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NWMO Document Title

Saugeen Ojibway Nation-South Bruce Site Biophysical Conceptual Site Model Update and Screening Level Change Assessment

NWMO Authorization

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NUCLEAR WASTE MANAGEMENT ORGANIZATION
ADAPTIVE PHASED MANAGEMENT PROJECT – SAUGEEN OJIBWAY NATION-SOUTH BRUCE SITE

BIOPHYSICAL CONCEPTUAL SITE MODEL UPDATE AND SCREENING LEVEL CHANGE ASSESSMENT

Final Report

Prepared by:
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Prepared for:
Nuclear Waste Management Organization

Project No. 3570

April 2023

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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

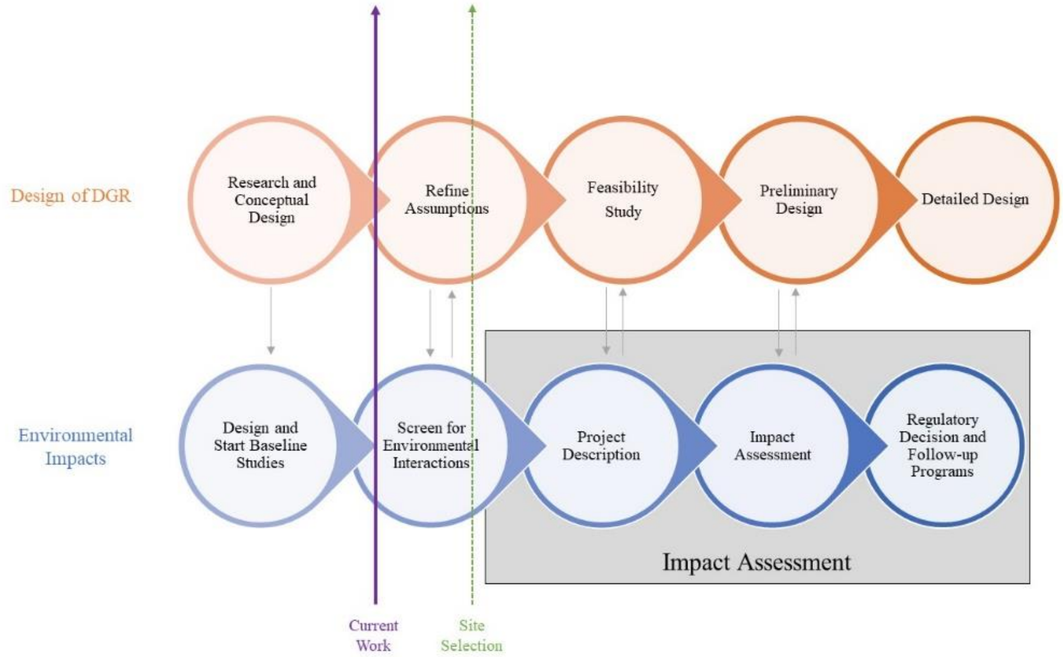
INTRODUCTION

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 the locations being considered is the Saugeen Ojibway Nation (SON)-South Bruce area, near Teeswater and within the Municipality of South Bruce. The site is located in the traditional lands of the SON, the Métis Nation of Ontario (MNO) Region 7, and the Historic Saugeen Métis (HSM).

This document describes one of the first steps in the overall process – 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 of Project design and assessment of environmental impacts.



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.

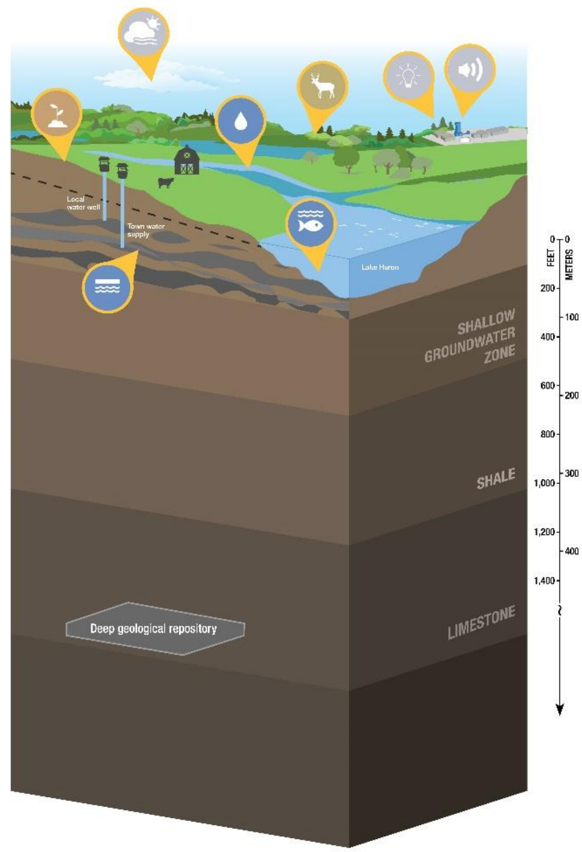
The NWMO has initiated engagement sessions and visioning workshops to contribute to a more detailed understanding of potential Project benefits, identify opportunities to work together, and determine how potential negative effects of the Project can be managed. Discussions are ongoing on various topics 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, soil, and bedrock). 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 a predominantly agricultural area within the Municipality of South Bruce. The region in general has a strong agricultural sector that is interspersed with populated communities, large wetland complexes, and fragmented forests and smaller wetlands. Some of these areas are used for hunting and fishing, as well as recreational activities. There are other industrial activities in the region including aggregate resources, Bruce Power, and waste disposal sites.

South Bruce lies almost entirely within the Saugeen River watershed, which drains into Lake Huron. The Teeswater River is the primary waterbody within the proposed area of the project and drains to the Saugeen River just upstream of Paisley. High flows occur in the spring (March and April), while the flow is lowest in the summer (July to September). The waterbodies in South Bruce and the adjoining region are predominantly rivers, streams, and wetlands, but there are some small lakes, such as Silver, Clam, Oppleck, and McGlinn lakes. There are three Provincially Significant Wetlands (PSWs) within South Bruce: the Greenock Swamp Wetland Complex, the

Teeswater Wetland Complex, and the Otter Creek Wetland. The Saugeen and Teeswater rivers contain fish, such as brook trout, brown trout, rainbow trout and smallmouth bass, and are important recreational fishing areas.

An extensive network of constructed and modified natural channels are present in the area that provide drainage in agricultural lands. These affect how water flows in the region.

Soil in the area consists of overburden dominated by glacial till and glaciofluvial outwash, varved silts and clays, and organic deposits. The bedrock geology of the AOI is defined by approximately 850 m to 900 m of Paleozoic-aged sedimentary rocks resting unconformably on Precambrian crystalline basement. The Paleozoic stratigraphy includes shale, carbonate, and evaporite units. The glaciofluvial deposits form mostly unconfined aquifer units within the overburden. The glaciofluvial deposits contribute to surface water and recharge of the shallow bedrock. Both the glaciofluvial deposits and shallow bedrock are used as drinking water resources. Groundwater use varies between rural domestic, industrial, and agricultural purposes with well depths ranging from 2.5 meters below ground surface (m bgs) to approximately 163 m bgs.

Local, regional, and national/international sources contribute to local air quality. The area has relatively hot, humid summers and cold winters. Higher amounts of precipitation are seen through late summer and the winter months; the increase in precipitation in winter is due to snow squall activity indicating the influence of Lake Huron and Georgian Bay. Climate change modelling suggests that the future is likely to be warmer and wetter, with more frequent intense rainfall events and greater precipitation amounts annually, although summer months will become drier.

South Bruce is located within the Deciduous Forest Region where mixed woodlands consist primarily of American beech and sugar maple, together with other species including basswood, red maple, and oak. The forest in the region provides important sustaining areas for wildlife and is also in line with known bird migration routes along the eastern shore of Lake Huron. The area also provides feeding, wintering, and calving sites for whitetail deer and concentration and nesting areas for raptors, herons, and waterfowl.

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. Traditional foods including whitetail deer, lake whitefish (also known as Adikameg to the Ojibway), and other sportfish species have been identified as potentially important traditional foods in the region. The NWMO is working to engage with local Indigenous Nations, governments, and communities to further identify and confirm species of interest.

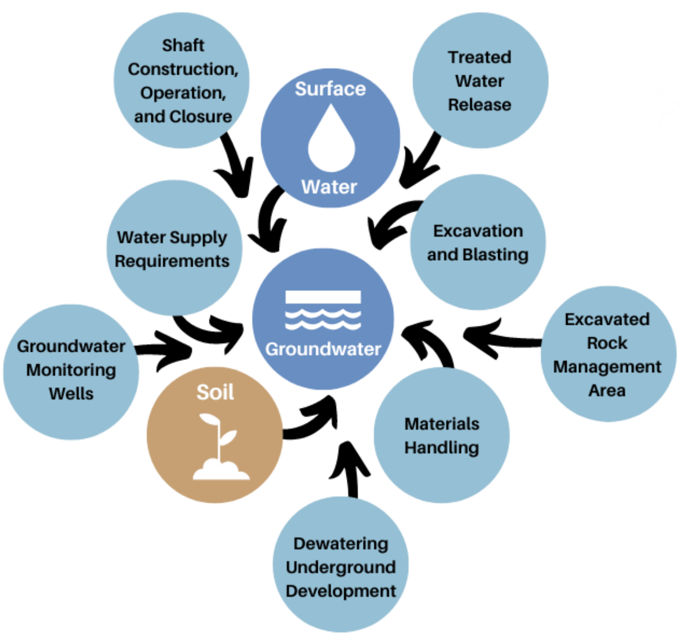
COMMUNITY CONCERNS

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. 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.

Drinking Water



One of the key community concerns is the protection of the community's water supply. The Municipality of South Bruce sources drinking water from groundwater, and there are wells for rural domestic, industrial, and agricultural purposes. The groundwater used for these purposes comes from the upper portion of the subsurface (generally above 150 m bgs herein referred to as the shallow groundwater) and there is a transition from fresh water to more saline, and non-potable, water at around 200 m bgs (NWMO 2022).

Groundwater below 200 m bgs is referred to in this document as the deep groundwater. The DGR will be located many hundreds of meters below the zone of potable groundwater and is also isolated from the overlying bedrock and unconsolidated materials by several hundreds of meters of low permeability sedimentary rock formations. The Project may directly interact with groundwater quantity and quality through the disturbance of the subsurface (excavation, shaft construction and dewatering), changing groundwater flow paths, or dewatering for water supply during facility construction or operation. Indirect interactions with water supply can also occur through changes to the ground surface.

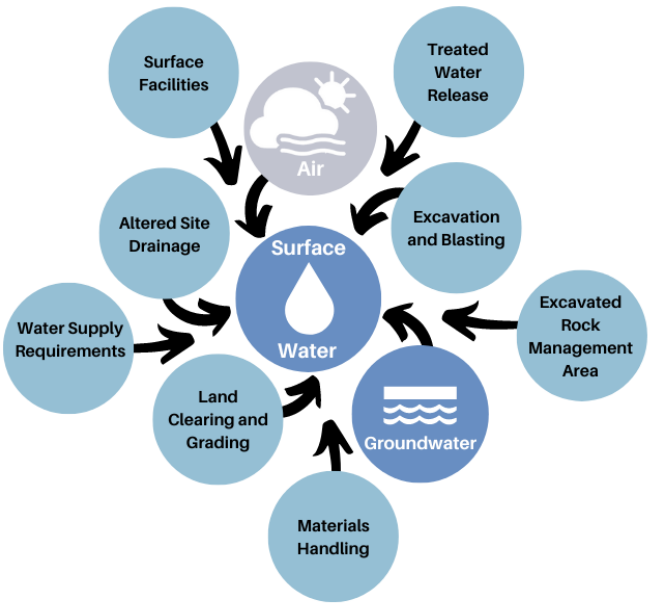
Since Project activities have the potential to interact with groundwater through many phases of the development, careful consideration needs to be included in design features and mitigation measures early in the planning process to reduce the potential for interactions where possible.

The NWMO understands the importance of the protection of groundwater. A survey of drinking water wells in the area was conducted to obtain baseline information on water quality. Additional wells are also being drilled to obtain more information on the shallow and deep groundwater. This information will be used to calibrate and refine a groundwater model that is being built to help identify areas that require additional investigation and develop the long-term monitoring plan. This model can then be used to estimate future conditions. To minimize changes to groundwater conditions, NWMO will follow best management practices for all phases of the project. A detailed monitoring and contingency plan will be developed with action levels to trigger follow on activities such as increased monitoring frequency, change in activities, alternate water supply.

Protect the Rivers and Greenock Swamp Wetland Complex

The protection of water quality is a high priority. The Project may interact with surface water through the drawdown of groundwater from underground development, release of water to receiving waterbodies, or accidental release of contaminants to water from materials handling. Indirect interactions with surface water can also occur through air airborne contaminants depositing into surface water or groundwater discharging into surface water.

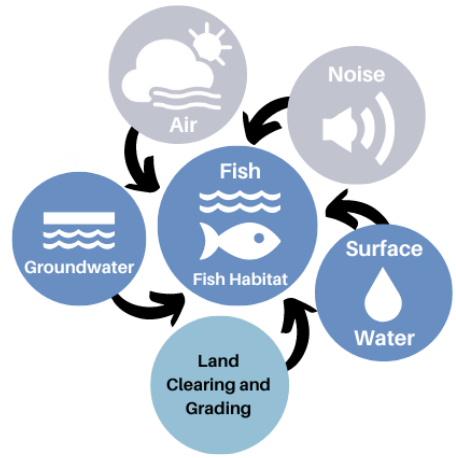
Drawdown can occur when pumping water from underground. In some cases, it can affect surface water levels in nearby lakes, ponds, rivers, and wetlands. Changes in groundwater levels can also occur due to changes in the ground surface due to grading, paving, or diversion of surface water. To examine these 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.



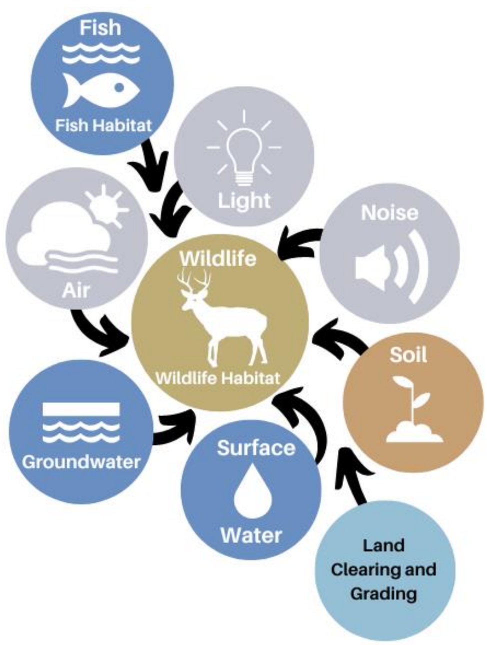
Water will be monitored and treated to meet applicable regulations before it is released. Both the quality and quantity of water released from the Project is important. It is expected that treated water released from the facility will be discharged to the Teeswater River. The Project will recycle and 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.

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, and sediment. 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



Protection of the natural environment - all living things and the habitats they need to be sustained - is important to community members and the NWMO. 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.

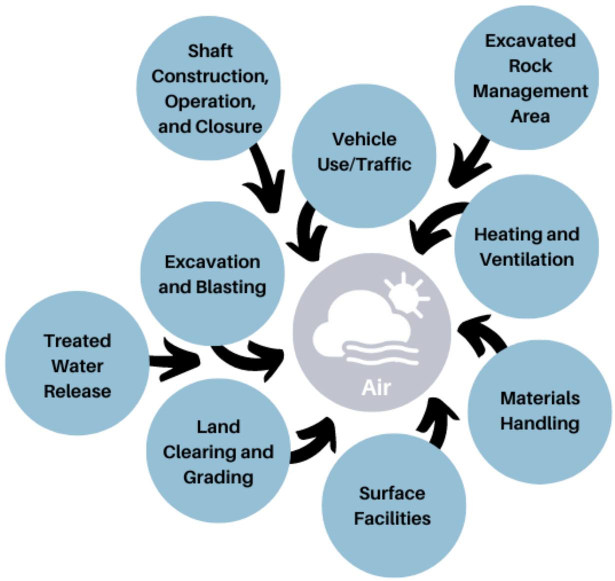


Project activities have the potential to interact with aquatic and terrestrial life through their changes to the physical environment including air, groundwater, soil, and surface water. Additionally, Project activities have the potential to result in the physical loss of available fish and wildlife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

The facility should be positioned as much as possible to avoid ecologically sensitive areas, such as Provincially Significant Wetlands, and minimize water crossings. Construction activities should also be timed to avoid disturbances during key periods, such as during breeding bird nesting periods and fish spawning 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.



The Project will have direct releases to the atmosphere during the site preparation and construction phases of the Project, 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 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. Further, 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 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 during the visioning workshops. This is the rock that will be removed during the development of the DGR and placed on surface. This 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 the Teeswater River and other 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 Teeswater River. Dust control measures can also be used to minimize the dust that would be generated from the rock. NWMO is collaborating with the Municipality of South Bruce to explore the benefical reuse of this resource (for example, use as aggregate).

Cumulative Effects – Particularly Agriculture

There was much discussion during the engagement sessions on the impact of the Project on the agricultural industry as well as the combined (cumulative) effect of the Project and the agricultural land use in the area. Baseline data are being collected now to help with this assessment, including information on groundwater and surface water quality and flow. Information on what pesticides and herbicides are the most used locally would be valuable, and sampling for these compounds can then be included in the surface water baseline program. 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. Design considerations, such as minimizing the Project footprint to maximize the useable agricultural land, 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.

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LIST OF ACRONYMS

Term	**Description**
AAFC	Agriculture Agri-Food Canada
ANSI	Area of Natural and Scientific Interest
AOI	Area of Interest
AMIS	Abandoned Mines Information System
APM	Adaptive Phased Management
BCFA	Bruce County Federation of Agriculture
BIS	Biodiversity Impact Studies
BMP	Best Management Practices
CLWRP	Collaborative Lake Whitefish Research Program
CNSC	Canadian Nuclear Safety Commission
CO	Carbon Monoxide
COPC	Contaminant(s) of Potential Concern
CSM	Conceptual Site Model
CWMP	Coastal Waters Monitoring Program
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
FNFNES	First Nations Food, Nutrition, and Environment Study
GBIF	Global Biodiversity Information Facility
HHERA	Human Health and Ecological Risk Assessment
HSM	Historic Saugeen Métis

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
MNRF	Ontario Ministry of Natural Resources and Forestry
MNO	Métis Nation of Ontario
MVCA	Maitland Valley Conservation Authority
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
O_3	Ozone
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 Compounds
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
PSW	Provincially Significant Wetlands
SAR	Species at Risk
SO_2	Sulphur Dioxide
SON	Saugeen Ojibway Nation

SWMP	Stormwater Management Pond
SVCA	Saugeen Valley Conservation Authority
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
WWIS	Water Well Information System
WWMF	Western Waste Management Facility

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 Saugeen Ojibway Nation (SON)-South Bruce area in the Municipality of South Bruce, as shown on Figure 1-1. The site is located in the traditional lands of the Saugeen Ojibway Nation (SON), the Métis Nation of Ontario (MNO) Region 7, and the Historic Saugeen Métis (HSM). The NWMO is aiming to select a single preferred site in a suitable rock geosphere with informed and willing hosts by 2024.

Figure 1-1 Proposed location for DGR in Saugeen Ojibway Nation-South Bruce area

The Municipality of South Bruce identified in its vision document and in its Guiding Principles that the Project needs to protect the environment (AECOM 2020). 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 information 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.

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 SON-South Bruce 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.

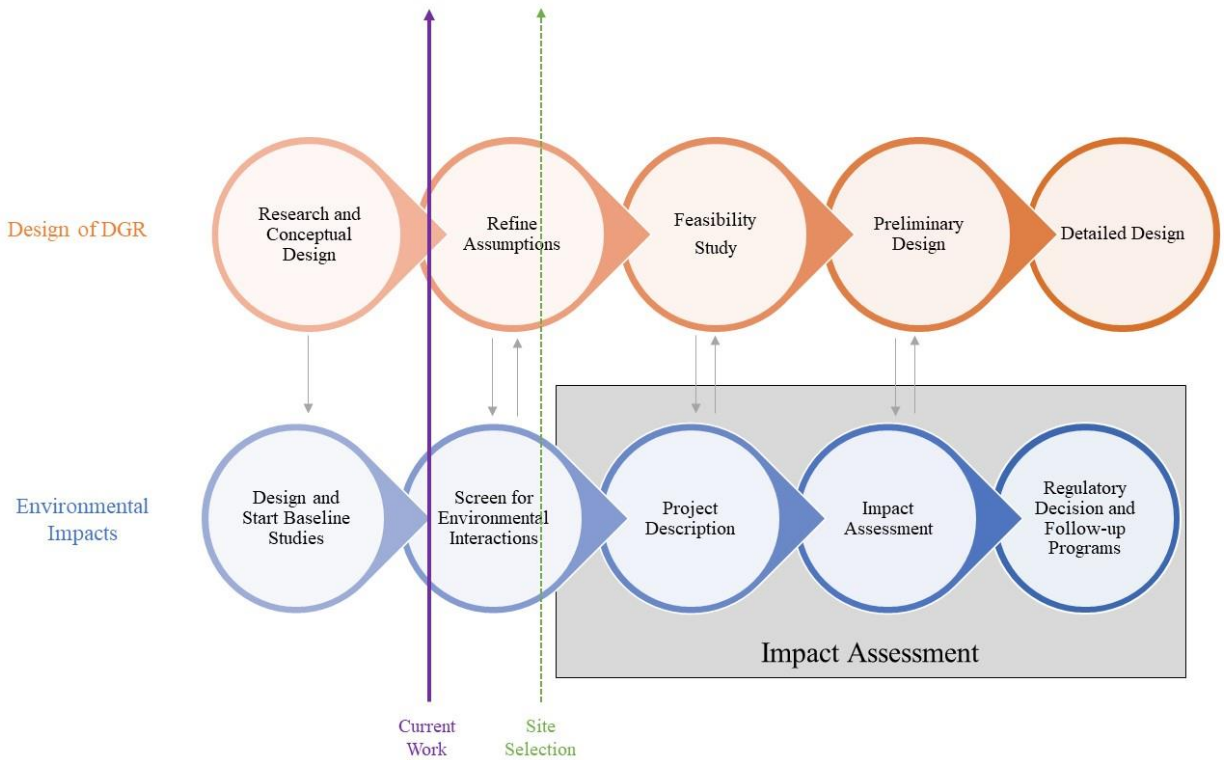
The information from the biophysical CSM and baseline studies will be used in the Impact Assessment (IA) if this site is selected for the location of the DGR. As the NWMO has yet to identify a preferred site, it is acknowledged that the IA process has not been initiated, and the Duty to Consult has not 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 situated on the Traditional Territory of the Anishinabek Nation: The People of the Three Fires known as Ojibwe, Odawa, and Pottawatomie Nations. The Chippewas of Saugeen and the Chippewas of Neyaashiinigmiing (Nawash), now known as the Saugeen Ojibway Nation, are the traditional keepers of this land and water. It is also recognized that the ancestors of the Historic Saugeen Métis and Georgian Bay Métis communities shared this land and these waters.

1.4 Documents Consulted

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

- AECOM. 2022. Preliminary flood hazard assessment at South Bruce study area. NWMO-TR-2022-xx Draft, June.
- DPRA and MHBC. 2022. Land use study report: Southwestern Ontario community study. Final report, May.
- 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 – South Bruce Site. NWMO-TR-2022-15, 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.

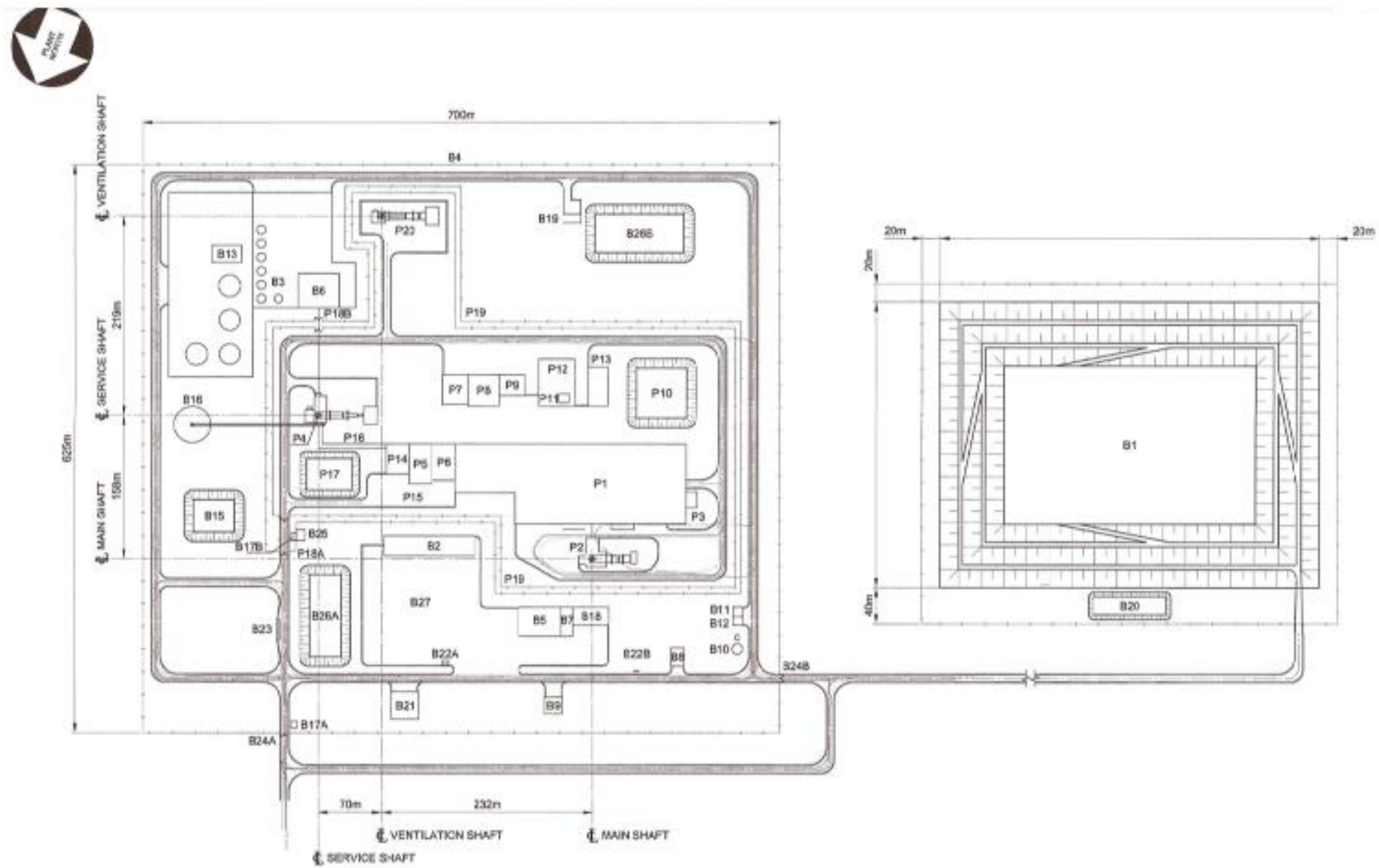
The current surface facilities layout is provided in Figure 2-1. A three-dimensional perspective of the surface facilities is provided in Figure 2-2. The land required to accommodate the Project will include an approximate footprint of 625 m x 700 m for the DGR surface facilities, and an approximate 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). 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.
- 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 the municipal supply (system to be expanded if this is the source) or from a new groundwater supply well (NWMO 2021).
- Power will be supplied by the existing grid.
- Existing roads will be used, except for a short access road.
- Treated effluent(s) will be discharged during each of the Project phases.
    - During construction, dewatering water will be retained to reduce sediment, allow for monitoring of water quality and temperature, 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.
    - It is assumed that discharges will occur to the Teeswater River owing to its larger flow in comparison to smaller streams (see Section 3.1); however, given

the commercial grade sand and gravel overburden at the site, a portion of discharged water may percolate into the overburden.

- Excavated rock, overburden, and soil piles 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. Overburden and soil may be placed in the ERMA for potential re-use (segregated from rock) or may be managed outside the ERMA in a separate area.
- 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 Nation, Métis, and stakeholder needs. NWMO staff and contractors have initiated engagement sessions and visioning workshops with 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. It is acknowledged that engagement with rights-holders, including First Nation and Métis, is a critical component of the engagement program and needs to be undertaken. Consequently, the NWMO is in the process of building up the capacity for meaningful engagement with rights-holders in the hopes that invaluable IK and input can be shared, while observing any confidentiality restrictions that may apply.

In 2020, a series of workshops were held in South Bruce to discuss the vision for the Project including priorities, objectives, and concerns (AECOM 2020). The results of the workshop reinforced that the Project must ensure safety and security of people and the environment. These were noted as the most important priorities and include the consideration of transportation, used fuel/waste storage, leaks/accidents and malfunctions, the public, and workers. Figure 2-3 provides a summary of the results of the visioning workshop.

Figure 2-3 South Bruce Project priorities

Source: AECOM (2020)

In terms of the natural environment, it was stated that the Project must protect the natural features of the community and region from any negative effects from the Project and, where possible, strengthen, improve, and enhance them. A clear priority was placed on water, particularly as it relates to the community's drinking water supply and water cycles, the Teeswater River, and other streams and waterbodies including the Great Lakes. An overall desire for a reduction of the Project footprint and implementation of improved environmental programs were also noted as priorities by participants. Some of key themes and priorities related to the environment include:

- Protect the community's water supply
- Minimize the surface footprint, maximize the agricultural land
- Keep or enhance green spaces, trails, parks; utilize the river(s) for green space/trails
- Protect the rivers and Greenock Swamp Wetland Complex

There was an interest in developing a wider understanding of water supply cycles and dynamics in the area. Concerns were expressed about the possible effects on water/lower geology associated with borehole drilling, as well as future construction and operations activities. Specific comments were raised on the excavated rock pile (whether it would always be located on the site, and innovative solutions to excavated rock management). At present it is NWMO's plan to store all excavated rock material on site; however, discussions have been held to collaborate with the Municipality of South Bruce to determine the best use of this resource. This will have to be determined, while minimizing the impact on commercial aggregate providers (Keir 2022a).

In the fall of 2020, a series of workshops were held to help inform the design of the EMBP. The workshops were held in-person and virtually considering COVID-19 and were designed to be informal and collaborative in nature, with opportunities for people to provide input and ask questions. A third series of workshops were held with stakeholders between November 16th and 25th, 2020 and with rights-holders between March 31st and April 14th, 2021, again using a combination of in-person and virtual platforms because of COVID-19 to provide information on preliminary sample areas and sample designs for the EMBP and BIS.

Although the goal of these workshops was to help design the baseline programs, community questions and concerns about the Project were expressed. The general themes of these comments were:

- Agriculture: Will the Project affect farmers? What are the cumulative impacts?
- Drinking water: Municipal aquifers, private drinking wells
- Existing ecology: Invasive species, aquatic biota diversity, forest health
- Water quality: Great Lakes, Saugeen River
- Hydrology: floodplain, tile drains, climate change
- Cumulative effects: aggregate, residential, traffic
- Air quality
- Traffic, with specific mention of noise

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, including:

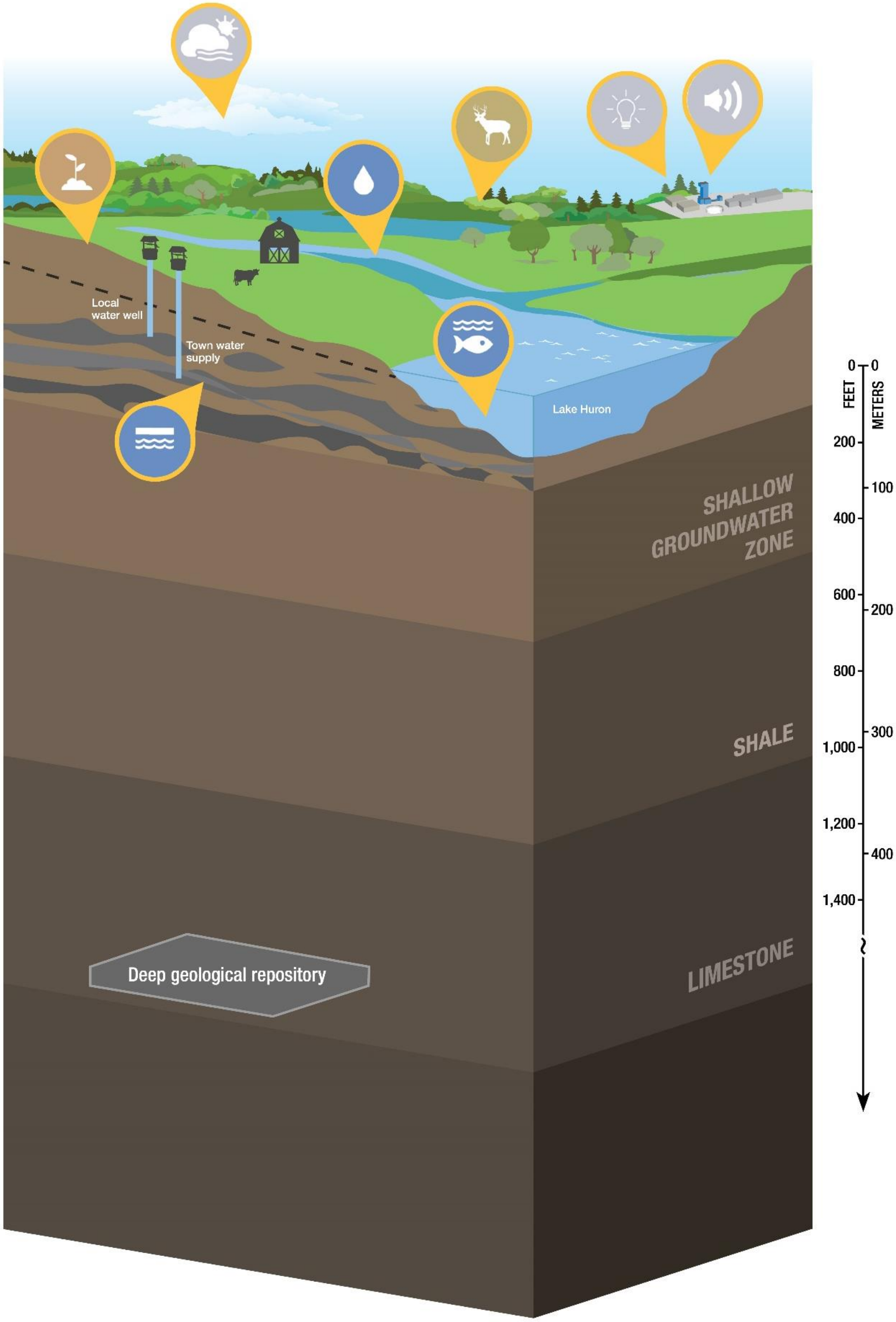
<u>Physical Environment</u>

- 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

<u>Biological Environment</u>

- 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 NWMO.

3.1 Study Area and Existing Environment

The proposed Project location is within the Municipality of South Bruce (hereafter called South Bruce) and the Teeswater River Watershed. South Bruce is approximately 489 km^2 in size, is situated in a sedimentary rock setting in southern Ontario and has a strong agricultural sector that is interspersed with small settlements including the villages of Mildmay, Formosa, and Teeswater. Mildmay is the largest community in South Bruce and Teeswater is the administrative centre of the municipality. The topography of the area is relatively flat with a relatively thick overburden layer of unconsolidated geologic materials, comprising modern alluvium and organic deposits, coarse and fine glaciolacustrine units, glacial moraines, glacial outwash, and ice-contact units. Bedrock is comprised of a thick Paleozoic sequence (Geofirma 2014). Preliminary studies conducted in 2014 suggested that there is potential for South Bruce to be suitable for the Project from multiple perspectives, including geoscientific suitability, engineering logistics, environmental health and safety, transportation safety, and social, economic, and cultural effects within the community (NWMO 2014a).

The NWMO has secured parcels of land under contract upon which the Project will be located that are situated starting 2.5 km northwest of Teeswater and extending westward. At the time of writing this report, the parcels of land purchased or optioned equate to an area of over 1,500 acres. These land parcels and the watershed boundary were used to delineate the Area of Interest (AOI). The general location of the AOI within the region is indicated in Figure 3-2. The AOI also includes other privately-owned lands that will not be purchased or optioned by the NWMO. 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, those used for commercial purposes (e.g., sand and gravel pits), or those located near to private farmlands.

Figure 3-2 Regional overview of the South Bruce site study area

3.1.1 Surface Water

South Bruce lies almost entirely within the Saugeen River tertiary watershed, which drains into Lake Huron at the town of Southampton, Ontario (Figure 3-2 and Figure 3-3). The Saugeen River drains an area of 4,025 km^2 and the main tributaries are the Teeswater, South Saugeen, Beatty Saugeen, Rocky Saugeen, and North Saugeen rivers (Geofirma 2014). The Teeswater River, which is part of the Teeswater River watershed, is the most noteworthy body of water in South Bruce and is the primary waterbody in the AOI (Figure 3-3). The Teeswater River is 75 km in length and drains a total area of 683 km^2 with tributaries including the Greenock, Formosa, Alps, Plum, Kinlough, Schmidt, and Allen creeks (SVCA 2018). The river flows through the community of Teeswater, then west for approximately 4.5 km before heading north through the AOI, northeast through the Greenock Swamp Wetland Complex, and eventually draining into the Saugeen River at Paisley, Ontario (Figure 3-2). Given the larger flow in the Teeswater River, it is likely a better candidate for assimilating potential treated effluent discharges compared to the smaller streams.

There are three evaluated Provincially Significant Wetlands (PSWs) within South Bruce including the Greenock Swamp Wetland Complex, the Teeswater Wetland Complex, and the Otter Creek Wetland, as shown in Figure 3-4 (Geofirma 2014). The Greenock Swamp Wetland Complex starts in the northern portion of the AOI and extends north into the Municipality of Brockton. The Teeswater Wetland Complex is located immediately south and upstream of the AOI and extends westward into the Township of Huron-Kinloss. The Otter Creek Wetland is located south of Mildmay and is not in the vicinity of the AOI. The waterbodies in South Bruce and the adjoining region are predominantly rivers, streams, and wetlands, but there are some small lakes, such as Silver, Clam, Oppleck, and McGlinn lakes. The Greenock Swamp Wetland Complex also contains small lakes, such as Schmidt Lake.

Waterbodies occurring within South Bruce are mostly classified as warm or cool water with some cold water habitat in the tributaries (Golder 2014). Amongst other species, the Saugeen and Teeswater rivers contain brook trout (*Salvelinus fontinalis*) and smallmouth bass (*Micropterus dolomieu*) and are important recreational fishing areas. The Saugeen River and its tributaries are also important habitats and recreational fisheries for both brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) that migrate upriver to spawn in the cooler tributaries of the Saugeen.

Figure 3-3 Watershed delineations in the South Bruce site region

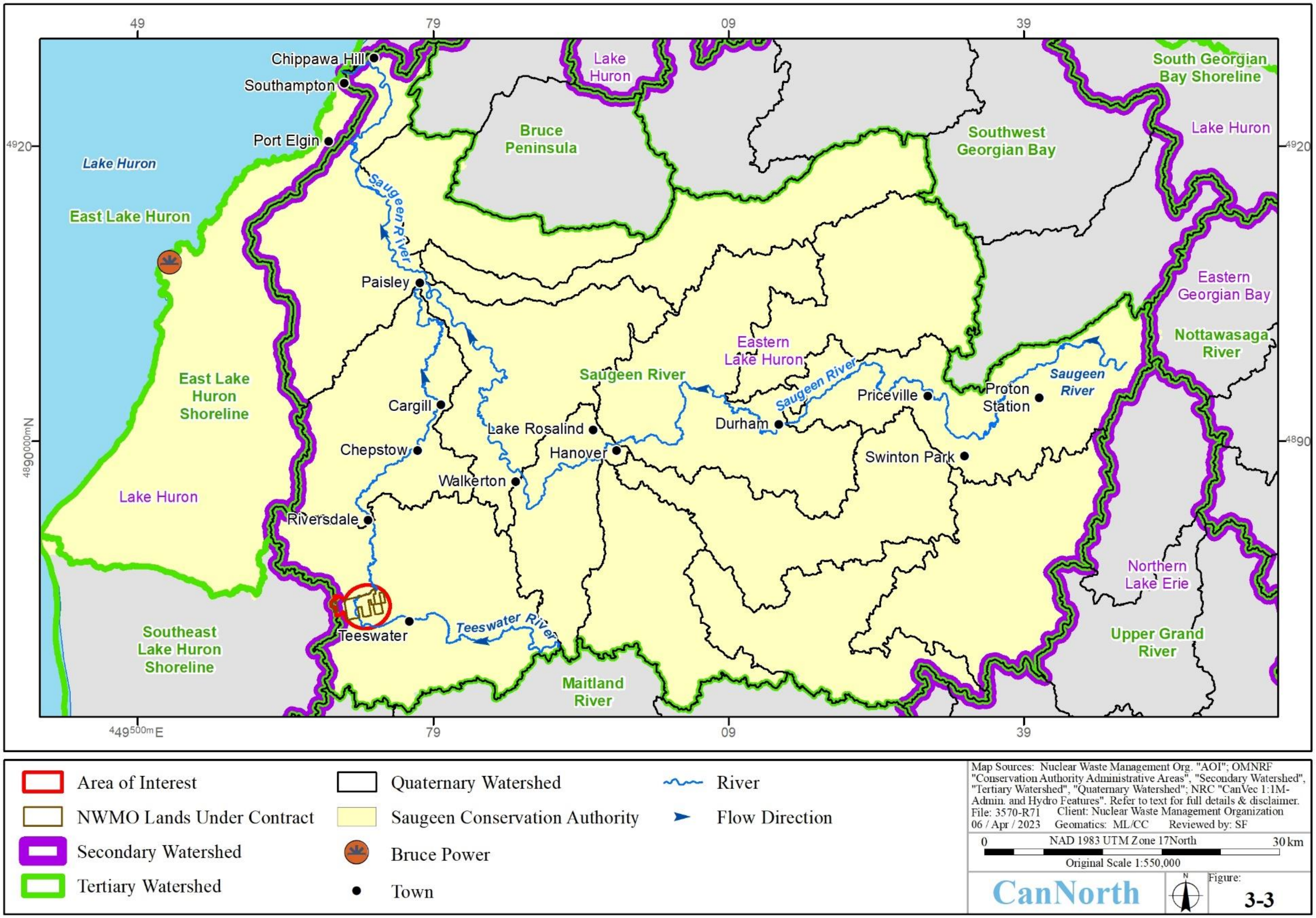
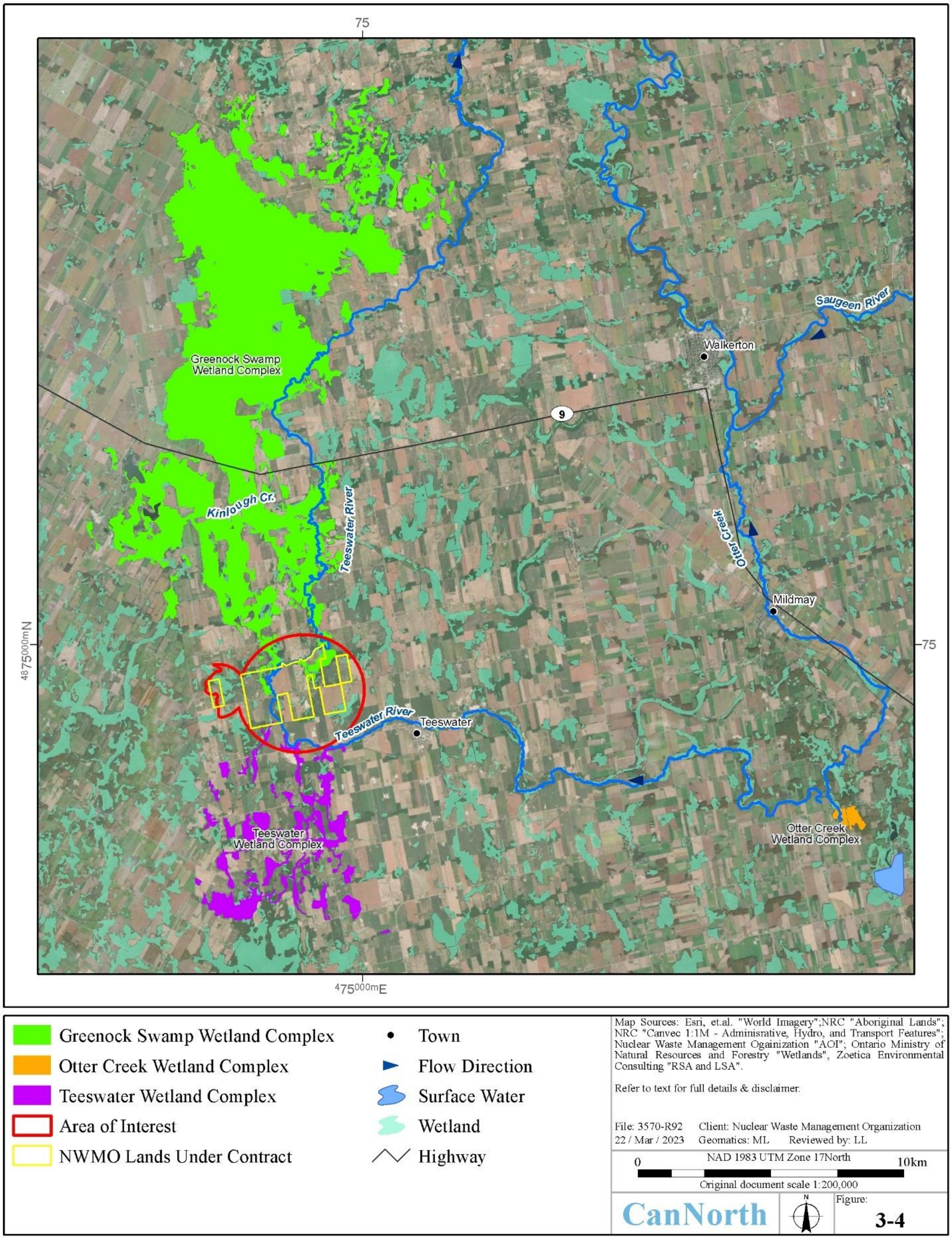


Figure 3-4 Provincially significant wetland complexes



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.

As described above, the Teeswater River is the major waterbody in the AOI and is the most likely candidate for assimilating potential treated effluent discharges, compared to the smaller streams. As a result, the hydrology along the Teeswater River is the focus of the hydrological component.

Aerial photos indicate that agricultural and rural low-density residential land use make up most of the tributary areas draining to the Teeswater River upstream of the AOI (Google Earth 2019). Compared to forested watersheds, crops on agricultural land generally lead to sparser ground cover and smaller depression storage than natural terrain with native, mature vegetation, allowing more stormwater runoff and greater erosion and soil loss. Stormwater runoff from impervious areas in rural residential areas also increases the stream flow and leads to higher peak stream flow during storm events and increases the sediment supply and risk of erosion. Water withdrawals from agricultural practices may also decrease the flows in the Teeswater River upstream of the AOI, affecting the river's capacity to assimilate discharges from the site.

Approximately 2 km downstream of the AOI, the Teeswater River enters the Greenock Swamp Wetland Complex and traverses along the eastern boundary of the Complex before its confluence with the Saugeen River. As a result of the river being hydraulically connected to forested wetland systems, an elevated water table and surface inundation may occur during winter; flooding from snowmelt in the spring provides hydrologic supplements in the wetland; and water levels decrease as the growing season progresses and evapotranspiration accelerates in the summer.

According to the Ontario Dam Inventory, two existing dam structures are located between the headwaters of Teeswater River and the AOI. One of these is located 5 km upstream of the AOI at the western boundary of the Teeswater community, and the other one is located approximately 16 km upstream of the AOI (MNRF 2021). Given the locations of these two privately-owned dam structures. These two structures likely alter the stream flow in the Teeswater River by attenuating flow in the stream. More information needs to be gathered via on-site surveys or other means in order to assess the impact of the dams to the stream hydrology.

Based on the Bruce County 1-m elevation contour data, the tributary drainage area along the Teeswater River upstream of the AOI has steeper slopes than the river reach area downstream of the AOI where the channel widens into the wetlands (Bruce County 2020). It is likely that the stormwater runoff from the steep headwaters area upstream of the AOI reaches the Teeswater River faster compared to river reaches further downstream due to the steeper slope, based on topographic data.

There are two water level and flow gauges operated by Environment and Natural Resources Canada (ENRC 2020) on the Teeswater River. One is 6 km upstream of the AOI at the community of Teeswater (station number 02FC020), and the other one is downstream of the AOI near the Village of Paisley downstream of the Greenock Swamp Wetland Complex before the confluence with the Saugeen River (station number 02FC015). Historical flow data dating back to 2005 for 02FC020 and 1972 for 02FC015 show similar seasonal patterns. The highest flow is observed in March and April due to spring circumstances such as the frost line disappearing in relation to the snow melting. The lowest flow is observed from July to September when evapotranspiration is high and rainfall is limited (i.e., dry summer period). The stream flow at the upstream gauge at Teeswater appears to have relatively slow response to rainfall likely due to the predominant pervious land cover in the tributary area. Based on the flow record at the upstream Teeswater gauge location, the Teeswater River is also flowing year-round (i.e., it is never frozen). However, the river appears to be partially frozen between this gauge and the AOI based on aerial imagery taken in the winter (Google Earth 2014). Two more flow gauges located closer to the AOI was proposed and installed as part of the baseline monitoring program to better understand the winter flow conditions, local flood conditions, and frozen period of the Teeswater River.

There are two meteorological stations located within the Teeswater River Watershed: Southampton 2 and Paisley; however, there are no available data for these stations from 2010 onwards (ECCC 2020). These two stations are located to the north of the AOI at the Town of Southampton and the Village of Paisley. The Goderich, Kincardine, Mount Forest, and Wroxeter meteorological stations are outside of the Teeswater River Watershed, but are within 30 km to 60 km of the AOI (ECCC 2020). The Goderich and Kincardine stations are located along Lake Huron to the west of the Teeswater River Watershed and the Mount Forest and Wroxeter stations are located further inland to the southeast of the Teeswater River Watershed.

Based on the available data from 1979 to 2019, the SON-South Bruce area on average experiences 60 mm to 100 mm of total precipitation per month. The monthly average air temperature ranges from -6 ºC to 3 ºC in the winter months (November to March), and ranges between 6 ºC to 20 ºC for the other months of the year (Golder 2020). Local lakes and waterbodies, including the shoreline of Lake Huron, are expected to freeze in winter months (November to March). Based on the information presented in the Golder report, the AOI is unlikely to experience drought conditions that would affect local waterbodies (Golder 2020); however, there is the risk of possible flooding along some creeks and rivers due to its location just downstream of the steep headwater drainage area and lower slope at the AOI.

Analysis of rainfall and snow records from 2017 to 2020 show different weather patterns between the lakeshore gauges and the inland gauges. Specifically, the inland areas receive much higher rainfall compared to the lakeshore areas (ECCC 2020). As a result, more site-specific meteorological data within the AOI and snow depth information at the nearby meteorological stations are required to better understand the hydrology to assess the potential for flooding and freezing near the AOI. This information will also be important for stormwater and hydrology modelling to understand how much water is running off the Project site and needs to be treated before discharge.

The Preliminary Flood Hazard Assessment at South Bruce Study Area indicated that the AOI is vulnerable to flooding from areas upstream along the Teeswater River during extreme rainfall events due to the relatively flat topography around the AOI (AECOM 2022). The selection of the exact location of the surface facilities proposed for the Project, including the protected areas inside of the fences and the ERMA, should take into consideration the extent of the floodplain along the Teeswater River and SVCA's Regulation of Development (SVCA 2006). If a portion of the surface facilities is located inside of the floodplain and/or the area where development is prohibited by law, appropriate mitigation measures should be designed and installed to minimize property damage and environmental impact posed by the potential flooding events. A more accurate hydraulic model with updated channel bathymetry, topography and appropriate design storm event should be developed for the flooding risk assessment. This assessment should also incorporate potential impact from climate change which may lead to more extreme rainfall events and changes in the thawing season.

Municipal Drains

An extensive network of person-made and modified natural channels that provide drainage in agricultural lands have been developed throughout Ontario, starting in the late 1800s and continuing to the present. They consist of a combination of tile drains, constructed channels, and natural watercourses that have been channelized and deepened for land drainage (Kavanaugh et al. 2017). The characteristics of natural streams often form in municipal drains over time, providing habitat for fish and other aquatic life; however, they differ in the type and sensitivity of the habitat they contain. There is one open drain located in the AOI called the Parker municipal drain that connects to the Teeswater River via an unnamed watercourse to the north of the drain.

3.1.1.2 Surface Water Parameters

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 surface water parameters component includes surface water quality, sediment quality, plankton, and benthic invertebrates.

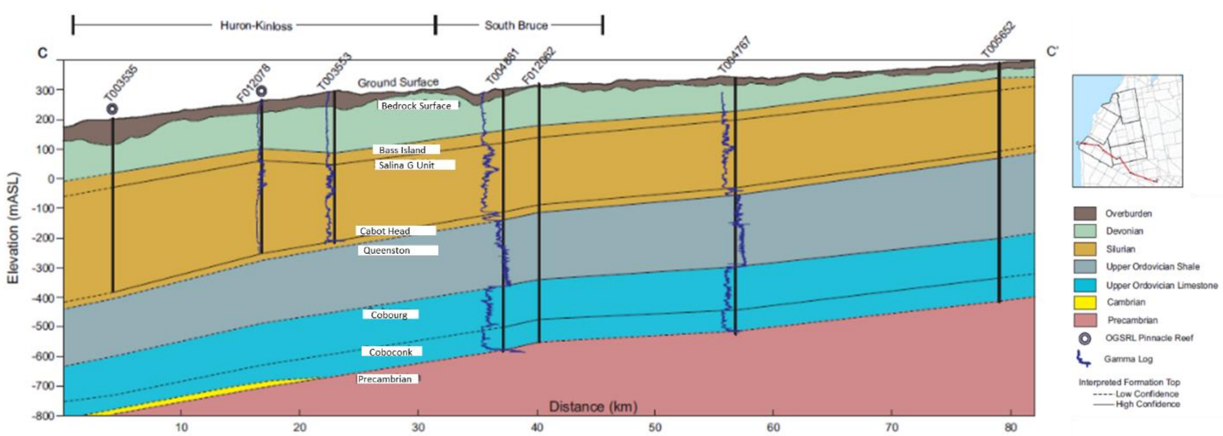
As described above in Section 3.1, the aquatic environment in the AOI and surrounding areas contains important river systems (the Teeswater River) and PSWs. The Teeswater River is an important water way that contains numerous tributaries, feeds into the Saugeen River (which flows into Lake Huron) and contains a plethora of fish species including those of commercial, recreational, and Indigenous importance. The Teeswater River is the main artery extending through the AOI and an assumption has been made that it will be the receiving waterbody for treated effluent(s) from the Project. As stated in the assumptions below, it is assumed that service water will be sourced from municipal supplied water or groundwater from a purpose-drilled well.

3.1.2 Geological and Hydrogeological Environment

The Quaternary geology of the AOI consists of overburden dominated by silty to clayey glacial till and glaciofluvial outwash, varved silts and clays, and organic deposits (Golder 2014). Collective interpretation of air photograph, digital elevation model, LiDAR imagery and examination of sediment-outcrop sections suggests that the AOI lays in a post-glacial area (Golder 2014; Slattery 2011) and the NRCan earthquake data and location relative to continental scale plate tectonics support that it is a tectonically stable zone of low seismicity (https://earthquakescanada.nrcan.gc.ca/).

The bedrock geology of the AOI is defined by the Paleozoic sequence of sedimentary rocks within the Michigan Sedimentary Basin resting unconformably on the Precambrian crystalline basement of the Grenville Province (Armstrong and Carter 2010). The Paleozoic stratigraphy includes shale, carbonate, and evaporite units (Johnson et al. 1992). The strata dip gently (3.5 m/km to 12 m/km) to the west or southwest, with approximate thickness of 850 m in borehole T004881, which is located about 3 km south of the AOI (Carter et al. 2019; Geofirma 2014). Based on the formation top depths logged in borehole T004881, the Ordovician Cobourg Formation (limestone) is anticipated to be intersected at approximately 660 m bgs to 670 m bgs in the AOI (Geofirma 2014). The Cobourg Formation is the preferred host rock for a DGR (NWMO 2014b) (Figure 3-5).

Figure 3-5 Schematic representation of the bedrock stratigraphic units in the vicinity of the AOI



Note: Figure 3.12a from Geofirma (2014).

Aquifer units within the AOI are understood as individual or combined stratigraphic units with variable groundwater yield. In South Bruce, the glaciofluvial deposits form mostly unconfined aquifer units within the overburden (SVCA 2008), being used as a drinking water resource and contributing to surface water and recharge of the shallow bedrock (Geofirma 2014). The shallow bedrock aquifer comprises the upper few metres to over 100 m ranging from the Middle Devonian Lucas Formation (dolostone) to the Upper Silurian Salina Group (dolostones, shales, and evaporites). There is a possibility that some of the deeper aquifers in the area may be saline; this will be evaluated as part of the ongoing Shallow and Deep Groundwater programs designed by NWMO. Groundwater occurrences below the Salina Group are of low yields and are only sufficient for groundwater sampling, not water supply (Carter et al. 2019; Geofirma 2014). While the AOI does not present known mapped karsts, karstic geomorphology has been inferred in the Lucas and Bass-Islands formations and considered potential in the Amherstburg and Guelph formations (Geofirma 2014).

Well records in the communities of South Bruce, Brockton, and Huron-Kinloss were obtained from the Ontario Ministry of Environment, Conservation and Parks (MECP) Water Well Information System (WWIS) database (Golder 2014; MECP 2020). In 2013, a total of 3,232 water records were identified, of which 2,680 provided useful information regarding the aquifer, yields, and other hydrogeological parameters (Golder 2014). Wells assigned to overburden aquifer summed 375 records with depths ranging from 2.5 m bgs to 115 m bgs and yields ranging from 4.5 L/min to 1,350 L/min. Wells assigned to shallow bedrock aquifer summed 2,305 records with depths ranging from 3.7 m bgs to 163 m bgs and yields ranging from 9.0 L/min to 1,230 L/min.

Groundwater use varies between rural domestic, industrial, and agricultural purposes. No water supply wells are known to be completed at the conceptual DGR depth (600 m bgs to 670 m bgs) in southern Ontario, and all known water wells in the municipalities of Brockton and South Bruce, and the Township of Huron-Kinloss obtain water from overburden or shallow bedrock sources at depths ranging from about 3 m bgs to 163 m bgs (Golder 2014). Nine water supply wells were identified within the AOI according to the WWIS (MECP 2020) (Table 3-1), with an additional five water supply wells not in the database that were identified by the NWMO Geoscience's surveys as part of their drilling program planning. There are also five monitoring wells (in addition to the water supply wells) identified in the WWIS (MECP 2020).

Table 3-1 Water supply wells within the AOI from the Ontario Well Records

Well ID	Easting[1]	Northing[1]	Date Completed	Depth (mBGS[2])	Screened Aquifer	Use
1401064	473589	4873275	1/20/1956	41.8	Shallow bedrock	Domestic and livestock
1401068	473864	4873525	1/12/1956	29.6	Shallow bedrock	Domestic and livestock
1405385	471765	4873125	9/6/1979	103	Shallow bedrock	Domestic
1406722	473314	4873300	10/29/1987	29.9	Shallow bedrock	Domestic and livestock
1407090	473125	4873482	4/26/1989	21.9	Shallow bedrock	Domestic
1409203	471886	4873633	8/14/1998	12.2	Shallow bedrock	Livestock
1410803	472779	4873062	9/22/2004	29.6	Shallow bedrock	Domestic and livestock
7047231	473357	4873515	7/3/2007	36.6	Not defined	Domestic
7192155	473937	4873669	9/10/2012	17.4	Not defined	Other

[1]UTM Zone 17T; [2]mBGS – meters below ground surface; data from MECP (2020).

Groundwater is the most important water resource for the communities surrounding the AOI (Geofirma 2014). Regionally, South Bruce relies on two supply wells located in Teeswater (with a depth of 85.3 m bgs with the casing extending 25.9 m bgs) and Mildmay (depth of 34.9 m bgs and cased to 34 n bgs), both screened in the shallow bedrock aquifer and with average annual extraction rates of 455 m^3/day (316 L/min) and 657 m^3/day (456 L/min), respectively (SVCA 2020a, 2020b). Groundwater quality information is available for these wells and a nearby provincial monitoring well (Well ID: W0000299-1 which is approximately 5.5 km downgradient of the AOI). This will be considered when evaluating what water quality criteria need to be analyzed for in the groundwater samples. The AOI does not overlap with any of the wellhead protection areas for the regional municipal supply wells. The main industrial/commercial activities in the area of the AOI are cement manufacturing, quarrying, and agriculture.

Significant groundwater recharge occurs within the AOI, mostly in flat-lying hummocky areas with sands and gravels at surface and limited land cover (SV-SWPA 2015). The AOI predominantly overlaps with areas of medium to high index of aquifer vulnerability (Geofirma 2014; MVCA 2019).

The regional groundwater flow typically follows the topography, assuming relatively homogeneous hydraulic properties of aquifer units. Regional potentiometry for the bedrock aquifer in the Saugeen Valley shows major groundwater flow direction towards Lake Huron, similar to surface water flow trending west-northwest towards Lake Huron within the tertiary Saugeen Watershed (Golder 2014; SV-SWPA 2015). The main surface waterbody and potential discharge area for the overburden and shallow bedrock aquifer units near the AOI is the Teeswater River. Local and regional distortions of these generally shallow groundwater flow patterns may occur due to heterogeneity and anisotropy within the overburden and shallow bedrock aquifer units, such as configured in the surrounding bedrock infilled valleys and potential karstic features (conduits) (Geofirma 2014). For example, there is a known bedrock-infilled valley on the west side of the AOI (Gao et al. 2006).

Comprehensive borehole hydraulic testing has been completed at the Bruce Power site (Geofirma 2014) located approximately 40 km to the northwest of the AOI. The lowest horizontal hydraulic conductivities (K_h) reported are associated with the Upper Ordovician limestones ranging from $4x10^{-15}$ m/s to $1x10^{-14}$ m/s.

The permeable pathways (primary and secondary porosity) in the shallow, intermediate, and deep bedrock aquifer and the bedding structure in the overburden layers requires further evaluation to determine aquifer heterogeneity and anisotropy within the AOI. The groundwater used for irrigation, industry and dringking water purposes comes from the upper 150 m bgs and there is a transition from fresh water to more saline, and non-potable, water at around 200 m bgs (NWMO 2022). The DGR will be located many hundreds of meters below the zone of potable groundwater and is also isolated from the overlying bedrock and unconsolidated materials by several hundreds of meters of low permeability sedimentary rock formations. The hydrogeological parameters of interest include hydraulic conductivity, specific storage, primary and secondary porosity, total dissolved solids (TDS) profiles, horizontal and vertical hydraulic gradients, fracture aperture and spacing, and bulk density. The zone of influence of potential groundwater extraction activities associated with the DGR should be determined in order to minimize/prevent alteration of the shallow groundwater flow regime (Snowdon et al. 2021).

The study areas for the groundwater will include highly vulnerable and significant groundwater recharge/discharge areas such as the Greenock Swamp Wetland Complex and the Teeswater Wetland Complex. The study areas boundaries have been set to reflect the assumed groundwater flow in the overburden and possibly the shallowest bedrock aquifer as a starting point, where the boundaries are more likely to be influenced by the surface water features. As additional data becomes available from the Shallow Groundwater program being conducted by the NWMO, which will evaluate the physical hydrogeology of the AOI, the extents of the study area boundaries may be refined.

3.1.3 Soil, Overburden, and Bedrock

Soil is the unconsolidated mix of organic particles, clay particles, and weathered rock and mineral particles at least 10 cm in thickness that naturally occurs at the earth's surface and is capable of supporting plant growth (Soil Classification Working Group 1998). 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.

Because overburden and bedrock in the study area consists largely of glacial till and sedimentary units that are prone to weathering, the definition of the soil medium for this baseline study is expanded to include both soil and rock that is placed on surface as a result of excavation during construction activities. The largest amount of excavated rock that would be placed at surface is the rock from the depth of the DGR and this be placed in the excavated rock management area (ERMA). Surficial soil, overburden materials and rock that might be excavated during construction activities are expected to be handled in separate stockpiled location(s) for reuse or management as appropriate.

As discussed above, the bedrock geology of the AOI consists of a Precambrian crystalline basement of the Grenville Province unconformably overlain by a sequence of Paleozoic sedimentary rocks (Armstrong and Carter 2010). The first 100 m bgs are defined by carbonaceous Devonian rocks of the Lucas, Amherstburg, and Bois Blanc Formations (Figure 3-5). The Lucas Formation is a fine-grained package of dolostone and limestone, the Amherstburg Formation is an oil-bearing bioclastic limestone and dolostone package (although not found to date to be oil-bearing in the AOI), and the Bois Blanc Formation consists of cherty limestones and argillic dolostones (Golder 2014).

Quaternary units in the AOI include coarse and fine glaciolacustrine units, glacial moraines, glacial outwash, and ice-contact units (Geofirma 2014). The topography of the land area within the AOI is generally flat or gently sloping (less than 6 degrees of slope), with scattered glacial remnants like drumlins or moraines making up most of the surficial landforms (Golder 2014).

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

The local atmospheric environment is characteristic of a southern Ontario air shed, where local, regional, and national/international sources contribute to local air quality. Within the SON-South Bruce area, there are several industrial sources that have atmospheric releases into the air shed, including the Bruce Power site (Bruce), Ontario Power Generation's (OPG) Western Waste Management Facility (WWMF), and a wide array of other local commercial and industrial facilities (e.g., quarrying, waste treatment and disposal, motor vehicle and transportation equipment, electronics, metal products, farm products, meats and animal foods, plastics, chemicals, pesticides/fertilizer, furniture, fibre mills). These industries contribute to releases of radiological contaminants (carbon-14, cesium-137, iodine-131, tritium), criteria air contaminants (i.e., carbon monoxide [CO], nitrogen oxides [NO_X], sulphur dioxide [SO_2], particulates), and in some cases volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), dioxins and furans, pesticides, and metals. In addition, the regional and local roadways in the area (e.g., Highway 9, Regional/County roads 4, 6, 20, and 86, and Concession Road 10), as well as agricultural operations and local households contribute to releases of fugitive dust and fuel combustion by-products that impact air quality. In addition to the baseline monitoring done to support the Project, there are monitoring stations at Tiverton (approximately 30 km from the AOI) and Grand Bend (approximately 85 km from the AOI), which monitor a limited number of conventional pollutants (NO, NO_x, NO_2, O_3, and $PM_{2.5}$).

There are other sources of noise emissions in the area such as transportation, agricultural, and industrial- or construction-based sources (e.g., Teeswater Concrete Ltd.), which will contribute to the existing and future noise conditions.

Although light effects are localized in nature, sky glow would be considered a potential regional concern which is attributable to collections of light sources such as cities and towns as opposed to a single source.

3.1.5 Biological Environment

South Bruce is located within the Deciduous Forest Region where mixed woodlands consist primarily of American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*), together with other species including basswood (*Tilia americana*), red maple (*Acer rubrum*), and oak (*Quercus sp.*) (NWMO 2014a). There are no forest management units assigned by the Ontario government for this part of the province. Forests and woodlands are managed jointly by the Ontario Ministry of Natural Resources and Forestry (MNRF), municipalities, and conservation authorities. The forest in the region contains important sustaining areas for wildlife and is also in line with known bird migration routes along the eastern shore of Lake Huron. The area also provides feeding, wintering, and calving sites for whitetail deer (*Odocoileus virginianus*) and concentration and nesting areas for raptors, herons, and waterfowl (Golder 2014). Recreational and traditional harvesting of white-tailed deer, waterfowl (geese and ducks), and wild turkey (*Meleagris gallopavo*) is common in the region in permitted areas. There is a lower diversity of furbearers in the region, but beaver (*Castor canadensis*) and muskrat (*Ondatra zibethicus*) are harvested by trappers (Golder 2014).

Recreational fishing is important in the Bruce region and the Saugeen River is home to world class fishing for several sport fish species including smallmouth bass, brook trout, brown trout, rainbow trout, and chinook salmon (*Oncorhynchus tshawytscha*) (MNRF 2020a). Although chinook salmon and other trout species are not all native to the Saugeen River system, they have thrived over the years due to grassroots organizations such as the Ontario Steelheader's Association, Trout Unlimited, and the Lake Huron Fishing Club working alongside the MNRF to help to protect the Saugeen River fisheries and release thousands of hatchlings into the river each year. The Teeswater River is home to several small- and large-bodied fish species, including largemouth bass (*Micropterus salmoides*), brook trout, northern pike (*Esox lucius*), and channel catfish (*lctalurus punctatus*), among others (MNRF 2020a).

Information characterizing habitat types, vegetation, and wildlife in the AOI and surrounding area is being collected in the Biodiversity Baseline Study. The recent report by 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.

A baseline study for biodiversity (i.e., the BIS) is being undertaken to support the Project. 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 the baseline studies as it provides data to be used in Human Health and Ecological Risk Assessments (HHERAs), the IA, and postclosure safety assessments. It will also establish baseline contaminant concentrations to which data from future monitoring programs can be compared.

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. Results from the First Nations Food, Nutrition, and Environment Study (FNFNES) across Ontario in the same ecozone (Mixedwood Plains) indicated that over 50% of those interviewed consumed wild game and fish, 15% consumed wild birds, 53% wild berries and/or nuts, and 37% wild plants (Chan et al. 2014). Traditional foods including whitetail deer and fish species, especially lake whitefish (*Coregonus clupeaformis*) also known as *Adikameg* to the Ojibway, have been identified as potentially important traditional foods in the region (Gobin and Lauzon 2019; Youngblood 2017), but the NWMO is working to engage with local Indigenous Nations, governments, and communities to further identify and confirm species of interest and sampling locations for inclusion in the tissues component of the EMBP.

The SON Environment Office is very active and involved in several environmental files and monitoring programs within the Bruce region. The SON has Treaty rights to fish in Georgian Bay and Lake Huron and have commercial fishery operations that provide some economic and employment opportunities and fish for personal consumption (Youngblood 2017). Other environmental monitoring programs include the Fisheries Assessment Program that samples commercially harvested fish from Lake Huron/Georgian Bay and the Collaborative Lake Whitefish Research Program (CLWRP) that took place from 2010 to 2015 and was developed following a Bruce Power relicensing hearing in 2008. The most recent program established in 2019 is the Coastal Waters Monitoring Program (CWMP). The CWMP is a nearshore monitoring program between SON and Bruce Power that is building an extensive baseline inventory along the shorelines of Lake Huron in SON territory that includes fish community, water quality, coastal wetland and aquatic vegetation, and SON traditional ecological knowledge (SON 2020).

During future engagement opportunities with local Indigenous Nations, governments, and communities, it is proposed that community dietary surveys be completed to collect information on the quantity, type, and general harvest locations of traditional and non-traditional foods (agricultural animals and produce) that are harvested and consumed within the region and close to the proposed Project site. The information collected from this survey will help to further define the regional study area and species of interest for the tissue sampling component of the EMBP. It will also be important for the modelling component for the HHERA, IA, and postclosure safety assessments for the region.

3.2 Land Use

A review was undertaken of historic and current land use in a 20 km area around the AOI (156,504 ha). As per Agriculture Agri-Food Canada land use (AFFC 2015), land use as of 2010 within 20 km of the AOI is predominately agricultural. There are several densely populated urban areas, such as the communities of Teeswater, Lucknow, Wingham, and Mildmay, to name a few, as well as Provincially Significant Wetlands including the Greenock Swamp, Teeswater, and Otter Creek Wetland Complexes, as shown in Figure 3-6. Fragmented forests and wetlands are scattered throughout the area. Land use within the AOI, based on current satellite imagery, is shown in Figure 3-7[1].

The land use data were used to help identify potential natural and anthropogenic components that may have Project interactions and, therefore, need consideration in the CSM and screening level change assessment.

[1] A separate land use study report (DPRA and MHBC 2022) has also been prepared to assess the likely changes in present and planned land use and development patterns that will occur with the Project in the Municipality of South Bruce and the neighbouring communities and its interaction with the emergency response plan for the future facility. The study provides information directly relevant to the Municipal Official Plan and zoning by-laws and is outside the scope of the current document.

Figure 3-6 Land use within a 20 km radius around the Area of Interest

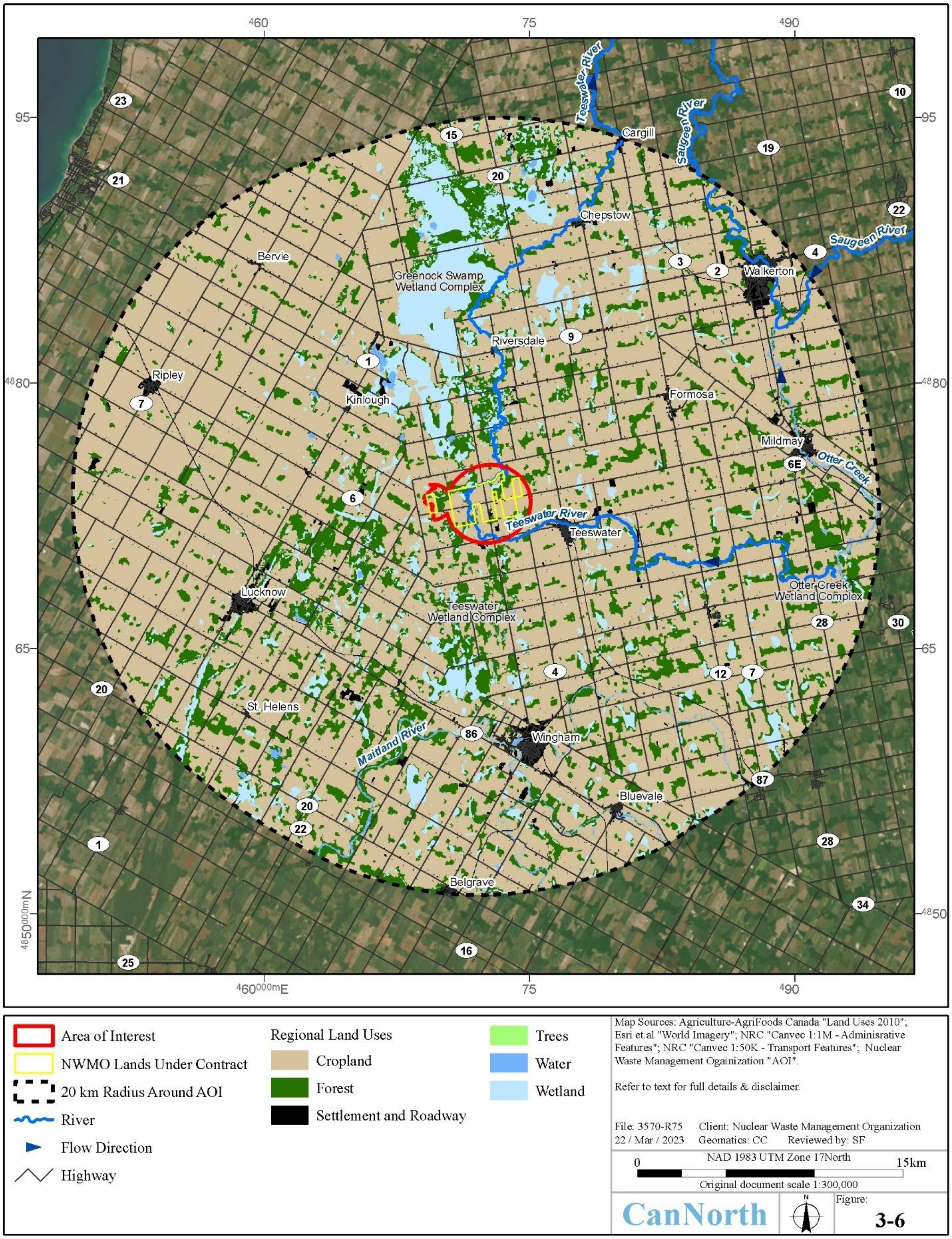
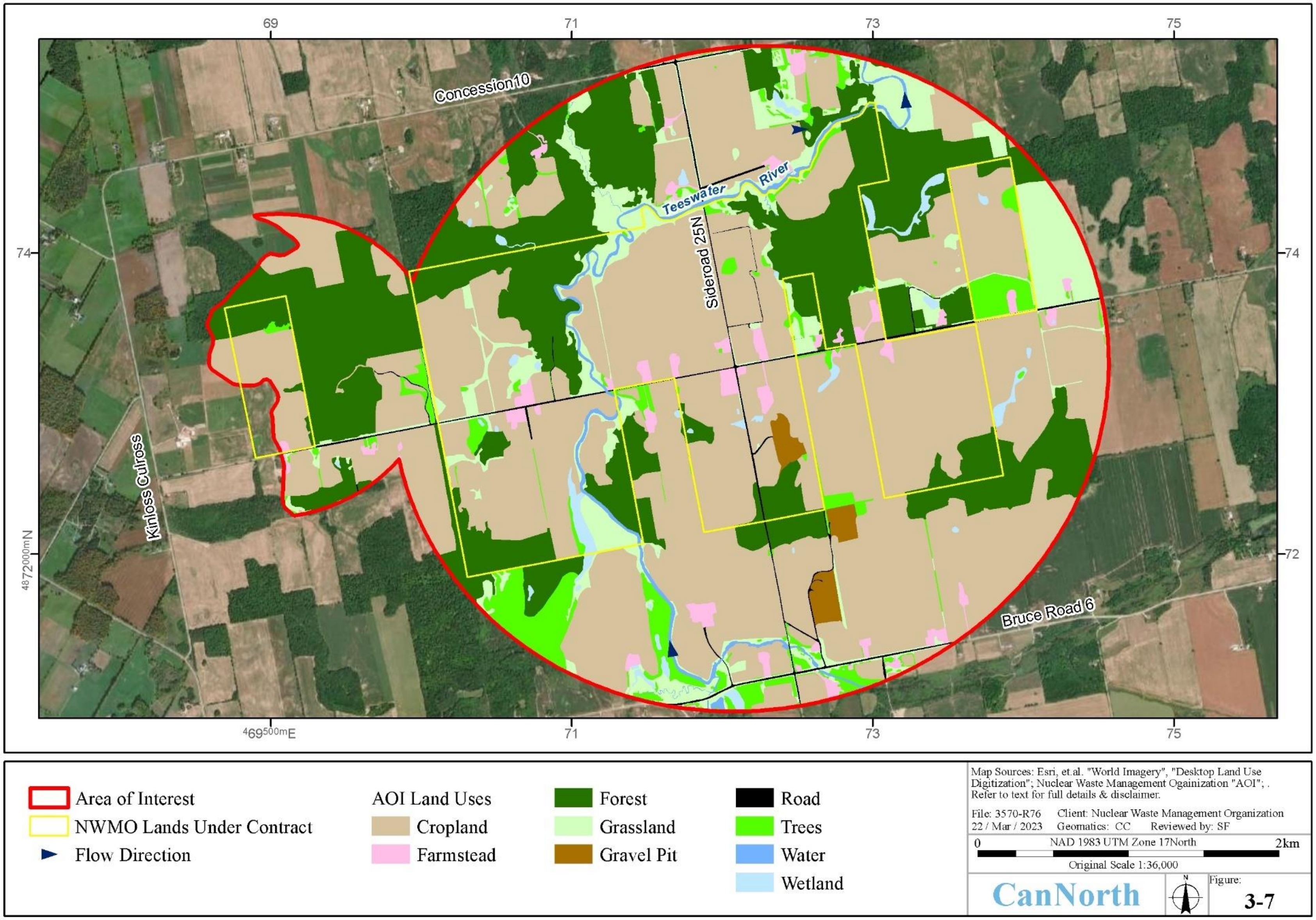


Figure 3-7 Land use within the Area of Interest



3.2.1 Industry

3.2.1.1 Agriculture

Farming is a very active industry in the area, with the Bruce County Federation of Agriculture (BCFA) representing the interests and concerns of 1,455 farm families in Bruce County who are members of the Ontario Federation of Agriculture. The South Bruce Community & Business Association lists 13 entries for Agriculture & Farm Services in the Municipality of South Bruce including farming, crop consulting, and supplies and services. Croplands, as defined by AAFC, within 20 km of the AOI are shown in Figure 3-6, while croplands and farmsteads (i.e., lands developed for human living and farm operations) within the AOI are shown on Figure 3-7.

3.2.1.2 Aggregate

The region has an abundant supply of aggregate resources that are illustrated in Figure 3-8. According to the MNRF spatial data sets, there are 63 areas authorized for active aggregate excavation within a 20 km radius of the AOI (MNRF 2017a). There are an additional 15 inactive authorized areas (MNRF 2020b). The 78 authorized areas represent a potential 2,188 hectares of land dedicated to aggregate extraction and processing; however, not all the area authorized for extraction is utilized and some inactive areas may have been rehabilitated. In addition, gravel pits held by the Ontario Ministry of Highways are not tracked by MNRF (2017b).

3.2.1.3 Mining

Using the Mining Lands Administration System (MLAS) of the Ontario Ministry of Energy, Northern Development and Mines (ENDM 2020), no mining claims were found within a 20 km radius of the AOI. Further, using the Abandoned Mines Information System (AMIS; ENDM 2018), no abandoned mines were found within the AOI. There is one abandoned salt mine that operated from 1900 to 1925[2] within 20 km of the AOI (Ministry of Mines 2019).

3.2.1.4 Nuclear Generating Stations and Waste Facilities

The Bruce Power Nuclear Generating Station is located on the Bruce nuclear site on the eastern shore of Lake Huron near Tiverton, Ontario, approximately 18 km north of Kincardine (Figure 3-2). Nuclear power has been generated from the site for the past 52

[2] http://www.geologyontario.mndm.gov.on.ca/mndmfiles/AMIS/data/records/04873.html; abandoned mine identifier 04873.

years, initially through the Douglas Point Nuclear Generating Station (1968 to 1982) and subsequently through the Bruce A and B Nuclear Generating Stations, which were put into service from 1977 to 1979 and from 1984 to 1987, respectively (Bruce Power 2020). Bruce A and B Nuclear Generating Stations each comprise four CANDU reactors as well as ancillary facilities. The Bruce nuclear site also encompasses lands currently occupied by OPG, Canadian Nuclear Laboratories Douglas Point, and Hydro One.

The WWMF, which has been developed in stages since 1974, is owned and operated by OPG and is located on OPG-retained lands within the boundary of the Bruce nuclear site. The facility receives and manages shipments of low- and intermediate-level radioactive waste from the Bruce, Pickering, and Darlington Nuclear Generating stations. The Western Used Fuel Dry Storage Facility stores used fuel from the Bruce site only.

In 2011, OPG completed an Environmental Impact Statement (EIS) to construct and operate a DGR on the Bruce nuclear site for the long-term management of low- and intermediate-level nuclear waste (Golder 2011). In January 2020, SON membership voted against the proposed DGR and, consequently, OPG withdrew their application in order to keep its commitment to SON to not proceed without their support.

3.2.1.5 Generalized Industrial Activities

Multiple sources were surveyed to identify industrial land uses and activities in the area. Data were compiled from available sources such as the Environmental Activity and Sector Registry (MECP 2015), the Environmental Compliance Approvals list (MECP 2017), the National Pollutant Release Inventory (ECCC 2017), and Natural Resources Canada CanVec data (NRC 2020). Within a 20 km radius of the AOI, 189 industrial locations of varying activity were identified (Figure 3-9); however, some of the locations may overlap as multiple environmental impacts were recorded. Some industrial activity was identified by its environmental impact type (sources of air emissions, sewage works, waste disposal, or waste management), while others were identified by their industry sector (manufacturing types, foundries, and salvage). While industrial activities are distributed throughout the 20 km radius of the AOI, they are concentrated in urbanized areas, particularly Wingham, Walkerton, Mildmay, and Teeswater.

Figure 3-8 Aggregate pit distribution within a 20 km radius around the Area of Interest

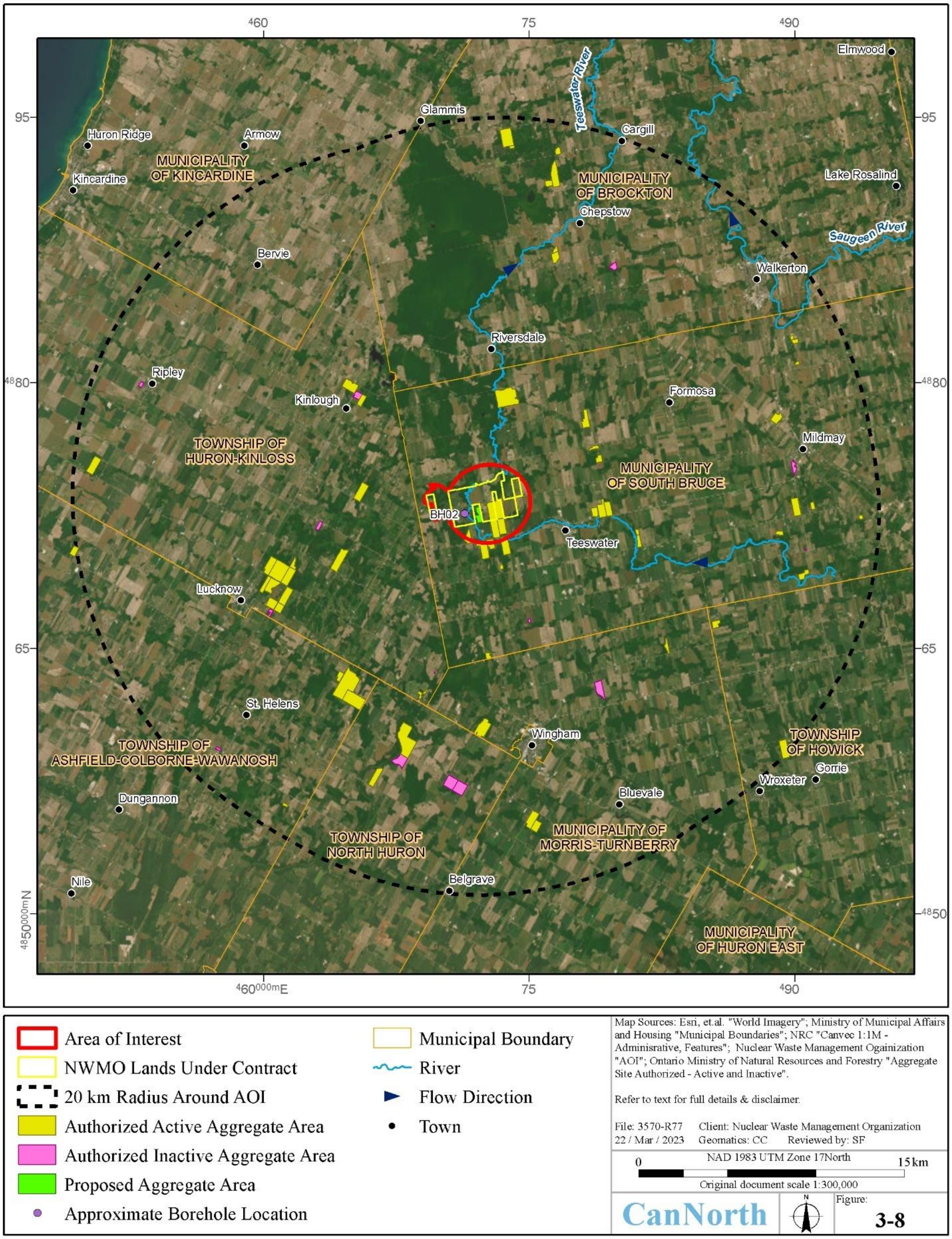
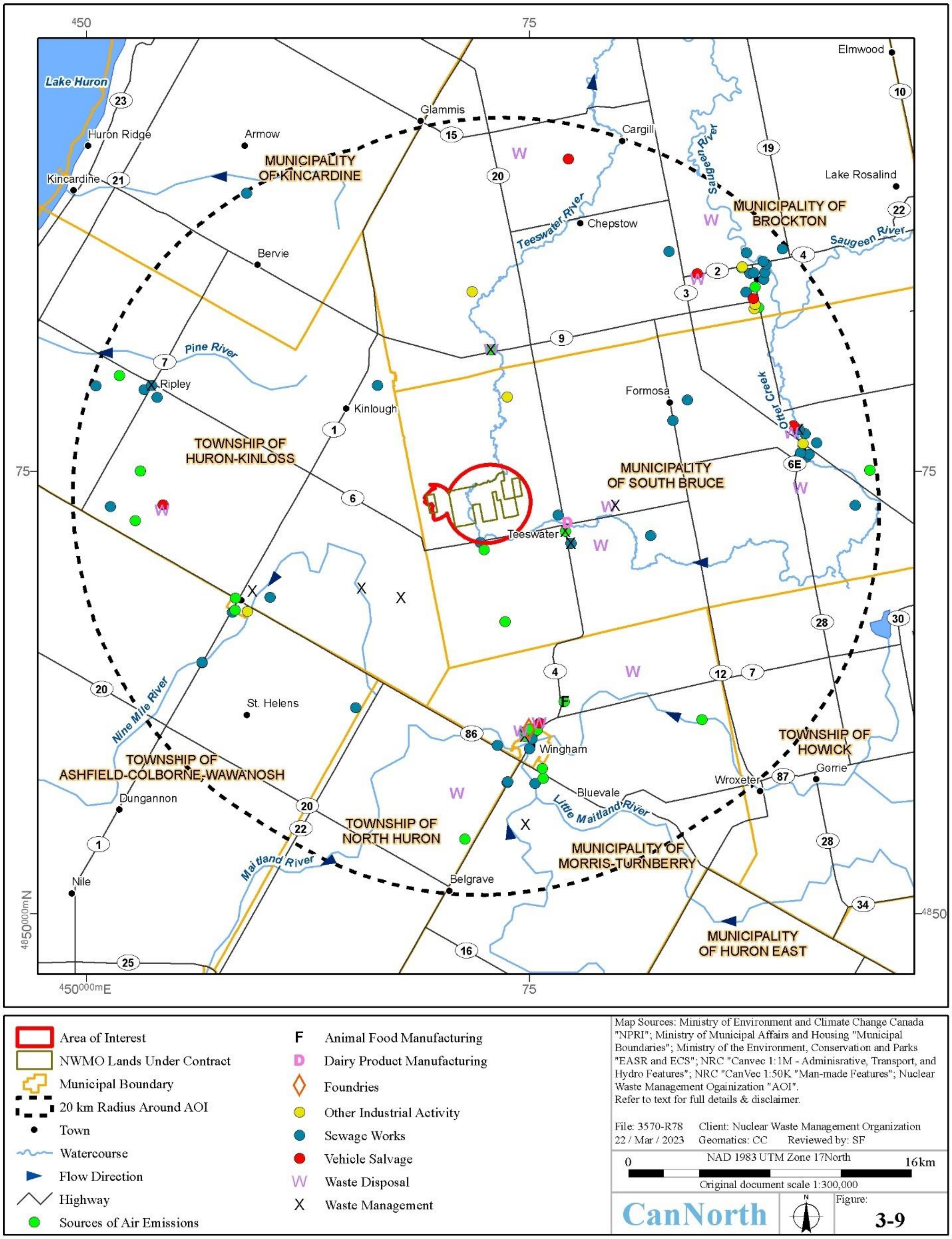


Figure 3-9 Industrial activity distribution within a 20 km radius around the Area of Interest



3.2.2 Urbanized Areas

There are several densely populated areas in the region. Within the Municipality of South Bruce this includes Teeswater, Mildmay and Formosa. The population of South Bruce is expected to grow by 2510 people between 2021 and 2046. Other nearby communities include Lucknow and Walkerton in the County of Bruce, Hanover in the County of Grey and Wingham in the County of Huron (DPRA and MHBC 2022).

3.2.3 Undeveloped Natural Areas

The region includes natural areas including provincial parks, wetlands, and conservation areas. Some of the areas are used for hunting and fishing, as well as recreational activities (e.g., Schmidt Lake walking trail and lookout).

3.2.3.1 Provincial Parks

There are two provincial parks located 42 km and 35 km to the northwest of the AOI (Figure 3-2) along the shores of Lake Huron (Ontario Parks 2020). MacGregor Point Provincial Park, located in the Town of Saugeen Shores, is 12 km^2 in size, is classed as a natural environment park, offers day use and overnight camping, and is open year-round. Inverhuron Provincial Park, a historical park in the Municipality of Kincardine, is 2.9 km^2 in size, and also offers day use and overnight camping (Golder 2014). Both parks are important protected areas for wetlands and diverse habitats that nurture and protect a variety of rare plants and many woodland animals and birds (Ontario Parks 2020). A third provincial park (Point Farms Provincial Park) is located approximately 35 km southwest of the AOI.

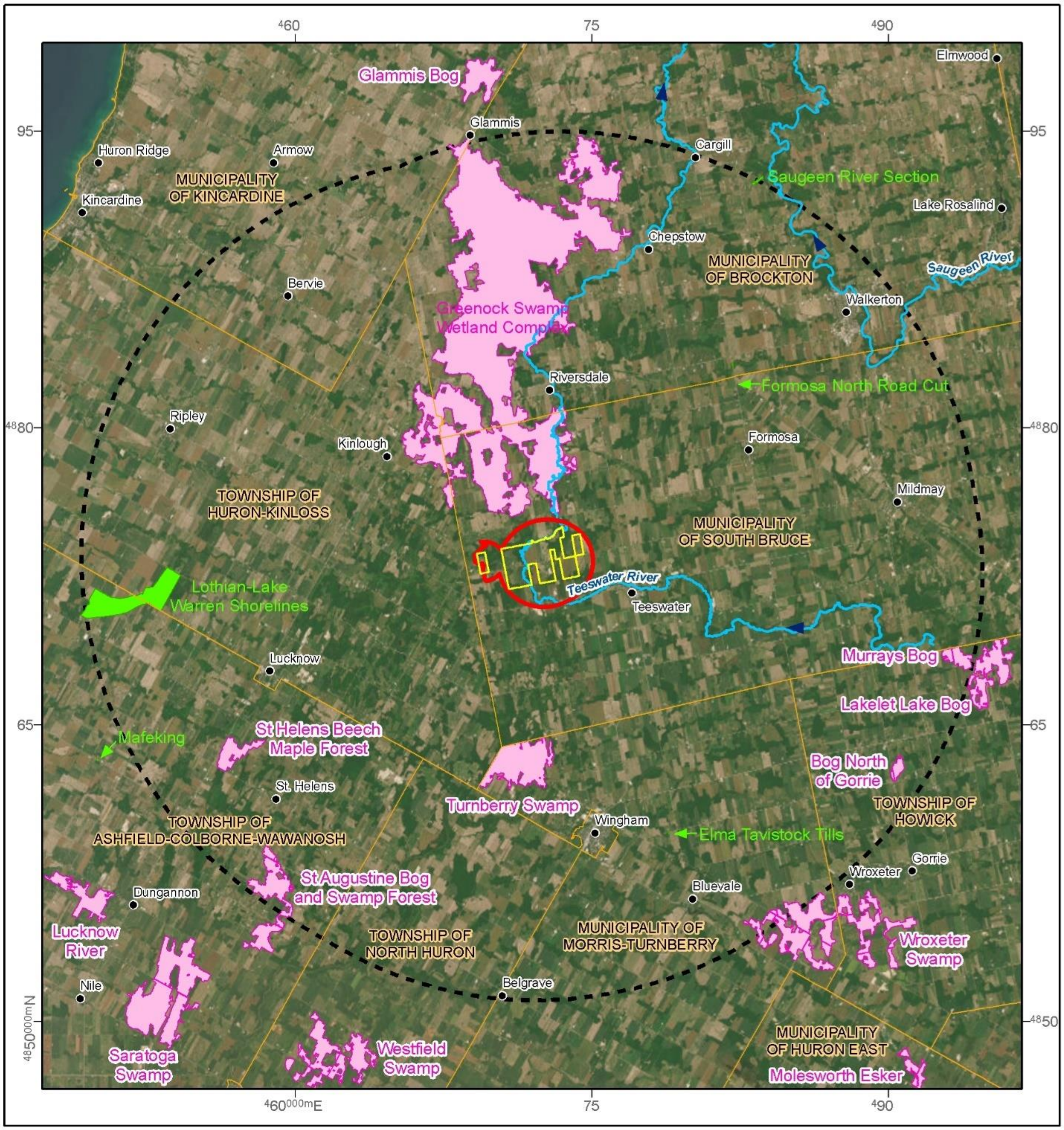
3.2.3.2 Provincially Significant Wetlands (PSW)

South Bruce contains a total of approximately 6% of protected areas, of which 5.5% are PSWs and 0.5% conservation areas/reserves. There are three PSWs evaluated within South Bruce including the Greenock Swamp Wetland Complex, the Teeswater Wetland Complex, and the Otter Creek Wetland (Figure 3-4). The Greenock Swamp Wetland Complex starts in the northern portion of the AOI and extends north into the Municipality of Brockton. It is one of the largest wetland areas in southern Ontario with an area of approximately 90 km^2 and accounting for roughly 12% of the Teeswater River watershed total area. It is classified as a Class 1 wetland (SVCA 2018). The Teeswater Wetland Complex is located immediately south of the AOI and extends westward into the Township of Huron-Kinloss. The Otter Creek Wetland is located south of Mildmay and is not in the vicinity of the AOI.

3.2.3.3 Areas of Natural and Scientific Interest (ANSI)

There are eleven Areas of Natural and Scientific Interest (ANSI) sites within a 20 km radius of the AOI (Figure 3-10). Four ANSI are Earth Science sites and seven are Life Science sites. The Greenock Swamp Wetland Complex ANSI-Life Science area is located approximately 750 m north of the AOI and reaches into the AOI; however, the current ANSI boundary does not coincide with the AOI (MNRF 2018).

Figure 3-10 Areas of Natural and Scientific Interest in the South Bruce site region



Area of Interest
NWMO Lands Under Contract
20 km Radius Around AOI
ANSI, Earth Science
ANSI, Life Science
Municipal Boundary
Town
River
Flow Direction

Map Sources: Esri, et.al. "World Imagery"; Ministry of Municipal Affairs and Housing "Municipal Boundaries"; NRC "Canvec 1:1M - Adminisrative, Features"; Nuclear Waste Management Ogainization "AOI"; Ontario Ministry of Natural Resources and Forestry "Areas of Natural and Scientific Interest".

Refer to text for full details & disclaimer.

File: 3570-R80 Client: Nuclear Waste Management Organization
22 / Mar / 2023 Geomatics: CC Reviewed by: SF

NAD 1983 UTM Zone 17North
0 15km
Original document scale 1:300,000

CanNorth Figure: 3-10

3.2.3.4 Conservation Areas

There are several conservation areas located within the SVCA lands, with some offering only day use areas (e.g., Allan Park Conservation Area, Bell's Lake Conservation Area, etc.) and others offering camping (e.g., Saugeen Bluffs Conservation Area, Brucedale Conservation Area, etc.). While many of these areas are not located near to the AOI, the Hardwood Hill Managed Forest is located approximately 500 m south of the AOI.

3.2.4 Indigenous Land Use

There are two First Nations reserves in Bruce County: Saugeen First Nation adjacent to Southampton and Chippewas of Nawash Unceded First Nations at Neyaashiinigmiing on the Bruce Peninsula. Collectively, they are known as the Saugeen Ojibway Nation or SON (SON 2020). There are also two Métis communities represented in the Bruce Peninsula: the HSM and the MNO Region 7 Georgian Bay Traditional Territory regionally-based community composed of the MNO Georgian Bay Métis Council, MNO Great Lakes Métis Council, MNO Moon River Métis Council, and MNO Barrie-South Simcoe Métis Council (MNO 2020).

Although preliminary engagement with local rights-holders was initiated in March and April of 2021, efforts are being made for further engagement with local First Nation and Métis communities. Any input learned going forward from future workshops with these communities, such as use of the land, will be considered moving forward.

3.3 Contaminants of Potential Concern

A comprehensive list of contaminants of potential concern (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 South Bruce site is provided in Table 3-2; 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. In particular, the list of pesticides and herbicides that are relevant to this area is under development and may be modified based on extent of use, community concern, and persistence.

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. This includes I-131, which is measured by Bruce Power. 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 may be present due to previous activities in the area (e.g., waste incineration). In addition, select pesticides are included (e.g., organochlorine insecticides) due to their potential presence.

Although not related to the Project, information on the presence of these compounds can inform the assessment of potential cumulative effects.

Table 3-2 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
	OC pesticides

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

3.4 Climate Change Considerations

The community of South Bruce is within a temperate and humid continental climate zone, with relatively hot, humid summers and cold winters (Golder 2014). The annual average temperature is 6°C, where the average summer temperature is approximately 18°C and the average winter temperature is -6°C. The annual average precipitation in the area is 1,193 mm. Higher amounts are seen through late summer and through the winter months; the increase in precipitation in winter is due to snow squall activity developing over the winter period, indicating the dominant influence of Lake Huron and Georgian Bay.

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). Following this methodology, Golder (2020) recently completed a climate change impact study to characterize the current and future climate conditions in the South Bruce study area. 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, with more frequent intense rainfall events and greater precipitation amounts annually. However, drought index analysis revealed that the period of late fall to mid spring will become wetter while the summer months will become drier. Projected changes in temperature ranged from 2.0°C to 2.9°C in the 2050s and from 3.1°C to 4.0°C in the 2080s, with fewer freezing and icing days projected along with a longer growing season, more summer days, and greater extreme minimum and maximum daily temperatures (Golder 2020).

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.

Based on the information presented in the Golder report, the AOI is unlikely to experience drought conditions that would affect local waterbodies (Golder 2020); however, there is the risk of possible flooding along some creeks and rivers due to its location just downstream of the steep headwater drainage area and lower slope at the AOI. This was supported by the Preliminary Flood Hazard Assessment that indicated that the AOI is vulnerable to flooding from areas upstream along the Teeswater River during extreme rainfall events due to the relatively flat topography around the AOI (AECOM 2022).

Obtaining strategic baseline meteorology and hydrology data will aid in Project planning for water management in consideration of these predicted climate change effects and the potential for flooding. These data will be used to develop a more accurate hydraulic model for the flooding risk assessment.

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 site preparation, construction, operations, extended monitoring, and decommissioning and closure (see Section 2.1). The preliminary Project description was reviewed to consider where the Project was likely to interact with the biophysical environment, 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, honey, medicinal plants) Agricultural products (crops, produce, poultry, livestock) Wetlands

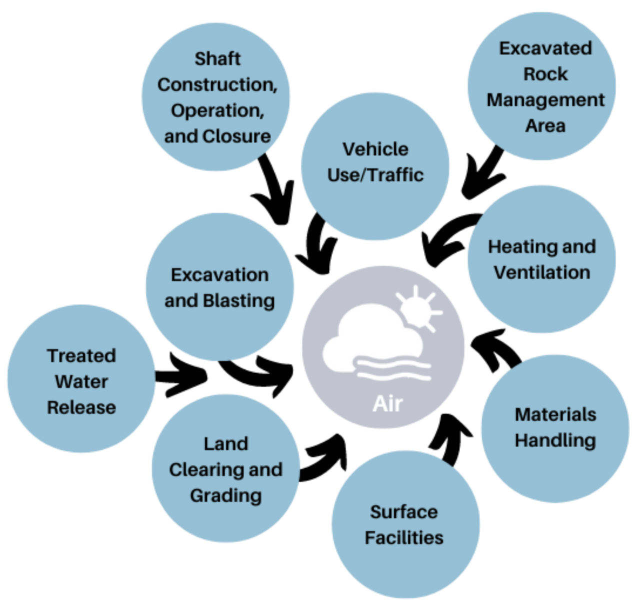
Note:
[a] Groundwater and bedrock below 100 m bgs is part of a different study and only discussed here as they may interact with the shallow groundwater and surface water.
[b] Meteorology is included within this component.

[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.

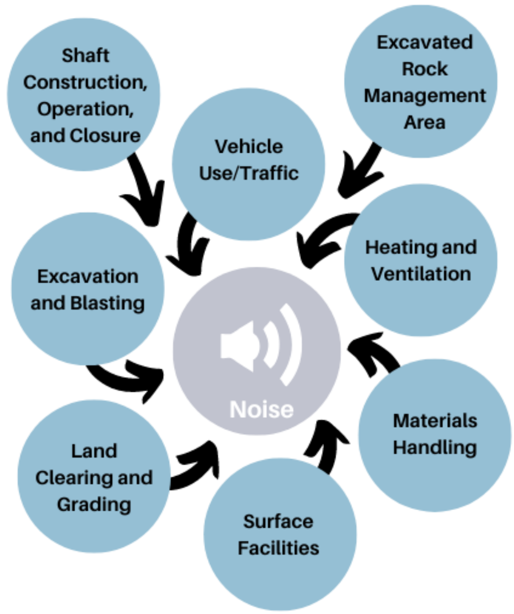
Additionally, study components for socio-economic conditions and human health will ultimately need to be included. These topics have been considered broadly here, though these are being assessed separately. Socio-economic includes social conditions (e.g., housing, community well-being, aesthetics) and 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.

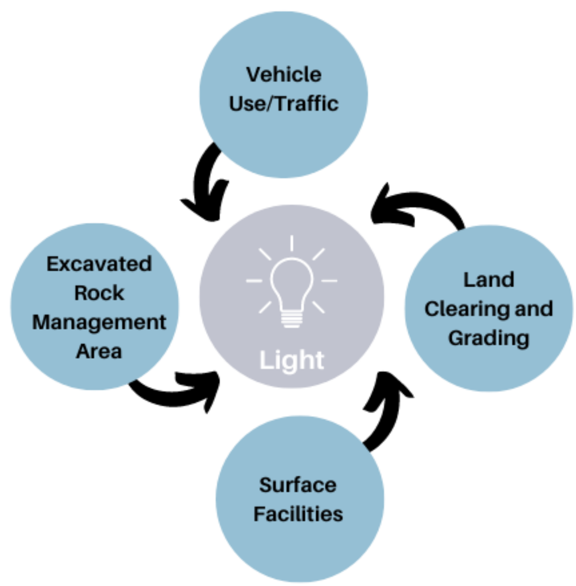
4.2 Noise



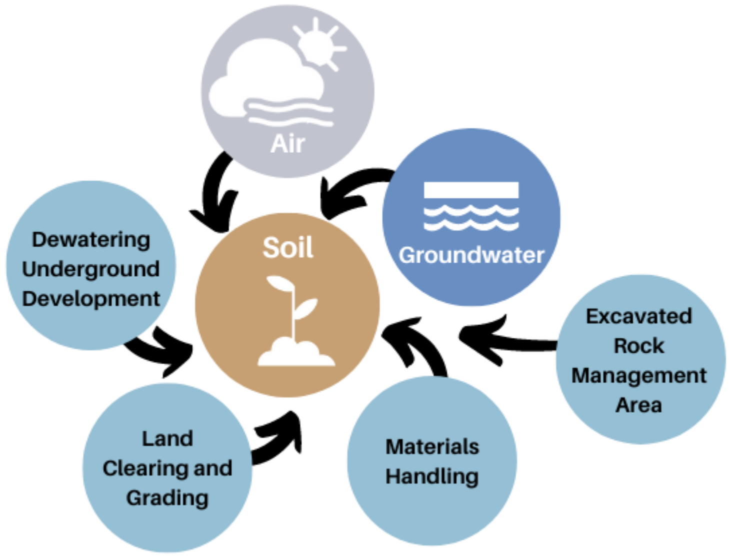
Project activities can directly interact with noise which can in turn affect wildlife and people (both socio-economic and human health components). Noise is a consideration in site preparation and construction activities such as land clearing, excavation and blasting, and materials handling as well as 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.



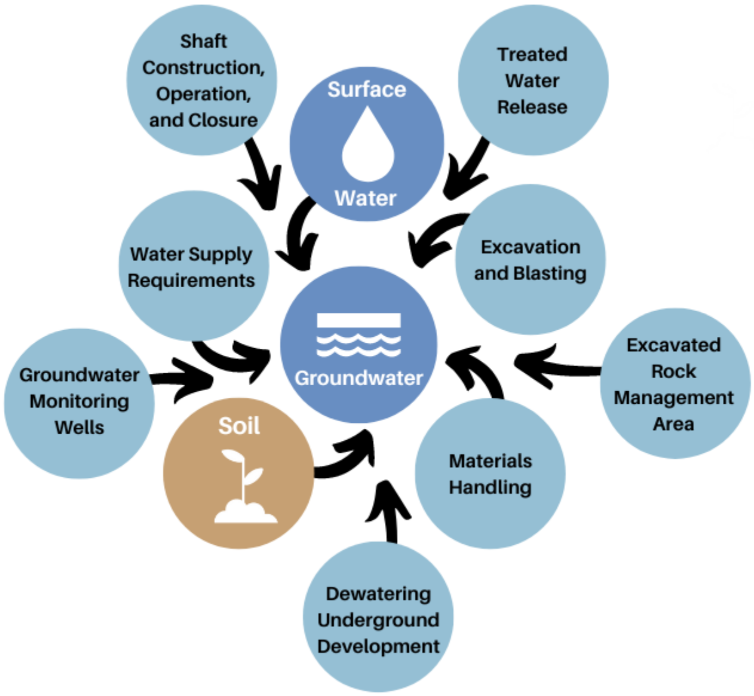
4.4 Soil, Overburden, and Bedrock



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 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; 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.

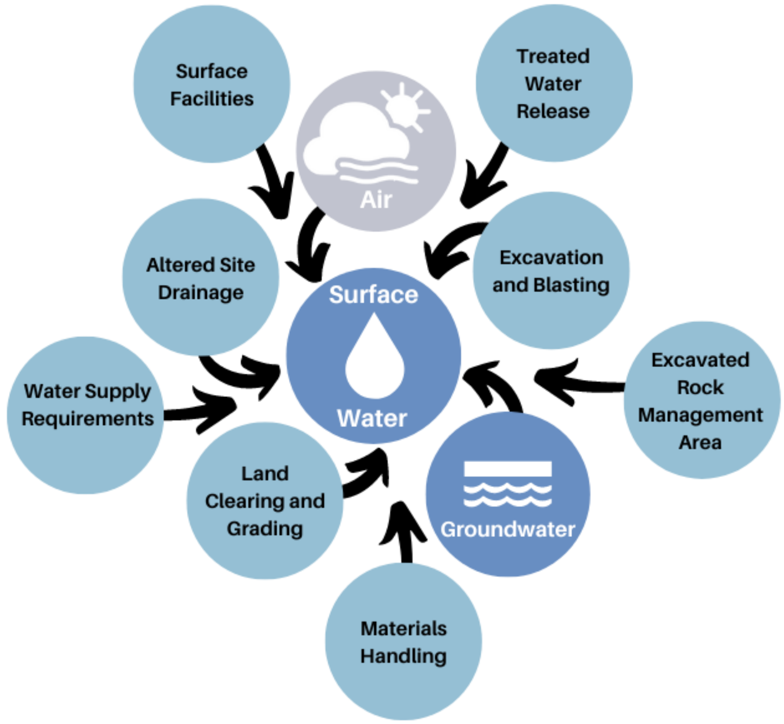
4.5 Groundwater

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 water supply during facility 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.



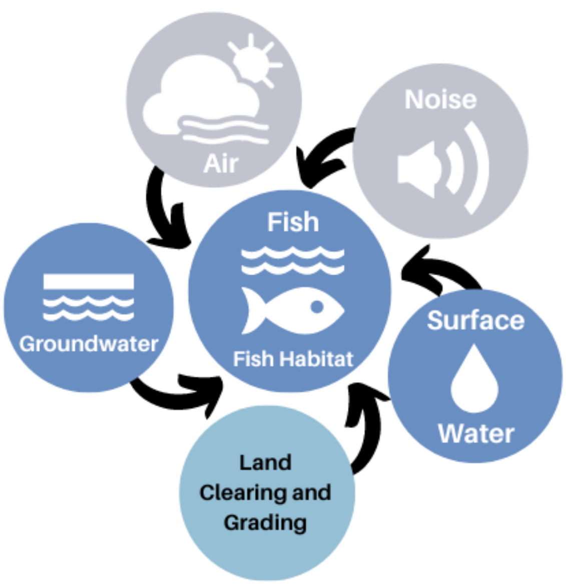
Project activities have the potential to interact with groundwater through many phases of the development and therefore careful consideration of design features and mitigation measures must be addressed early in the planning process to reduce the potential for interactions where possible.

4.6 Surface Water



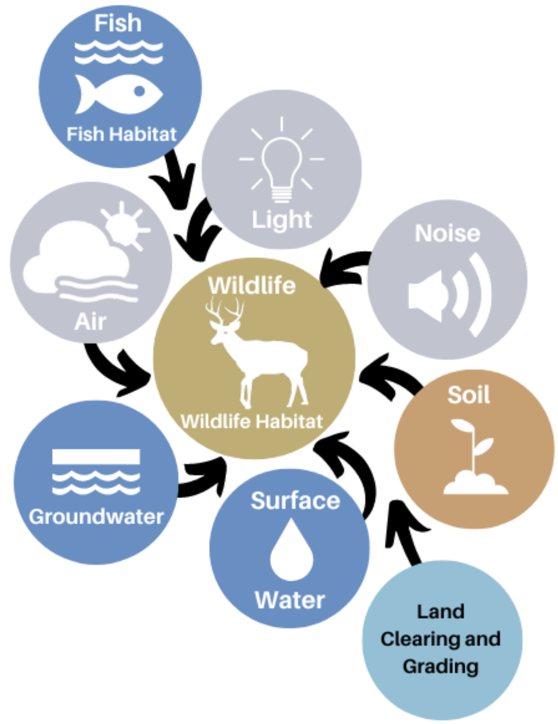
Project activities can directly interact with surface water quality through the release of water (treated or through drainage) to receiving waterbodies, drawdown of water from underground developments, or accidental release of contaminants to water from materials handling. Indirect interactions with 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 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.

4.7 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 • 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	

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 receptors, 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 • Extended monitoring	The water supply requirements could affect the freshwater supply (either groundwater or surface water, depending on source) which in turn could affect aquatic, terrestrial, and human receptors.					x	x	x	x	x	
	Lowered water table from groundwater supply source 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: • Site Preparation • 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 waterbody 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 5.7 for design features and/or mitigation measures.

Dewatering

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		
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 brine 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 sewage water to downstream receiving waterbody could affect groundwater, soil (if water used for irrigation), surface water quality and aquatic and terrestrial receptors.				x	x	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: • Site preparation • 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		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 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 standards 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.
- 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 materials 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 SON-South Bruce area it is assumed that the water supply will be locally sourced from the municipality (groundwater sourced from expanded municipal system) or sourced directly from shallow groundwater.

- Recycle and reuse service water to the extent practical to reduce the Project's water use footprint.
- Minimize impacts through design alterations to account for the maximum preservation of existing resources/users.

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.
- Measures should be taken to prevent contamination of water bodies 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 NWMO's plan to store all excavated rock material on site; however, discussions are ongoing to collaborate with the Municipality of South Bruce to determine whether the material can be reused as aggregate (Keir 2022b). As these discussions progress the environmental consequences of this approach (e.g., any on-site processing) can be considered. Other 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 SON-South Bruce Area has not yet been conducted on the core from the SON-South Bruce area; however, other tests performed on core from the nearby Bruce nuclear site in Kincardine determined the rock 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; and
    - 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 Teeswater 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.

  - o 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.
  - o 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 SON, MNO, and HSM 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	Teeswater River (owing to its larger flow in comparison to smaller streams)	1	• There will be two treated discharge streams: one from the ERMA, and one for all other sources (on-site treated effluent, treated sewage, treated stormwater runoff, UFPP) • Are there other waterbodies that can assimilate the discharges? • Data from the EMBP (hydrology) will assist with determining best waterbody
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	• To be estimated during Pre-Feasibility level site specific design
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	Municipal or new groundwater supply well	6	• If municipal, system to be expanded • Aquifer needs to be able to support water extraction/use without impacts to other water users and the natural environment • Need to be mindful of distance/cost for pumping

Type	Data Requirement	Current Value, Assumption, or Stage	Reference Number	Notes/Details
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	
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	Planned	9	• To inform future air dispersion, noise, and light modelling • Any changes to during site preparation and construction should be well characterized
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

Type	Data Requirement	Current Value, Assumption, or Stage	Reference Number	Notes/Details
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 SON-South Bruce area is completed
	Size and locations of the facility structures, roadways, laydown areas	Planned	15b	• Need to consider distance to adjacent waterways (Teeswater River and Parker municipal drain)
	Purchased or optioned parcels of land (acres)	1,500	15c	• Current value
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
Data	**Meteorological data within the AOI**			
	Total precipitation (mm)	In Progress	18	• At the AOI and near headwater location of the Teeswater River; to refine hydraulic model and define 1-in-500 year storm event
	Snow depth (mm)			
	Ambient air temperature (°C)			
	Atmospheric pressure (kPa)			
	Soil moisture (%)			
	Solar radiation (kWh/m^2)			
	Wind speed (km/hr)			
	Wind direction			
	Potential evapotranspiration (mm/d)			
Data	**Characterization of overburden units**			
	Thickness (m)	In Progress	19	• It cannot be assumed that infiltration will be minimal as significant groundwater recharge occurs within the AOI and the AOI predominantly overlaps with areas of medium to high aquifer vulnerability (Geofirma 2014; MVCA 2019; SV-SWPA 2015) • May need additional wells to further characterize the overburden units as currently only one depth interval/overburden screen unit per well cluster
	Horizontal K (m/s)			
	Vertical K (m/s)			
	Specific storage (1/m)			
	Porosity (--)			
	Lithologic description (--)			
Data	**Characterization of shallow bedrock units**			
	Equivalent K horizontal (m/s)	In Progress	20	• Data is needed for design and safety case • Need to characterize the subsurface and groundwater flow sufficiently to understand groundwater surface
	Equivalent K vertical (m/s)			
	Specific storage (1/m)			

Type	Data Requirement	Current Value, Assumption, or Stage	Reference Number	Notes/Details
	Matrix porosity (--) *Mean discontinuity or major flow zone spacing (m)*			water interactions, design of short- and long-term monitoring networks, modeling inputs and calibration, and protection of current groundwater users (potable, irrigation, other)
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 many components of 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	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 • Initial round of results expected 2023 • Need complementary analytical suites for leach tests / SW/GW • Determine metals and salt 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 sedimentary rock (limestone) near DGR depth (m/s)	1.00E-14	24	• Based on NWMO (2022)

Type	Data Requirement	Current Value, Assumption, or Stage	Reference Number	Notes/Details
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, modeling inputs and calibration, and protection of current shallow 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/Planned	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)
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)
	Construction (deep)	Up to 350	30b	

Type	Data Requirement	Current Value, Assumption, or Stage	Reference Number	Notes/Details
	Operations (deep)	Up to 180	30c	• 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
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 and salt 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 also 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	
Data	**Characterization of waterbodies within and adjacent to the AOI**			
	Stage (m; vertical datum: NAVD 88)	In Progress	36a	• Continuous stream gauges - Teeswater River and the Beatty Saugeen River (reference river)
	Flow rate (m^3/s)	In Progress	36b	• Continuous stream gauges - Teeswater River and the Beatty Saugeen River (reference river)
	Channel Bathymetry	In Progress	36c	• Teeswater River within the AOI
	Lake Bathymetry	In Progress	36d	• Silver Lake and Clam Lake • Robson Lake and Hines Lake (reference site)

Type	Data Requirement	Current Value, Assumption, or Stage	Reference Number	Notes/Details
	Stage (m; vertical datum: NAVD 88)	In Progress	36e	• Staff gauges (discrete): Silver, Clam, Robson, and Hines lakes; Greenock Swamp, Teeswater Wetland Complex, Saratoga Wetland Complex, Elderslie Swamp, Arran Lake Wetland Complex and Osprey Wetland
	Presence of flow, seasonal variation of flow, tributary areas, channel geometry and presence of sensitive species	Proposed	36f	• Parker Municipal Drain within the AOI before confluence with Teeswater River
Data	Visual / aesthetics / lighting	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-c)	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 (existing municipal supply or new groundwater well) and discharge receiving waterbody
  - Hydrology data collected through the EMBP
  - Groundwater characterization
    - These could include pump tests of local supply wells; further data collection on existing groundwater users identifying location, depth,

amount of water used; data collection on groundwater elevation at the regional and local scale from multiple depths within each of the hydrostratigraphic units to provide an understanding of the regional and local hydrogeology and sufficient data to calibrate the flow model being developed

- Determination of whether or not water supply requirements will cause lowered water levels in source waterbody/aquifer or other sensitive receptors
  - See above – similar studies needed
  - 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 provide 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

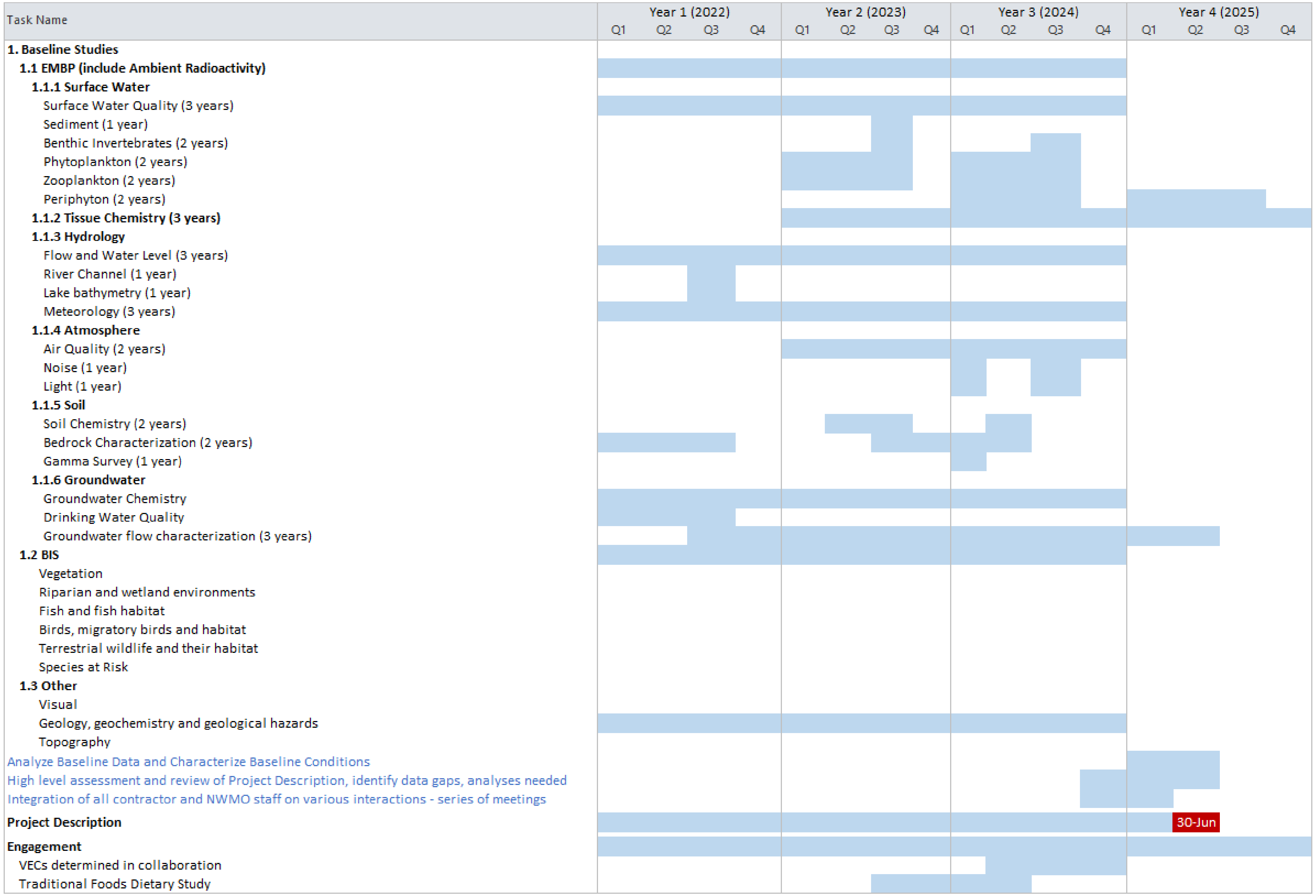
In the event that the Project does move forward at the proposed Site, an IA would need to be completed, which would require the completion of numerous supporting studies. Related to the biophysical environment, the Impact Assessment Agency of Canada (IAAC 2020) requires the following information be contained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

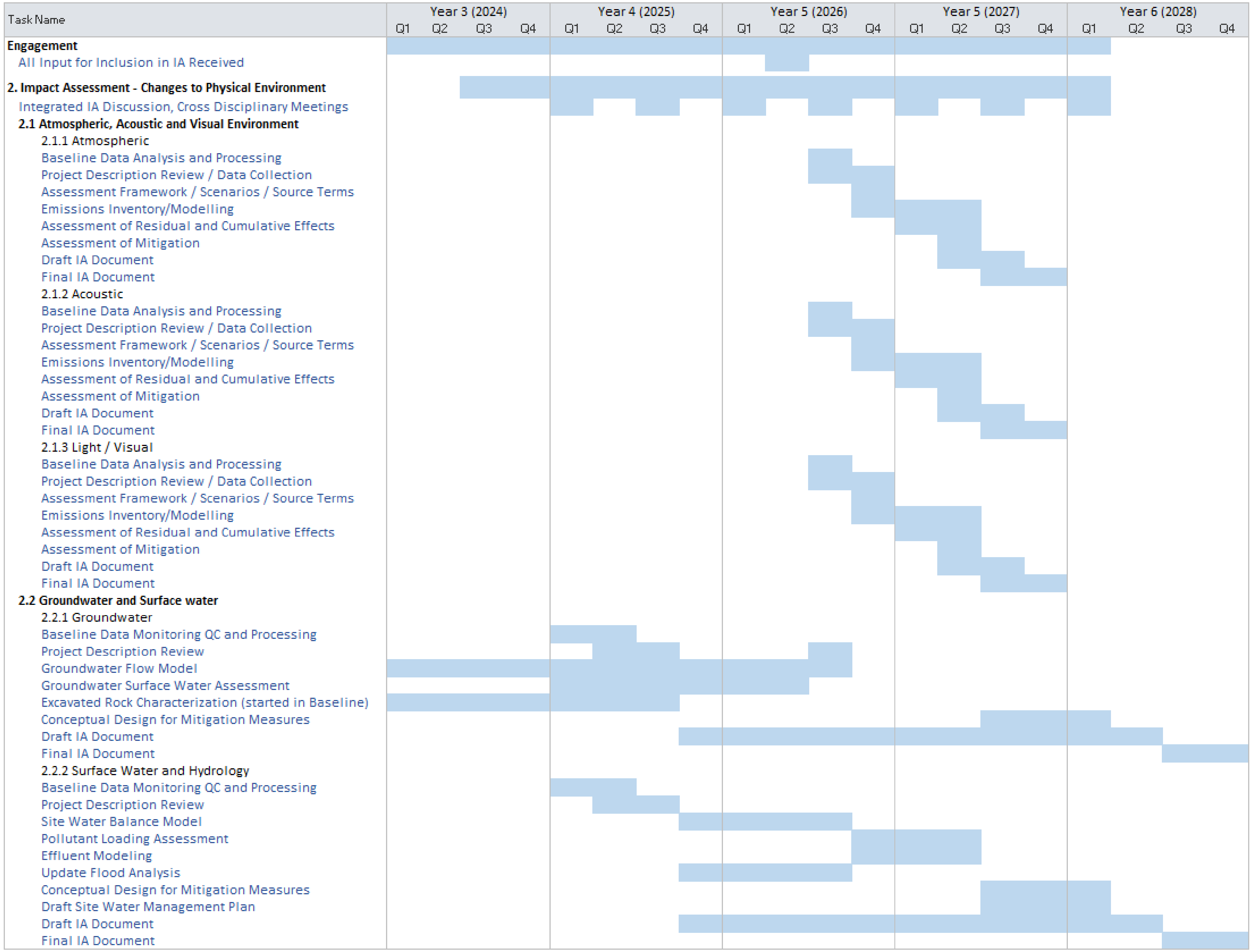
Prior to an IA, the NWMO would need to file an initial Project Description. Based on an assumed filing date of June 30, 2025, followed by filing of the IA document by May 31, 2028, a general schedule of the supporting studies that must be completed is provided in Figure 6-1.

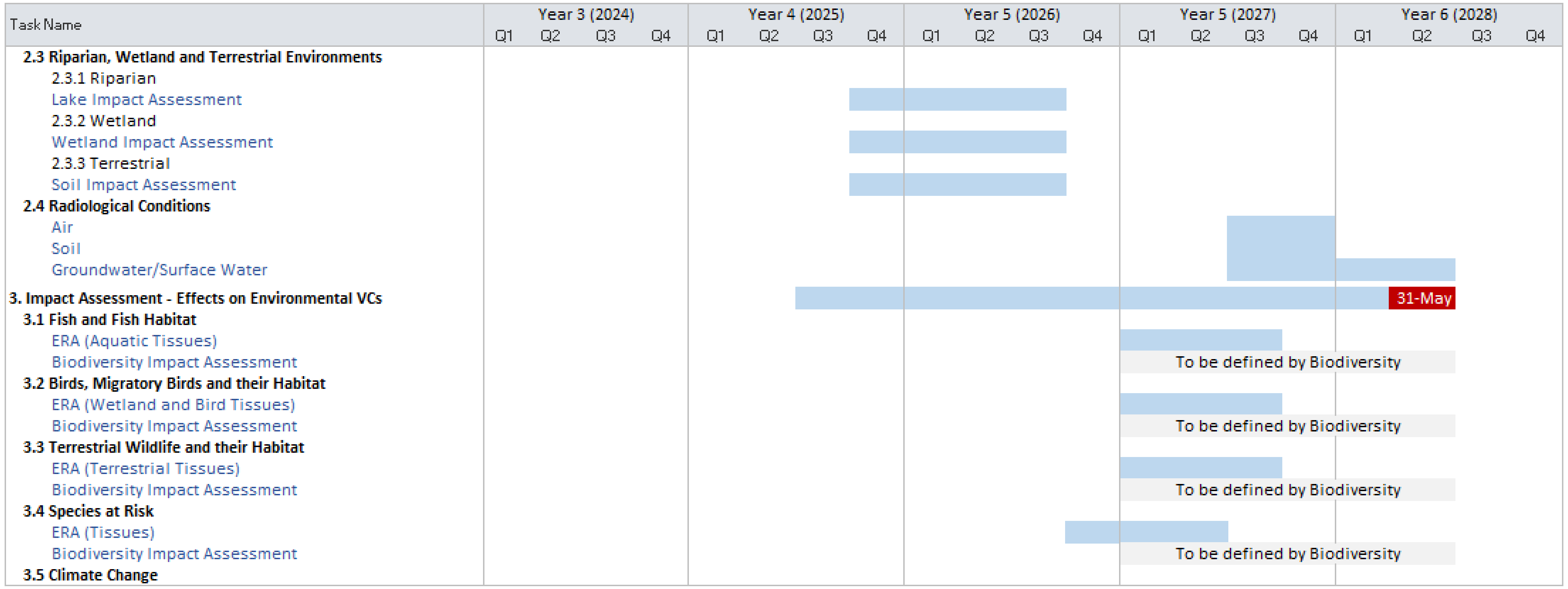
Figure 6-1 Schedule of studies in support of the Impact Assessment

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

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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

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

- Water Supply Wells: Requirements and Best Practices | Ontario.ca

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

A.3.5 Altered Site Drainage and Surface Water Runoff

A.3.6 Stormwater 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.3.7 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.3.8 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.3.9 Dewatering

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

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

A.3.10 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.3.10.1 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.3.10.2 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.3.10.3 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.3.11 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.3.12 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.3.13 Heating and Ventilation of the Project Facility

- ASHRAE standards/guidelines

A.3.14 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

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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.

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

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