists, quality control and record drawings. Interactive Stormwater Best Management Practices Performance Evaluation Tool

A.3.6 Excavated Rock Management Area (ERMA)

- Tailings and waste rock: guide to reporting - Canada.ca
- A Guide to the Management of Tailings Facilities, v 3.2 (The Mining Association of Canada 2021) https://mining.ca/download/31758/
- https://mining.ca/towards-sustainable-mining/protocols-frameworks/tailings-management-protocol/

BMPs for nuisance impacts (e.g., dust, odours) presented in Attachment A should also be followed.

A.3.7 Surface Facilities

Apply best management practices to minimize water quality impacts to groundwater recharge areas such as reduced infiltration along access roads, storage areas, or other well travelled areas where soil compaction may occur

- Monitoring of releases from the surface facilities will need to be compliant with CSA N288.5: https://www.csagroup.org/store/product/N288.5-11/

BMPs for nuisance impacts (e.g., dust, odours) presented in Attachment A should also be followed.

A.3.8 Dewatering

Water management: policies, guidelines, provincial water quality objectives | ontario.ca

Test holes and dewatering wells - Requirements and best management practices | Ontario.ca

A.3.9 Discharge of Treated Water

In-water construction of the treated water discharge will need to consider BMPs described in this section, including:

- Ontario species at risk guides and resources: Best management practices https://www.ontario.ca/page/species-risk-guides-and-resources#section-3
- DFO's *Measures to Protect Fish and Fish Habitat* (DFO 2019) https://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures-eng.html

- DFO's Codes of Practice https://www.dfo-mpo.gc.ca/pnw-ppe/practice-practique-eng.html
- In-water Work Timing Window Guidelines (OMNR 2013) https://www.ontario.ca/document/water-work-timing-window-guidelines
- Guidelines to avoid harm to migratory birds https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/reduce-risk-migratory-birds.html

A.3.9.1 Treated Effluent

The ensure potential effects are mitigated for the release of treated water into the downstream receiving waterbody, the following guidance documents/guidelines and BMPs should be considered for the Project:

- Environmental Code of Practice for Metal Mines: https://www.ec.gc.ca/lcpe-cepa/documents/codes/mm/mm-eng.pdf
- Metal mining guidance document for aquatic environmental effects monitoring https://www.canada.ca/en/environment-climate-change/services/managing-pollution/environmental-effects-monitoring/metal-mining-technical-guidance/metal-mining-technical-guidance-environmental-effects-monitoring.html
- Effluent monitoring programs will need to be compliant with CSA N288.5: https://www.csagroup.org/store/product/N288.5-11/
- Action levels for treated effluent will be developed following CSA 288.8: https://www.csagroup.org/store/product/N288.8-17/
- Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities. Mining Associate of Canada. 2011. https://mining.ca/resources/guides-manuals/developing-an-operation-maintenance-and-surveillance-manual-for-tailings-and-water-management-facilities/

A.3.9.2 Treated Sewage

- Best management practices for POTW Compliance: Critical elements of successful wastewater treatment https://www.epa.gov/compliance/best-management-practices-potw-compliance-critical-elements-successful-wastewater

- Wastewater Systems Effluent Regulations of the *Fisheries Act*: https://laws-lois.justice.gc.ca/eng/regulations/SOR-2012-139/FullText.html

A.3.9.3 Water Monitoring

The design of the monitoring program cannot be determined at this stage. Once baseline data are available and the site design has progressed the objectives of the plan can be determined and the detailed design developed that will continue from site preparation, construction, operations through to closure. It will be designed with sufficient locations, frequency and parameters to ensure that any significant project impacts can be detected. It can include multiple components in the aquatic environment, such as discussed by Chapman (1996).

- All environmental monitoring programs will need to be compliant with CSA N288.4: https://www.csagroup.org/store/product/2700822/
- CNSC Regulation Policy P-223 Protection of the Environment: https://nuclearsafety.gc.ca/eng/acts-and-regulations/consultation/comment/regdoc2-9-1-policy.cfm
- CNSC Regulatory Document 2.9.1 Environmental Protection: Environmental Protection Policies, Programs and Procedures: https://nuclearsafety.gc.ca/eng/acts-and-regulations/regulatory-documents/published/html/regdoc2-9-1-vol1-2/index.cfm
- Metal Mining Technical Guidance for Environmental Effects Monitoring: https://www.ec.gc.ca/esee-eem/default.asp?lang=En&n=aec7c481-1
- Water management in mines: https://www.ontario.ca/page/water-management-mines
- Test holes and dewatering wells - Requirements and best management practices | Ontario.ca

A.3.10 Groundwater Monitoring Wells

Follow best management practices for drilling, installation, maintenance, and abandonment of wells to minimize risk of surface impacts to groundwater and mixing of groundwater from different aquifers during drilling, monitoring, and after well abandonment phase.

- Groundwater protection will follow CSA N288.7: https://www.csagroup.org/store/product/2423303/

- Test holes and dewatering wells - Requirements and best management practices | Ontario.ca

A.3.11 Shaft Construction, Operation, and Closure

- Follow best management practices for excavation, blasting, maintenance, and closure of shafts to minimize mixing of groundwater from different aquifers during drilling, monitoring and after closure phases.
- Follow best management practices for excavation, blasting, maintenance, and closure of shafts to minimize creating fractures or preferential flow paths along the shafts that could result in changes to groundwater flow patterns.
- Follow any additional best management practices for nuisance impacts (e.g., dust, odours, noise) related to shaft construction, operation and closure Attachment A.

A.3.12 Heating and Ventilation of the Project Facility

- ASHRAE standards/guidelines

A.3.13 Materials Handling

- Follow any additional best management practices for nuisance impacts (e.g., dust, odours, noise) related to material handling Attachment A.
- Guidelines for environmental protection measures at chemical and waste storage facilities: https://www.ontario.ca/page/guidelines-environmental-protection-measures-chemical-and-waste-storage-facilities
- Good Practices in Emergency Preparedness and Response. International Council on Mining and Metals. 2006.

A.4 Literature Cited

Chapman, D. 1996. Water quality assessments - a guide to use of biota, sediments and water in environmental monitoring. Second Edition. Published on behalf of the United Nations Education, Scientific and Cultural Organization, World Health Organization, United Nations Environment Programme.

US EPA (United States Environmental Protection Agency). 2022. National menu of best management practices (BMPs) for storewater-construction. Available on-line: https://www.epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater-construction.

Zoetica. 2022. Biodiversity impact studies – Northwestern Ontario region: 2022 change assessment memorandum. Draft. Prepared for the Nuclear Waste Management Organization, Toronto, ON.

ATTACHMENT A - BEST MANAGEMENT PRACTICES (NUISANCE)

1. Noise Management
    - Optimize site layout to maximize separation distance between nuisance-intensive sources/activities and receivers (break line of sight between equipment and receivers).
    - Optimization of scheduling to reduce nuisance-intensive activities during nighttime operations.
    - Provide notice and warning to community if near surface blasting is planned.
    - Reduction of warning horns and signals while maintaining safety.
    - Optimization of frequency and pitch of sirens (reverse alarms, safety alarms, PA system, etc.) to minimize noise propagation offsite while maintaining safety.
    - Enclose power equipment (switchyard, generators) indoors or surround with noise barriers. If the equipment cannot be enclosed, investigate exhaust silencers and acoustic enclosures instead.
    - Establish on-site vehicle restrictions, including restrictions on tail gate banging during offloading, use of jake brakes for trucks and haulage trucks to and from site.
    - Minimize idling time.
    - Development of Traffic Management Plan.
    - Provide training to equipment operators and consider operator certification; and
    - Development of maintenance and monitoring schedule for power equipment and other engines.
    - Use of noise barriers / breaking line of site to receivers
    - Provide training to equipment operators and consider operator certification
    - Substitution of diesel generators with battery energy storage systems (BESS)
    - Substitution of ICE vehicles with electric vehicles
    - Substitute emergency generators with battery energy storage systems (BESS).

2. Dust Management
    - Optimize site layout to maximize separation distance between significant sources and receivers
    - Contain all Concrete Batch Plant, SMPP, UFPP operations indoors.
    - Contain Concrete Batch Plant, Waste Management stockpiles indoors.
    - Equip concrete batch plant process exhaust stacks with particulate control technology (ex. baghouse).
    - Minimize distances travelled for delivery of materials
    - Restrict working areas in high wind, dry conditions.
    - Compact disturbed soil
    - Misting of stockpiles, aggregate crushing, and screening activities.
    - Install permanent perimeter wind fencing with 50% or less porosity.
    - Minimize on-site storage of soil.
    - Restrict stockpile height (outside of ERMA) to 10m.
    - Cover or stabilize stockpiles (excluding ERMA) with vegetation or tarp if they will remain inactive for longer than 14 days.
    - Minimize steep shaping of piles
    - Employ surface and slope stabilization measures

- Use low-silt-content materials on unpaved roads.
- Pave all permanent roads
- Limit the application of de-icing materials.
- Apply water or dust suppressants in disturbed areas and on unpaved roads.
- Control speed of vehicles on roadways
- Contain aggregate crushing and screening activities within an aggregate dome and use chutes for transfer of materials.
- Equip dust-generating equipment with a particulate filter (e.g., bag filter, HEPA).
- Limit maximum drop height to minimize dust emissions during handling of excavated rock.
- Develop truck wash stations and requirements for wheel washing during construction; and
- Incorporate the use of track-out control measures such as mud mats or rumble grates.
- Grade the site in phases to allow vegetation and cover to remain intact within the construction zone until just prior to construction starting in that specific area.
- Conduct frequent visual inspections for dust emissions
- Prohibit burning of materials on-site
- Provide notice to community of when near surface blasting will occur
- Maximize use of prefabricated components to reduce dust generation.

3. Vibration Management Plan
    - Provide notice and warning to community if near-surface blasting will occur; and
    - Develop vibration setback and buffer areas.

4. Odour Management Plan
    - Minimize disturbance of bogs and naturalized areas.
    - Monitor and agitate still water, storm water management (SWM) ponds, and other water management features.
    - Develop maintenance and monitoring schedule for water and sewage treatment operations.
    - Development of a spill clean-up response and procedure; and
    - Prohibit open burning of materials on-site.
    - Design an impervious liner under SWM ponds; and
    - Implement oil/grit separator into SWM design to separate odorous oils from SWM releases.
    - Equip areas with a high odour (waste management areas, inlet area, sludge handling, etc.) with air handling and odour treatment units for the foul air (ex. carbon filters).
    - Incorporate the use of dry ponds; and
    - Equip aeration system in stormwater management ponds.

5. Visual Impact Management:
    - Choose building materials of natural colours and textures to blend into natural landscape.

- o Utilize landscape architecture to block the line of sight from roadways and receivers.
- o Bury underground utilities.

6. Light Impact Management
   - o Fully shield outdoor light fixtures.
   - o Utilize compact fluorescent lamps (CFL) or light-emitting diodes (LED) for outdoor light fixtures.
   - o Incorporate amber outdoor fixtures where it does not interfere with security lighting.
   - o Incorporate smart lighting controls where it does not interfere with security lighting
   - o Utilize non-reflective colours and finishes on exterior infrastructure.